Part 1:

Energy Security White Paper: Policy Directions for Inclusive and Sustainable Development for The People's Democratic Republic of Lao and the Implications for the Association of Southeast Asian Nations

This chapter should be cite as:
Phoumin, H. (2024),'Energy Security White Paper', in Phoumin, H. and A.Phongsavath (eds.), *Energy Security White Paper:Policy Directions for Inclusive and Sustainable Development for Lao PDR and the Implications for ASEAN.* Jakarta: ERIA, pp. 2-40.

1. Overview of Energy Policy Directions

The People's Democratic Republic of Lao (Lao PDR) along with the rest of the Association of Southeast Asian Nations (ASEAN) has pledged to comply with the goals to cut carbon dioxide (CO_2) emissions and find pathways to reach carbon neutrality by 2050 that are set out in the Paris Agreement. Meeting the carbon neutrality goals will require all nations to achieve large-scale reductions in greenhouse gas (GHG) emissions through fundamental transformation of energy systems — the decarbonisation of the power sector, followed by electrification or decarbonisation of energy consumption other than electricity, and offsetting the remaining CO_2 emissions using negative-emission technologies. However, the availability of power systems or low-carbon energy and the possibility of using alternative energy varies significantly across countries and regions, and energy transition cannot be accomplished uniformly. While numerous opportunities exist to reduce emissions in the ASEAN and East Asia region to meet the carbon neutrality targets by 2050, the transition to carbon neutrality must safeguard energy supplies against this backdrop, recognising that some cannot leap suddenly to renewable energy due to economic constraints and their inability to pay the huge costs of decarbonisation.

Lao PDR's energy primarily comes from coal, oil, hydropower, and other sources, including biomass, solar, and electricity for export. The energy supply of Lao PDR is predicted to double from 6.29 million tonnes of oil equivalent (Mtoe) in 2020 to 12.78 Mtoe in 2030, and it will triple by 2050 (18.57 Mtoe). Combined coal and oil constituted the largest share (60%) of the total supply in 2017. However, coal and oil combined are expected to reduce to about 20% by 2050 in the carbon neutrality scenario (CN2050). Hydro, solar, wind, and biomass have large potential in Lao PDR. They could allow the country to maximise its electricity net export on the ASEAN grid with the following expected capacity and schedule: 45 terawatt-hours (TWh) by 2030; 73 TWh by 2040; and 161 TWh by 2050. Renewable energy such as hydropower, solar photovoltaic, wind, and biomass will be the dominant fuel sources by 2050. Other clean fuels such as ammonia also play a role in decarbonising the power sector through coal/ammonia co-combustion. Electricity export could generate about $121 billion in cross revenue by 2050 – that excludes the potential from carbon credits generated from renewable carbon offsetting energy projects and the forest-reserves.

In 2024, Lao PDR is exporting electricty to neigbouring countries, but it has high import dependency (100% import of finished old products such as gasoline, diesel, and kerosene) for transportation, commercial, and residential consumption. In the medium term, import levels of these finished fuel products will continue to increase in Lao PDR, putting pressure on energy security. It is expected that there will be an increasing energy demand in Lao PDR for all sectors until 2050. This increasing energy demand poses a threat to supply security, and Lao PDR is yet to develop energy security measures to cope with unexpected supply disruption.

For end-use sectors, electricity is expected to comprise the largest share of final energy consumption by 2050. Its share is predicted to increase from a low base of 13% in 2017 to 42% by 2050 (Chapter 2). The increasing share of electricity consumption in end-use sectors will be key for decarbonisation. According to CN2050, In the final energy demand, oil and biomass will remain the dominant energy fuel sources until 2050. Lao PDR can do more to accelerate the use of electricity in transportation to reduce oil consumption. In fact, the transportation sector could embrace further acceleration of electric vehicles (EV) by 2050. Industries could also embrace the use of electricity or green hydrogen, as Lao PDR has the potential to develop substantial amounts of green electricity from hydropower, solar, wind, and biomass.

Lao PDR has a long journey ahead to decarbonise its whole energy system, as it needs to deal with the

currently operational, 1,878 megawatts (MW) Hongsa coal-fired power plant, as well as a few more fleets of coal-fired power plants in the southern part of Lao PDR that the government has already committed to building (Chapter 1). It will need to find an appropriate strategy to deal with all of them. One solution could be to use clean coal technology combined with carbon capture, utilisation, and storage (CCUS). Since Lao PDR will have clean hydrogen production, the carbon from the power plant could be used to produce the synthetic fuels for transportation uses. Lao PDR has huge potential to decarbonise the energy system if the coal-fired power plants are put into retirement by 2050 and no additional coal power plants are built, except for those that the government has already committed to. If coal continues to be used during the energy transition, it will need to be co-combusted with ammonia and be integrated with CCUS for the CN2050.

Lao PDR has a broad policy direction for the inclusive and sustainable development of its energy security. It has explored the entire energy system and produced a set of policy recommendations and suggestions to ensure that the transformation of the energy system can be financed, the technology can be transferred; the energy cost is affordable; and the human resources and capacity can be built along the required technologies.

Due to renewable resource potentials, Lao PDR and ASEAN may need to accelerate the penetration of variable renewable energy and other carbon-free technologies (hydro, geothermal, biomass, nuclear, CO_2 free hydrogen, and CCUS) and negative-emission technologies, such as forest carbon sinks. All these renewable and clean technologies should contribute to carbon neutrality by 2050 and promote sustainable economic development. However, during energy transition periods, fuel switching from coal to natural gas, deployment of more efficient turbines, and co-firing with hydrogen or ammonia all play important roles in decarbonisation and energy security. While affordable technologies will be deployed in the mid-term, more niche but expensive technologies will be required in the last stage of complete carbon neutrality, including CCUS, hydrogen, and ammonia. The cost of decarbonisation is one of the most important concerns for Lao PDR and ASEAN as it could affect their affordability. In this regard, mitigation costs must be reduced through technological innovation, large-scale deployment of low-carbon technologies, and regional and international cooperation.

While multiple pathways for decarbonisation have been agreed, there are three important steps involving technological development and transformation that could allow developing countries such as Lao PDR, as well as ASEAN as a whole, to ensure smooth energy transitions.

i. Early decarbonisation transition technologies: These technologies involve the immediate switching from coal to natural gas power generation, waste to energy power plants in the power sector, and leak detection for fugitive emission reduction upstream. These technologies can be deployed in the early phases of a country's transition pathway and may be retired before reaching net-zero emissions.
ii. Partial emissions reduction transition technologies: These technologies include the co-combustion of coal-fired power generation with biomass, or ammonia, and the co-combustion of gas-fired power generation with hydrogen fuel. The share of biomass, ammonia, and hydrogen to the power generation mix must increase over time. For the upstream sector, introducing electrification in gas production and processing is highly recommended.
iii. Deep decarbonisation transition technologies: These technologies include CCUS combined with coal/gas power generation, blue hydrogen, blue ammonia, and CCUS in gas processing. Countries must embrace technologies that involve the power sector and the end-use sector as part of their pathway to carbon neutrality.

Financing clean technologies and renewables is still one of the most critical issues in Lao PDR and

ASEAN. Striving for a circular economy may offer environmental benefits and save resources through recirculating a larger share of materials, reducing waste in production, lightweighting products and structures, and extending the lifetime of products. All these activities also offer the opportunity for new business models. In addition, digitisation will give all countries the opportunity to transform the efficiency of their economies by ensuring that all economic activities become more energy saving and more energy efficient. This could contribute to overall emission reduction and particularly a reduction in energy intensity for the economy. Lao PDR and ASEAN countries will need to undertake as much technological innovation as possible, as well as helping to integrate nature-based carbon sinks into the solutions for emission reduction.

2. Energy Supply Security

Lao PDR, being a net importer of finished oil products, acknowledges that its oil consumption has increased over the past decade, however there are no substitute fuels available to balance this increase. Its continued reliance on oil imports and petroleum products (liquefied petroleum gas (LPG) and oil) and its growing electricity consumption means that to protect its energy security, the country must begin to plan its fuel and power reserves. Lao PDR should consider two options when designing a strategic oil reserve: i) a Strategic Petroleum Reserve, which the government will establish and control and where commercial stocks remain unaffected, and ii) a Mandatory Petroleum Reserve with enforcing laws that mandate oil traders to maintain certain levels of stock.

Lao PDR may need to designate a responsible party to oversee and evaluate the risk and determine the amount of oil reserves that will be required. This may be a subcommittee or an existing department within the Ministry of Energy and Mines (MEM) or related ministries. The party should consider the establishment of an oil reserve within Lao PDR and also assess any ongoing risks, such as those related to geopolitics and the supply and demand of oil outside of Lao PDR. The task should encompass the protocols for determining the triggering point (supply disruption level or amount of time in distress) at which the government must intervene when the situation reaches a predetermined level of oil supply insecurity. In this case, Lao PDR may need to develop multiple scenarios that might influence the oil security of the country, analyse the risks associated with each scenario, and determine its probability and impact. This planning includes how action plans are formatted to manage various incidents and other emergencies that may arise in Lao PDR or its neighbouring countries that could disrupt the supply of oil imports into the country. The incidents could occur domestically; in nearby countries; or present geopolitical risks, such as the emergency closure of domestic oil terminals, an emergency shutdown of refineries in countries that supply oil, such as Thailand and others, the crisis between Israel and Hamas, or the conflict between the US and Iran. Risk analysis should be undertaken simultaneously and spontaneously to assess the likelihood of potential damage and the seriousness of the emergencies. The government can evaluate an oil shortage incident in advance and use planned countermeasures to mitigate the effects by analysing the appropriate strategic fuel reserve during a crisis or unusual circumstance. It is recommended that a qualitative risk assessment should be developed by professionals in the oil and related industries to determine the risk factors relating to the supply and demand sides, the degree of severity of the impact, and the probability of an event occurring.

Oil logistics play a crucial role in the integration of the oil supply network, significantly influencing the distribution of oil to end-users. A well-designed and functional oil logistics system helps to facilitate timely and efficient oil transport from suppliers to customers in the appropriate quantity and at the proper time. If oil logistics are not operating at maximum efficiency, they can have a negative effect and seriously harm both the country's transportation system and its economy. Within the oil supply chain, oil logistics plays a pivotal role in enabling the nation to adapt to changes in the global economy. It is recommended that Lao PDR investigate ways to enhance the oil supply logistics system to improve the security of the oil supply, as oil logistics play a critical role in supporting the oil security system. It is also recommended that Lao PDR begin the analysis immediately by compiling information on the tankage facilities (tank capacities and fuel services) across Lao PDR's provinces and regions and compares the tankage capacity with the local demand. It should be noted that the scope of this exercise could be expanded to include monitoring the effects of seasonal variations in demand. Moreover, tankage-to-consumption ratios should be examined to ascertain the optimal ratio for every area. Lao PDR should determine the proper ratio or index for major cities and rural provinces, then design the corresponding facilities to ensure the quantity of reserves and storage meets demand. Lao PDR could also consider constructing an integrated oil logistics network or an oil hub to connect its oil terminals to the pipeline system in the northern region of Thailand to facilitate the oil distribution from Thailand to Lao PDR for a quick supply in an emergency, The oil supply could then be redistributed to the remaining regions of Lao PDR.

Those looking for better fuel for their homes are increasingly adopting LPG in residential settings to replace biomass. LPG can be the preferred choice because it offers a superior heating solution in many applications. It generates consistent heat as opposed to burning biomass, which is also less convenient, Because it is convenient and clean, LPG has become the standard fuel in the industrial sector. Monitoring of LPG consumption in the country should be a priority, considering that LPG consumption has been rising over the past few years and this is a trend that is continuing. It should be noted, however, that the reserves of LPG and oil do not always have to be the same due to their differing types of use. LPG is primarily used in the residential sector, whereas oil is primarily used in the transportation sector. Lao PDR should also consider the fact that, unlike LPG users in households who have options and may choose to switch back to biomass in the event of a shortage, oil consumers in the transportation sector lack alternative fuel sources as a backup. In contrast, most industrial plants have backup alternative fuel sources. Therefore, it is important to consider potential differences in the urgency of demand use when determining the rate of reserve for LPG versus oil.

It is recommended that the following specific procedures be designed to enable the petroleum reserve design strategy for Lao PDR to be conducted:

i. evaluate the reserve alternatives and their pros and cons;
ii. delegate a responsible party to oversee and evaluate the risk and determine the amount of oil reserves required;
iii. plan for a variety of scenarios that could impact Lao PDR's oil security;
iv. conduct a risk analysis of each scenario and assess its impact and likelihood of occurring;
v. calculate the quantity of oil to be reserved for emergencies in terms of percentages of monthly oil consumption or the number of days Lao PDR must maintain oil in storage;
vi. design the logistics system to keep the oil reserve in secure locations ready to be further distributed to support the whole oil system in Lao PDR; and
vii. apply this systematic approach to electricity and other electricity dependent sectors, such as EVs if the need arises.

3. Resilient Power Systems and Power Market

3.1. Grids and Mini Grids

Countries and companies are currently facing a volatile, uncertain, and rapidly evolving global energy landscape. Meeting the growing demand for electricity while pursuing GHG emission reductions in ASEAN will require huge investments in power generation capacity from decarbonisation strategies such as renewable energy and power system expansion. To address these challenges, it is necessary to implement a range of mechanisms and technologies, and from a grid perspective, it is believed that one of the keys is the development of multilateral power trading in ASEAN, known as the ASEAN Power Grid. Multilateral power trading focuses on optimising resources on a regional, rather than a national, basis to meet electricity demand across the region at the lowest possible cost. Potential benefits of multilateral power trading are:

i. more efficient use of the region's energy resources, leading to lower overall production costs in the ASEAN Power Grid, as optimal investments can be made at the regional level, rather than suboptimal solutions in each country;
ii. assistance for utilities in the region to balance their excess supply and demand, improve access to energy services, and reduce the cost of developing energy infrastructure;
iii. increased development and integration of renewable energy capacity into the regional grid; and
iv. reduced need for investment in power reserves to meet peak demand, thereby reducing operating costs and system losses, while achieving more reliable supply.

There have been significant, albeit slow, developments within ASEAN to increase regional trade based on bilateral agreements and to use existing infrastructure to move electricity throughout the subregion. However, there is still a long way to go before a fully-fledged ASEAN regional electricity market is established. One of the reasons for the slow progress is the variety of power sector structures and markets across ASEAN, which creates problems and barriers at all levels of cooperation. To address this issue, there is a need to accelerate close discussions amongst ASEAN-related sectoral energy bodies to establish a regional regulatory framework and technical standards. This should include institutional arrangements with clearly defined roles, responsibilities, and coordination mechanisms (including regional institutions); a comprehensive vision for decarbonisation that highlights the multiple benefits of multilateral power trading; and an identification of minimum technical requirements.

While aiming to develop an efficient power supply system between national grids by promoting multilateral power trading, it should be noted that there are still areas with no or low electrification in the islands and remote areas of the ASEAN region. In such areas, it is often unprofitable to connect to a large grid such as a national grid due to the cost of installing mountain and undersea transmission lines. As a result, small-scale diesel generation systems are popular, but diesel generation is also expensive and has a high environmental impact. Therefore, the introduction of renewable energy is expected, and when the cost of batteries becomes affordable, a combined battery/renewable energy system is expected to

complement the intermittency of renewable energy, thereby reducing reliance on diesel generation. In a future phase, replacing existing diesel generators with power generation systems fuelled by liquefied natural gas, biofuels, and blue or green hydrogen would also be an effective approach. As they have a lower environmental impact than diesel generation, it is expected that their introduction will be promoted in areas where it is feasible to do so, considering profitability.

There is a growing need to adopt the emerging new technologies. The shift to cleaner energy requires smarter grids to manage the variability of renewables and to integrate distributed energy resources. For example, smart grid technologies such as real-time monitoring, data analytics, and advanced control systems will improve grid stability and enable efficient integration of variable renewable energy sources such as solar and wind. Artificial intelligence also plays a crucial role in this evolution, enhancing smart grids with predictive analytics for demand forecasting, fault detection, and optimised grid operation. In addition, an energy management system (EMS) combined with batteries and other energy storage solutions, are becoming essential to balance supply and demand and improve grid resilience. This confluence of innovative technologies can be an enabler, paving the way for a more decentralised, intelligent, and sustainable energy future.

3.2 Development of Renewable Energy Power Plants

In addition to hydropower plants, there is a need to develop renewable energy sources such as solar and wind power plants in sufficient quantity and efficiency to ensure power supply capacity for domestic demand and to meet the needs of neighbouring countries. Lao PDR's development plan aims to diversify its power sources for domestic supply by developing hydropower, coal-fired power, and other renewable energies. Although coal-fired power generation makes use of home-grown coal, the country must proceed cautiously with its development in the future due to its carbon-neutral orientation and the difficulty of financing it. In addition, the cost of wind and solar power generation has been decreasing in recent years thanks to their global spread, and if the energy can be utilised without waste and the output fluctuations and characteristics of the electricity system can be well controlled, wind and solar power can be an alternative to coal-fired power plants. For this reason, it is expected that Lao PDR will shift its policy emphasis to the development of renewable energy sources such as hydropower, solar, and wind power as a source of energy in the country.

These renewable energy sources also have carbon-neutral value and are in high demand from neighbouring countries, where thermal power plants still account for a large share of the electrical energy supply. Renewable energy exports can make the region carbon neutral, improve the security of the energy supply, and increase its efficiency of supply. Monetising the export production of surplus renewable energy is also important for Lao PDR. In addition to optimising electricity export contracts, measures to develop a certification system for renewable energy, and to promote sales to neighbouring countries should also be considered. The Government of Lao PDR needs to develop a comprehensive plan for hydropower, solar, and wind, and their power systems, including both domestic supply and exports, with priorities, implementation plans, processes, and indicative funding and cost-sharing.

3.3 Integration of the Electricity System for Domestic Supply and the Electricity System Dedicated to Export

To effectively supply electricity generated in Lao PDR for domestic demand and to export to neighbouring countries without any surplus, the power system for domestic supply will be integrated and operated with a dedicated transmission line for export. The integration of the power systems will enable the transmission of electricity from the power producers to both domestic users and neighbouring countries. The domestic grid and the transmission lines of the export-only power producers will operate as an integrated unit, and the power producers will sell their electricity on the integrated power system.

To promote the integration of power grids and the strengthening of wide-area transmission networks that are interconnected with neighbouring countries, guidelines should be developed for the planning process and the selection of the entities to implement the transmission line projects. When integrating power systems for domestic supply and those dedicated to export, a transmission system operator is required to coordinate the power supply from the producer to both the domestic market and the export supply in neighbouring countries.

If a market is created, a wide range of grid operations tasks should be carried out, from balancing supply and demand based on the amount of electricity traded on the market, to responding to accidents. Transmission system operators could identify the required power system facilities and participate in, or lead in, the formulation of transmission network plans. It is essential to optimise the planning process and to develop a grid code to operate, plan, and build an efficient, integrated, renewable energy power system with a high degree of supply reliability and with domestic and international interconnected lines. For renewable energies, studies should be carried out on the adjustment of output fluctuations due to weather and seasonal changes, and on the standards and control of inverter equipment used for grid connection and its operational methods. The findings should be reflected in grid codes, guidelines, and manuals.

3.4 Development of Market Mechanisms

When integrating a power system for domestic supply and a power system exclusively for export, there are two possible forms of power sales contracts that the power producer can conclude: either the power producer sells power to both the domestic electricity provider, Électricité du Laos (Electricity of Lao PDR) (EDL), and the electricity provider in the neighbouring country; or the power producer sells power to a single organisation, Single Buyer, which in turn sells power to EDL and the electricity provider in the neighbouring country. In the first case, there are examples of power generators in areas with well-developed international electricity markets, such as the European Union and North America, Here, countries sell electricity to their own domestic markets as well as exporting it across borders to other countries. As the network expands from Lao PDR to neighbouring countries, this approach is likely to require an organisation to manage the intraregional market operator and export process, as multiple power generators will be selling electricity not only to their own country, but also to neighbouring countries. If the integrated system develops into a market with multiple power producers, cooperation between market participant entities and cooperation with neighbouring countries will be essential to ensure the smooth operation of the market, including agreement on the intramarket pricing mechanism, securing priority for domestic electricity supply, and managing the intraregional electricity market and international interconnection lines.

In addition to long-term contracts between two parties, there are several other market formats, ranging from contracting for delivery some time in advance, such as in the day-ahead market, to spot markets where the seller and buyer each identify and contract with the other party in real time through a price mechanism. However, to ensure reliability in grid operation, it is preferable to proceed from a long-term contract between two parties where the amount of supply is determined some time in advance, or from a contract with a large day-ahead market. This could be applied in Lao PDR by starting with small-scale transactions in one area or with one power producer, and then gradually expanding the scope of application.

When considering the Single Buyer scenario, there are examples of EDL purchasing electricity from power producers in the south and exporting it to Cambodia[1]. It is conceivable that the EDL could expand and apply the scope of its exports in this way, but the scale of electricity it manages would be several times larger than that of the domestic electricity sales, which would be considered too risky given the scale of the EDL's operations. Considerable capital and funding would be required. Therefore, as the scale increases, it is expected that the role of Single Buyer will be taken up by another entity that can control more funds.

[1] The EDL and Electricite du Cambodge (Electricity of Cambodia) have an agreement to export electricity from Lao PDR; the contract between the EDL and the Electricity Generating Authority of Thailand (EGAT) provides for the flexible exchange of electricity between them.

4. Sustainable Transportation Systems

Transitioning to a sustainable transport system in Lao PDR has the potential to not only reduce CO_2 emission levels but also improve energy security and economic impacts. Lao PDR aims to achieve a 30% EV share by 2030, with supporting factors such as abundant hydropower, technological adaptability, and international collaboration, including proximity to China's EV industry. However, challenges include low infrastructure development, limited financing schemes and technical resources, and policy and regulation gaps. Although developing EV is crucial, transitioning towards sustainable transport may need to go beyond EV only. Other alternatives are biofuel development, public transport improvements, intercity rail enhancements, and logistics and distribution centre advancements. To achieve a sustainable transport system in Lao PDR, the country should develop a series of implementation programmes and policies over a short, medium, and long timeframe.

4.1. Short-Term Plan (2–5 Years)

i. EV acceleration strategies:
   - *Provide regulatory frameworks specifically for EV.*
     Policies such as incentives, standardisation, charging tariff, charging infrastructure, and vehicle registration should be created to increase the attractiveness of EVs, both on the demand and supply side.
   - *Expand EV-use in public transport i.e. electric buses, electric minibuses, or electric minivans.*
     Incentives should be provided to private companies willing to invest in EV public transport, to enable those in suburban areas (mainly on low incomes) to access public services in the urban areas or urban centres.
   - *Prioritise electric motorcycles for private EVs.*
     Motorcycles constitute a more affordable mode of private vehicle than cars. They also make up a higher share of private vehicles overall.

ii. Biofuel development:
   - *Incentivise private sectors willing to implement biofuel production on an industrial scale.*
     Fiscal incentives may be provided to increase the attractiveness and profitability of the biofuel business. Other non-fiscal support may be provided such as training and capacity building for smaller scale business in rural areas.

iii. Public transport improvement:
   - *Renew old bus fleets.*
     Inefficient, high-CO_2 emitting bus fleets should be replaced with newer fleets to improve the reliability of the whole bus transport system.
   - *Improve transit system governance.*
     The efficiency, punctuality, reliability, and convenience of the current bus transit system should be improved.

iv. Intercity passenger and freight rail development:
   - *Develop new special economic zones (SEZs) in regions along the railway systems.*
     This will accelerate the economic impact of the rail network and will attract new opportunities to the country.

v. Domestic fuel price adjustment:
   - Adjust domestic gasoline/diesel price to reflect international oil prices.
     Strategically reducing subsidies will lessens the dependency on oil consumption and make transition to EVs, or alternative transport modes other than private vehicles with internal combustion engines, more appealing. However, it will need to be done carefully to avoid a big impact on the economy.

vi. Transportation systems integration and intramodality:
   - *Integrate different modes of transportation to establish a smooth and uninterrupted travel experience for all.*
     The availability of multimodal hubs will facilitate seamless transfers between trains, buses, and other transportation modes.

vii. Sustainable tourism development:
   - *Implement regulations and incentives to encourage sustainable practices in the tourism industry.*
     This could include the use of eco-friendly transport options, such as bicycles, electric scooters, and walking paths within tourist destinations.

viii. Community engagement development:
   - *Engage with local communities in transportation planning and decision-making processes.*
     The aim would be to effectively address community needs and align with their priorities and preferences.

4.2. Medium-Term Plan (5–10 Years)

i. Electric vehicle industries development:
   - *Prepare an area for the EV industry in a SEZ.*
     Providing a specific area for EV industry will attract investments. Situating a SEZ near Lao–China Railway (LCR) would be ideal, given the connectivity with China, which will secure the supply chain of components.
   - *Create a transfer of technology policy for foreign investors.*
     The policy will stimulate the development of the domestic EV industry and accelerate research and development (R&D) with smaller state budget spending.

ii. Biofuel Development:
   - *Ensure integration of the biofuel market with the international supply chain.*
     Ensuring the international market for biofuel products will increase profitability for local businesses. However, certain policies will be required to ensure domestic demand is securely provided.

iii. Intercity passenger and freight development:
- *Develop new logistic hubs near LCR and SEZs.*
  New logistic hubs will improve freight transport coverage as well as increase economic activity in regions close to LCR, especially in SEZs.
- *Modernise the cargo transport sector in Lao PDR.*
  This will include the increased functional integration of supply chains and the growing role of distribution centres.

iv. Public transport expansion:
- *Expand urban public transport systems in other emerging cities.*

v. Logistics and distribution centres development:
- *Open the country to integrate to the global supply chain.*
  Lao PDR should start unlocking its market and distribution potential by developing a more geographically integrated system, not only at national level but also at a broader regional level. While the country may not currently be the main destination or origin of the commodities trade, it needs to explore its potential as an intermediate location in the regional distribution network. This will be fundamental to the geography of freight circulation as Lao PDR provides connectivity between corridors of circulation in the region. With this involvement in the global supply chain, the internal logistics and distribution centres of Lao PDR should be developed. This, in turn will bring the local production centres into the network.
- *Improve integration between transport and inventory control through the promotion of major coordinators and integrators (logistics providers) in the logistics industry.*
  Freight distribution in Lao PDR should start to shift from the paradigm of inventory-based to replenishment-based logistics where manufacturers will play a dominant role in matching the commodity demand by taking advantage of more integrated and efficient suppliers, manufacturers, and distributors.

4.3. Long-Term Plan (10–20 Years)

i. Railway expansion across the country:
- *Enhance connectivity between different regions of Lao PDR.*
  This will boost cross-border commerce, promote regional integration, and strengthen Lao PDR's position as transit hub. Expansion should be focused on connecting the southern part of Lao PDR.

ii. EV development with a focus on accessibility and low-cost travel:
- *Expand public transport services through development of EVs.*
  Electric buses, electric minibuses, or electric vans should be used to enable people in suburban areas, mostly those on low incomes, to access public services in urban centres.
- *Provide fiscal and non-fiscal facilities for private sector development of EV public transport, including the development of the charging infrastructure and systems.*
  If EVs are introduced as private vehicles, then priority should be given to electric motorcycles that constitute a more affordable private vehicle than cars.

iii. Logistic and distribution centre development:
- *Integrate functionality into supply chains.*
  After an initial short-term period where supply and logistics chains in Lao PDR have become more integrated, in the longer term, a more functional integration should be achieved. This should include the emergence of large logistics operators that control many segments of the supply chain, developed economies of scale in distribution supported by advanced information technology, and intermodal transport integration.
- *Develop distribution centres that provide a more fundamental link between production and consumption.*
  In this phase, distribution centres should provide an interface between the industrial and retail geographies of the supply chain concerned. Distribution centres can then perform numerous value-added activities, ranging from simple tasks, such as warehousing, packaging, and labelling, to complex processes, such as providing some level of final assembly and taking returns.

5. Securing Affordable Energy for the Growing Industrial, Commercial, and Residential Sectors

Access to affordable energy is vital for the economy and wellbeing of the people of Lao PDR and is crucial for promoting economic growth across all sectors (industrial, commercial, and residential). However, reliance on heavy subsidies can lead to economic losses and put pressure on government budgets. The current energy price setting (especially the electricity tariff) has several challenges. First, electricity price setting does not follow a market-based approach. It relies on government policies to provide cheap energy for the residential and private sectors to improve livelihoods and industrial development. As a result, electricity prices in Lao PDR are lower than those in other ASEAN countries. Second, price setting is not based on supply and demand. There is an overproduction of electricity during the rainy season and an underproduction during the dry season. More than 80% of Lao PDR's electricity for domestic use comes from hydropower plants and some electricity power plants do not have the necessary reservoirs to store water for the dry season. Because EDL needs to buy electricity from the Electricity Generating Authority of Thailand (EGAT) at high prices during the dry season, it is important to set the price based on the market approach. EDL purchases electricity from the Independent Power Producers (IPPs) and others at high prices, but then sells the electricity (especially for the residential sectors) at low prices. To sell at the low prices set by the Government of Lao PDR and enforced by the MEM, EDL must subsidise the electricity to its consumers, leading to financial difficulties for the company that creates debts and deficits. To provide a reliable and cost-effective electricity supply, Lao PDR should consider the following key recommendations:

i. Electricity prices should be calculated on a market-based approach. As mentioned above, electricity prices in Lao PDR are lower than in other ASEAN countries. Electricity tariffs should be restructured to cover costs and to be based on supply and demand that incorporates seasonal adjustment for the rainy season and dry season. On average, EDL has purchased electricity from IPPs at around $0.62/kilowatt hour (kWh). In 2023, approximately 11.5 billion kWh was purchased for domestic electricity and in 2024, the figure was around 14 billion kWh. EDL must subsidise approximately $0.04–$0.05 cents/kWh, which is estimated to equate to $500–$600 million in 2024.
ii. Electricity sources should be secured during the dry season. Exploring and promoting more solar, wind, and biomass energy is crucial and an effective approach is to develop solar energy in the reservoirs of hydropower plants. Negotiations with IPPs and EGAT on purchasing price settings and price adjustments for electricity are necessary. The IPPs need to lower prices during the dry season. Without implementing changes now, the electricity prices will gradually increase in the medium- and long-term.
iii. The electricity system should be improved. This can be achieved through reducing electricity loss and promoting energy efficiency and conservation (EEC). The existing electricity infrastructure is inefficient, leading to high distribution losses in the national power grid between 2014 and 2024. The average electricity loss was 13% in 2014, 8.80% in 2022, and 6.8% in 2023.Although efficiency figures are improving, the process must be accelerated to secure the energy supply.
iv. There should be greater flexibility to negotiate with IPPs to use electricity to meet the growing domestic demand and to charge affordable prices. At present, more than 90% of the electricity from IPP hydropower projects is exported. It is crucial for EDL to have flexibility to negotiate with IPPs to meet the domestic demand.
v. Energy subsidies should be overhauled and targeted to groups that need energy for their basic needs, such as cooking, lighting, and transportation. The electricity price reform should fulfil the following requirements:
    - *Transparency*. The government should publicise the gradual removal of electricity subsidies. Transparency will help to garner public support during the reform process. Public campaigns and education outreach will be needed to clearly show how energy subsidies impact welfare, discourage investment, and reduce competition.
    - *Consistency*. Well-established programmes to monitor progress and mitigate any negative impacts will be needed. Reporting, monitoring, and disseminating information on the reform process with clear timeframes, sector-by-sector, will allow all stakeholders to envisage the costs they and their businesses will incur in the future. This will ensure greater success for the reform programme. The reform process will benefit welfare, investments, and future growth, so government strategies need to build on these arguments and facts to show the public the benefits in a transparent and timely manner.
    - *Policy support*. Policy support and investment in efficient technologies, including environmental technologies, are key to promoting competitiveness due to lower energy consumption and higher savings.

6. Energy Efficiency in End-Use Sectors

EEC implementation will bring about multiple benefits to Lao PDR such as enhancing energy security; improving the affordability of, and access to, the energy supply; supporting economic growth; and contributing towards decarbonisation and climate change mitigation. Policy directions for immediate- and long-term planning and implementation of energy efficiency strategies and programmes have been identified to be a prudent measure for achieving energy security and sustainable development for Lao PDR. However, the journey to implementing the EEC implementation plan must commence with a government directive, i.e. a top-down approach, while the EEC implementation programmes listed below will constitute a bottom-up approach. Therefore, it is recommended that the implementation programmes for accelerating EEC agenda in Lao PDR are executed in two stages as set out below.

6.1 Short-Term Plan within 2–3 Years from the Start of the Energy Efficiency and Conservation Implementation Plan

i. *Establish an implementing agency/department for the implementation plan:*
   - This agency/department is empowered with authority, manpower, and financial resources to implement, collect energy data, monitor and analyse energy performance, disseminate information, promote EEC activities, and provide guidance to end-use sectors.
   - It will be responsible to execute other EEC programmes listed below.

ii. *Execute the EEC programmes: EEC programmes to be developed will comprise the following:*
   - EEC guidelines to be developed and published for commercial and industrial sectors. These include:
     - EnMS: Procedural guides will establish an EnMS that is based on a systematic Plan-Do-Check-Act concept. EnMS should also include guides on best practices in maintenance to achieve energy efficiency.
     - Decarbonisation: EEC implantation will contribute significantly to carbon emission reduction and decarbonisation.
     - Computation of energy efficiency indicators and establishment of benchmarking for respective commercial and industrial sub-sectors.
     - Digitalisation: Application of state-of-the-art digital technologies will enable greater control, flexibility, optimisation, and savings in equipment capital investments due to energy optimisation, and energy-efficient plant operation.
     - Categories of EEC measures, i.e. low, medium, and high investment initiatives.
     - Passive and active design measures for the commercial building sector.
     - Significant Energy Users complete and specific energy consumption and guides on best practices in selection, optimisation, design, installation, testing and commissioning, and operation and maintenance.

- Energy efficiency indicators, e.g. Building Energy Intensity for the commercial building sector, and Energy Use Intensity for the industrial sector with statistical benchmarking values to be established.
- Implementation of energy saving measures for industrial and commercial building sectors with the establishment and participation of Energy Services Companies (ESCO).
- Minimum Energy Performance Standard (MEPS) for energy-efficient electrical appliances and equipment which are primarily used in the residential sector. Some of these appliances and equipment are also used in other sectors.

iii. *Develop and implement EEC partnering programmes*: The partnering programme is a consultative programme which is designed to involve pre-identified stakeholder organisations, such as industrial and commercial subsector associations, professional bodies, academia, research institutions, and other government departments. The objectives of the partnering programme are:
- to obtain stakeholders' input for greater effectiveness and coverage of EEC programmes;
- to facilitate the dissemination of information about EEC programmes; and
- to improve the stakeholders' 'buy-in' process and gain immediate nationwide acceptance and participation of EEC programmes.

iv. *Develop and implement capacity building programmes*: Capacity building is an important part of the EEC implementation. Expertise and resources within ASEAN should be sourced to provide assistance, guidance and to expedite the programme. The development and implementation of capacity building should cover the following areas:
- Immediate measures:
  - professional training courses at elementary, intermediate, and advanced levels, for the development of expertise and skills in energy efficient design, systems operation and energy management, and energy audits;
  - continuous professional development to update participants on latest developments and practices; and
  - awareness campaigns through roadshows, seminars, workshops, social media, and other publicity drives.
- Long-term measure
  - Educational curricula for high schools and universities.

6.2 Long-Term Plans within 4–5 Years from the Start of the Energy Efficiency and Conservation Implementation

If Lao PDR were to embark on a programme to accelerate the uptake of EEC measures in line with the Joint Ministerial Statement declared at the 41st ASEAN Ministers of Energy Meeting in 2023, it would become necessary to establish an EEC legislative framework The development and enactment of a legislative framework will take time, but it will enable Lao PDR to accelerate the EEC programmes as part of the country's sustainable development policy.

The requirements given in EEC programmes will become mandatory for large consumers who exceed a predetermined yearly threshold value of energy consumption in industrial and commercial building sectors, and this threshold value of yearly energy consumption will be defined in Lao PDR's EEC laws. The laws will also stipulate compliance requirements and penalties for repeated non-compliance.

Once an EEC legislative framework is established, manpower resources to enforce EEC legislative requirements will need to increase. This increase will include more skilled manpower resources in commercial and industrial sectors to be available and ready for EEC implementation.

By implementing policy direction to implement EEC plans as soon as possible, Lao PDR will be in the best position to develop and establish an EEC legislative framework for the country's long-term sustainable energy plan.

7. Energy Management and Energy Service Companies

To reap the vast potential of energy savings through the implementation of efficient EnMs and ESCOs and taking into consideration the lengthy gestation period needed to develop effective national policies, it is recommended that policies be implemented from year one (short-term policies), year three (medium-term policies), and year four (long-term policies).

7.1. Short-Term Policies

i. *Issue a special order or ministerial directive to implement EnMS*: The directive will compel all government buildings, institutional buildings, government-owned manufacturing plants, and installations consuming more than 500,000 kWh per month of electricity, to implement EnMs. Private sector buildings consuming similar thresholds may be requested to comply with this directive.

ii. *Fast-track registration of ESCOs*: This fast-track registration scheme will be available to local engineering consultancy companies, practicing engineers and architects who have experience in providing energy services locally and/or working with Registered Foreign Professional Engineers, or registered ESCOs from any of the ASEAN economies on transfer of energy efficiency (EE) knowledge. This policy allows Lao PDR to register an initial pool of ESCOs and the corresponding professionals to conduct energy audits, EE consultancy, buildings or facilities retrofitting, and Energy Performance Contract (EPC) services.

iii. *Implement a national demonstration project*. A government-owned buildings or factory that has high energy consumption should be chosen to trial an EE demonstration project to be implemented by the maintenance staff of the building and a registered ESCO. The scope of works for the demonstration

project should include: i) an energy Investment Grade Audit; iii) implementation of energy saving practices that range from no-cost to high-cost measures; iii) implementation of medium- and high-cost measures with either an EPC Shared Saving Model or the EPC Guaranteed Saving Model; and iv) implementation of an EnMS. The project should run for 2 to 3 years with a monthly energy performance report being sent to MEM.

iv. *Build the capacity of energy efficiency professionals through structured training*: A Strengths, Weaknesses, Opportunities, and Threats analysis identified one of the areas of weaknesses in Lao PDR's energy management structure as the low capacity of the EE professionals who are the energy auditors, energy managers, and measurement and verification professionals. Since it is these professionals who will support the effective implementation of the EnMS and the long-term national plans for EEC, it is vital that they are given effective, structured training to achieve this.

v. *Promote EEC nationally through a communication plan*: Awareness of EEC is crucial to lower maximum demand and final energy use and to achieve a slower increase in energy supply and installed capacity. The communication plan should cut across all sectors, including industrial, commercial, residential, agricultural, and other non-energy use sectors. Stakeholder engagement seminars and workshops are necessary to impart information about EEC. There should be a focus on educating the public on EEC and energy conservation through simple acts, such as switching off unused equipment (lights, TVs, air-conditioners, etc) rather than leaving them on standby mode, which is a waste of energy. The promotion and awareness campaigns should achieve behavioural and mindset change.

7.2. Medium- to Long-Term Policies

One of Lao PDR's key EEC policies will be the eventual enactment of a holistic, national EEC decree or legislation and the subsidiary legislation to support it. As with other ASEAN nations, the process of developing the act takes considerable time. The following are the recommended medium- to long-term policy areas that should be covered:

i. *Legislate a national EEC act*: The act shall have the following provisions:
   - prescribed premises relating EE to the industrial, commercial, and residential sectors;
   - prescribed energy-using products;
   - operational requirements for prescribed premises to implement EnMS and conduct energy audits;
   - establishment of a national implementation agency under MEM;
   - registration of ESCOs, energy managers, energy auditors, and training providers;
   - provision of a sustainable EE funding mechanism.
   - information gathering power and enforcement provisions; and
   - general provisions such as publication of information, the power of ministers to make regulations, and the power of authorities to make rules and issue guidelines.

ii. *Legislate EEC regulations*: While the EEC act stipulates broad provisions through laws for EEC, regulations are required to cater for the dynamic changes to the ecosystems of EEC such as lowering the threshold of prescribed premises to capture more energy consumers and others. The regulation shall include the following key provisions:

- an obligation to submit information on EnMS;
- qualification requirements for EE professionals;
- a certificate of registration;
- a description of the function and duties of ESCO and EE professionals;
- the fee structure for ESCO and EE professionals;
- the type of report for EnMS; and
- a declaration by registered EE professionals.

iii. Equip the implementation agency: The main functions of the implementation agency as empowered by the proposed act shall be to i) effectively coordinate with prescribed premises and to collaborate with government agencies and other bodies to recognise and utilise existing resources and infrastructure; and ii) to perform such functions and exercise such powers as may be assigned to it. The functions and powers include to:
   - prescribe measures including guidelines for factories;
   - prescribe measures including guidelines for buildings;
   - register ESCO and EE professionals;
   - prescribe measures including guidelines for energy-using equipment;
   - promote measures for consumers;
   - prescribe common measures including to disseminate financial assistance and incentives;
   - create data and information repository centre; and
   - create regional offices.

   The existing EE department of MEM can be expanded into a national implementation agency with adequate human, technical, technological, and financial resources to effectively manage all provisions of the EE act and regulations.

iv. *Establish a sustainable funding mechanism*: The success of any project depends on timeliness and adequate financial resources to meet the yearly budget requirements. The mechanism should, amongst other things, be independent of the fiscal budget and sufficiently sustainable to meet the operational budget of the implementation agency, the expenditure of EE campaigns, and the incentives to implement high-cost energy saving measures.

v. *Enhance capacity building through structured training*: With growth in gross domestic product (GDP) and population in the near future, it is inevitable that final energy demand will increase. But it is hoped that with effective implementation of an EE legislative framework, an EnMS, and the competent work of ESCO, the final energy demand will decouple from the business-as-usual scenario. There will be a growing need for EE professionals to support implementation of the act and the regulations and it is worth noting that capacity building of ESCO and EE professionals is a process of nurturing and takes time. The following are some proposed courses to be conducted for capacity building of ESCO and EE professionals to achieve this goal:
   - ISO 50001 EnMS;
   - energy audit processes;
   - measurement and verification;
   - EPC mechanisms: the Guaranteed and Shared Saving Models;
   - registration, functions, and roles of ESCO;
   - project management; and
   - energy saving measures for electrical and thermal systems.

8. Minimum Energy Performance Standards

The implementation of MEPS is expected to take a considerable amount of time due to the requirements of capacity building, the wide range of equipment and appliances available in the market, insufficient test facilities, and insufficient performance standards.

Implementation of MEPS will happen in stages, given the factors already discussed, but gives Lao PDR great potential to reduce energy consumption.

8.1. Short-Term Plan within 2–3 years of the Start of Minimum Energy Performance Standards Implementation

i. *Create EE awareness*: Lack of EE awareness prevents consumer from 'buying-in' to the concept of energy savings. An EE awareness programme should be set up to raise awareness of the importance of reducing energy consumption. The EE awareness programme could be conducted through an educational school curriculum, public road shows, and promotion through seminars and workshops.
ii. *Establish an implementing agency*: An implementing agency or department will be established to lead and execute the MEPS implementation plan. This agency or department shall develop the necessary product specifications and test procedures, manage the certification bodies, and set up the registration bodies.
iii. *Develop performance and testing standards*: This shall be conducted through a consultative programme. Stakeholders, such as professional bodies, industrial and commercial associations, academics, and research institutions whose involvement are crucial to the implementation of MEPS shall be identified and invited to join this programme.
Engagement with these stakeholders will improve the impact of targeted products related to the energy reduction objectives and will establish the EE levels that are achievable, based on manufacturers' readiness and the best available technologies.

8.2. Long-Term Plan within 4–5 Years of the Start of Minimum Energy Performance Standards Implementation

Setting up testing facilities is an important long-term element of MEPS and they are required to conduct product compliance tests.

In the absence of accredited testing laboratories, an interim measure would be to accept independent, third-party testing for EE verification. International and regional laboratories are available to ensure that testing conforms to the standards set.

9. Renewable Electricity and the Opportunity of Green Hydrogen and Ammonia

To make hydrogen a feasible alternative in ASEAN, it is imperative to implement specific policies such as subsidies, tax incentives, and international collaboration for infrastructure development. Implementing these will effectively reduce the financial disparity and improve the competitiveness of hydrogen technologies, especially during the initial phases of implementation.

Lao PDR is aggressively investigating the potential of hydrogen energy as a key component of its renewable energy plan. The country possesses a substantial capacity for renewable energy, particularly hydropower, which can be used to generate hydrogen. Lao PDR has the potential to become a significant participant in the regional hydrogen economy by exporting hydrogen generated from the country's renewable resources. The Government of Lao PDR continues to rely on the electricity sector as a major driver of growth and development and as a source of increased revenue through exports to neighbouring countries. With the huge potential of renewable energy sources, Lao PDR also has an opportunity to produce green hydrogen and ammonia from clean sources of electricity. To realise the future potential of green hydrogen and ammonia, Lao PDR may consider the following recommendations:

i. *Form a national task force* responsible for coordinating the development of the green hydrogen and ammonia industry. The task force would include government agencies, industry associations, and experts, to monitor and help implement the national strategy and action plan for green hydrogen and ammonia. The task force would facilitate policy and regulatory discussions, evaluate infrastructure development, and promote public-private partnerships.

ii. *Establish a centre of excellence* as a trusted source of data and analysis, integrate Lao PDR ministry research institutes and the National University of Lao PDR with a mandated focus on hydrogen and ammonia research development, and select a site for a hydrogen-ammonia pilot plant.

iii. *Establish a green hydrogen and ammonia industry association* to represent the interests of industry stakeholders, enabling collaboration between the public and private sectors and development partners.

iv. *Negotiate and formalise international carbon credit trading networks*, a legal and statutory property rights framework for hydrogen and ammonia carbon offsets, and tradable renewable energy certificates based on green hydrogen and ammonia production in Lao PDR. The distribution of revenue from carbon trading will need to be specified in contractual arrangements with foreign entities investing in hydrogen-ammonia production and distribution. The proposed hydrogen and ammonia association could also play an active role in negotiations.

v. *Adapt existing special economic zone tax breaks* including subsidies and import duty exemptions for hydrogen and ammonia capital goods as part of a wider push to create incentives for developing a green hydrogen and green ammonia industry.

vi. *Create strong collaborative frameworks* to accelerate the uptake of emerging hydrogen and ammonia technologies by fostering knowledge transfer, promoting economies of scale, and identifying costly mistakes and failures. Weak cooperation mechanisms can slow down the deployment of technologies in the demonstration phase by up to ten years or more.

vii. Access international *expertise* and training to support sound energy and financial analysis of hydrogen and ammonia investments and trends.

viii. Actively *collaborate with regional neighbours* to expand information sharing with Lao PDR's neighbours and to build relations with the Greater Mekong Subregion regarding hydrogen and ammonia production, safety, transport, and utilisation.

Multiple endeavours are currently in progress to foster the growth of the hydrogen industry in Lao PDR. For instance, the government is collaborating with international partners such as the Asian Development Bank (ADB) and the Global Environment Centre Foundation to develop a power-to-gas masterplan. The purpose of this strategy is to delineate the necessary procedures for implementing hydrogen production and utilisation on a large-scale, commercial level. This involves implementing regulations, infrastructure, and business plans to facilitate the growth of the hydrogen economy, as recommended by ADB and the Climate Technology Centre & Network.

In addition, Lao PDR is pursuing collaboration with EGAT, Mitsubishi, and the Government of Thailand to look into the establishment of green hydrogen and ammonia production plants. These facilities will harness the country's renewable energy potential to produce hydrogen. This programme is a component of a wider plan aimed at increasing the proportion of renewable energy sources in the energy composition mix and decreasing dependence on imported fossil fuels. Lao PDR shows significant potential to develop green hydrogen in the future, as the potential of its hydropower capacity is predicted to be approximately 26.5 GW, which is far more than its present energy requirements. The country can leverage this excess to generate hydrogen, establishing itself as a prominent player in the hydrogen supply chain.

10. Optimising Sustainable Hydropower Development on the Mekong: What Direction Should Lao PDR Take?

To navigate the challenges and fortify Lao PDR's journey towards sustainable hydropower development, four strategic actions and policy directions are suggested.

10.1. Implementation of Planned Options and Identification of New Options for Joint Investment Projects

i. Lao PDR should raise the importance of the proposed mainstream hydropower dams projects, planned along the border between Lao PDR and Thailand (i.e. Pak Chom and Ban Khoum), and develop them as national joint projects with the Government of Thailand. Both countries can then work on the pre-feasibility and feasibility stages, with the technical and facilitating support of the Mekong River Commission (MRC) Secretariat. This will ensure good quality reports and studies that illustrate clear impact assessments and mitigation measures. This pre-prior consultation engagement with the MRC Secretariat will help when it comes to the eventual submission and application of the prior consultation process within the MRC framework while both countries could jointly submit these proposed hydropower dam to the MRC.

ii. Lao PDR should solidifying the work with the MRC and other Mekong–Lancang countries to identify potential new joint investment projects in the MRC Adaptive Basin Plan. The MRC would like to formulate this with other member countries under proactive regional planning by the end 2024, with projects completed by 2027. These projects can be invested in, operated, or managed by two or more riparian countries to implement, or support the implementation of, those projects that have been identified to tackle flood and drought, optimise energy production, and secure food production for the Mekong basin and region.

10.2. Identification and Implementation of Alternative and Complementary Cost-Effective Energy/Water System Integration Options

i. The government should identify and implement projects to develop alternative renewable energy sources, such as solar and wind. Aligning with Lao PDR's energy development plans and leveraging advancements in technology, these alternative energy sources offer the potential for reduced investment and greater energy resilience, as well as saving the river environment for future generations. Embracing such diversification also addresses the pressing challenges to water security at Lao PDR's arsenal of hydropower dams, posed by climate change.

ii. Lao PDR should then identify other water-related, alternative energy infrastructure projects, such as floating solar and pumped storage hydropower development and implement the projects to supplement the energy supply available from existing hydropower projects.

10.3. Strengthening and Applying Mekong River Commission Procedures, Tools, and Guidelines

i. The government should strengthen early and effective application and use of the MRC procedures, tools, and guidelines, as well as data and studies, such as the Procedures for Notification, Prior Consultation, and Agreement (PNPCA), and the Transboundary Environmental Impact Assessment (Chapter 10). They should further the uptake of these documents into the national process of hydropower project development through dissemination to relevant line agencies (especially environmental impact assessment authorities) and companies and through targeted capacity building. Doing this will enable Lao PDR to conduct high-quality feasibility studies and reliable environmental and social impact assessments as well as proposed mitigation measures to avoid, minimise, and mitigate potential adverse impacts at both national and transboundary levels.

ii. Further work should be done to strengthen the implementation of the post-PNPCA process including the Joint Action Plan agreed at the completion of the PNPCA prior consultation process of the hydropower projects. These joint action plans are considered a mechanism for dialogue amongst the MRC Member Counties and other stakeholders, as the agreements keep them informed about the development of the submitted hydropower projects. Improvements in the implementation of the joint action plans will demonstrate Lao PDR's commitment to transparency and openness and its willingness to cooperate. In return, Lao PDR will win more trust and support for its future hydropower developments.

10.4. Working towards Coordinated Water Infrastructure Operation and Communication in Mekong River Basin for Multiple Benefits Including Disaster Mitigation and Management

i. It is important to further the work on national regulations and platforms to establish dam coordination and management centres to facilitate data and information sharing amongst the different dam operators. Good data and information sharing is crucial, considering that dams in the region are operated by many different operators. A coordination and monitoring centre could help support such coordinated operation and management for energy (and water) optimisation, as well as backup disaster mitigation and management efforts. The centre could be hosted by MEM with active participation of the Ministry of Natural Resources and Environment (MONRE) and connection to the MRC.

ii. There should be a focus on working under the MRC platform to share the operational data relating to the hydropower dams amongst MRC member countries and other basin countries to improve data, share information, and increase transboundary coordination in the basin regarding management of flow, sediment, and emergency procedures.

11. Voluntary Carbon Markets and Mechanisms

The following are the policy directions and recommendations for the development of carbon market initiatives in Lao PDR's energy sector.

11.1. Aligning the Policy Objectives of Carbon Markets Initiatives

Policymakers in Lao PDR need to establish objectives and prioritise the roles of carbon markets and crediting. This step is crucial to shape the ecosystem of the carbon market in the country and its participation in the international voluntary carbon market (VCM). Potential policy objectives are set out below.

i. Reduce GHG Emissions and contribute to meeting NDC Targets
A domestic crediting mechanism not only assists in GHG emissions abatement but also contributes to Lao PDR's Nationally Determined Contribution (NDC) targets. However, international cooperation under Article 6 of the Paris Agreement might not provide substantial benefits to meet the host country's NDC targets. This is because the mitigation outcomes from the project will need corresponding adjustments. Under Article 6.2, the sharing ratio of mitigation outcomes will depend on the agreement between the host and acquiring countries. For instance, the Government of Japan shared at least 80% of the issued credits for most of the Joint Credit Mechanism (JCM) projects (Chapter 11). Similarly, with international carbon trading through Article 6.4 – The Paris Agreement Crediting Mechanism – participating countries will need to adjust their national GHG emissions inventories, accordingly, based on the traded credits when accounting for the host country's GHG emissions inventory.

ii. Generate government revenue and capitalise debt swaps with creditors
The 9th National Socio-Economic Development Plan Financing Strategy (2023–2025) acknowledges that emissions trading schemes could generate a significant amount of revenue for Lao PDR (Chapter 11). However, implementing such schemes will require the development of guidelines, procedures, systems, and capacity building, and hence regional-level consideration, to be cost-effective. Nevertheless, mandating carbon or emissions trading projects to register and trade under the administration of a national registry will generate revenue for the government, irrespective of whether it is a mandatory emissions trading system or a voluntary carbon crediting mechanism. Additionally, the strategy also considers debt-for-nature swaps as an innovative fiscal policy. This concept can be applied to the Article 6.2 approach by cooperating with creditor countries. For instance, generated credits for interest repayments can be integrated into negotiation strategies to alleviate the debt burden. However, this might be more suitable for nature-based activities due to lower costs compared to energy-related activities.

iii. Mobilise green investment and measure the benefits
The VCMs and crediting mechanisms can channel private or foreign investments into mitigation activities. For instance, foreign investors can invest in specific projects to obtain carbon credits through Article 6 approaches or independent crediting mechanisms. Additionally, the methodologies used in crediting mechanisms can be used by governments and private investors to estimate the GHG emissions reduction value of a particular measure or to understand the GHG emissions reduction impact of a financial investment. This approach is used in results-based climate finance, which relies on the ability to measure the actual GHG performance of a specific investment in a cost-effective way. Consequently, it provides a tangible investment opportunity that can attract investments from a broad range of financial players. As the issued carbon credits are used as a metric of carbon performance for results-based climate finance, but not for meeting the financial providers' NDCs, these credits are defined as Mitigation Contribution Units under Article 6.4 and are not obliged to corresponding adjustments.

iv. Promote low-carbon development and local environmental benefits
In many developing countries, prioritising the development of emerging economic sectors or addressing local environmental issues often takes precedence over emissions mitigation. Carbon crediting mechanisms offer the potential to generate additional benefits beyond simply reducing emissions. They can serve as a financial incentive for businesses to adopt cleaner technologies, thereby facilitating climate change mitigation alongside other objectives such as enhancing air quality,

safeguarding water resources, promoting soil health and biodiversity, and increasing productivity. Additionally, there are social and economic advantages, including improved energy access, job creation through the implementation of new technologies, enhanced livelihoods, and support for the early commercialisation of emissions reduction technologies or products. Furthermore, while Article 6 may not be the primary approach for meeting a host country's NDCs, activities undertaken within its framework must ensure environmental integrity and promote sustainable development, thus yielding environmental benefits.

v. Gauge the market response to carbon-pricing signals

According to the 9th National Socio-Economic Development Plan Financing Strategy (2023–2025), one of the agreed actions that Lao PDR will take to finance environmental and climate priorities is to study the feasibility of environmental fiscal reform, including introducing a carbon tax (Chapter 11). In this context, a crediting mechanism could be a useful option if there are barriers, such as legal hurdles or political resistance, to implementing a mandatory emissions trading system or carbon tax. Thus, a crediting mechanism may serve as a good starting point to send a carbon-pricing signal and build familiarity with market mechanisms. Furthermore, by assessing the market sensitivity to carbon-pricing signals, Lao PDR may further evaluate whether there will be sufficient supply and demand for credits before embarking on a mandatory or voluntary domestic emissions trading scheme.

vi. Provide offset options for corporate climate objectives and compliance obligations

The VCMs and crediting mechanisms can facilitate stronger voluntary commitments to emissions abatement, particularly where mandatory carbon pricing is absent or for entities not subject to mandatory policies or emission constraints. These approaches provide a source of credible emissions reductions that businesses and other organisations can use to voluntarily offset their emissions. Moreover, Lao PDR is considering a carbon tax as one of the options for financing environmental and climate priorities. Therefore, if a carbon tax is introduced, VCM and crediting mechanisms can offer additional flexibility to compliance options by allowing offsets in addition to tax payments.

However, in this context, to ensure there is sufficient supply for the domestic carbon market, jurisdictions may limit the domestic carbon credits to trade at international markets. Additionally, most jurisdictions that allow the use of offsets, limit them to either credits from domestic carbon markets or carbon trading that apply corresponding adjustments to ensure the outcomes contribute to achieving their NDCs. For instance, Singapore is the first country to implement a carbon tax with an offsetting mechanism that aligns with the requirements of Article 6 under the Paris Agreement. By establishing offsetting criteria compliant with Article 6, all emissions offset through international platforms contribute to its national GHG emissions reduction. These carbon credits are compulsory for corresponding adjustments, making them eligible for claiming emissions reductions toward meeting NDCs (Chapter 11).

In contrast, internationally transferred carbon credits that do not undergo corresponding adjustments should not be used to meet NDCs. Singapore's offsetting mechanism could serve as an example for other ASEAN countries on how to benefit from international cooperation and meet their NDCs through Article 6.

11.2. Enhancing the Regulatory Framework and Market Infrastructure

As the national focal point for climate change, the MONRE is aggressively strengthening Lao PDR's participation in VCMs, including the introduction of regulatory frameworks and market infrastructure for carbon trading, and the development of governance frameworks for Article 6. However, these efforts focus on nature-based activities. If Lao PDR plans to explore the potential of carbon trading beyond forest contributions, the regulatory framework will need to expand in the future to cover other sectors. Establishing clear guidelines for project approval, monitoring, and verification, is crucial to ensure effective governance of carbon trading. Additionally, Lao PDR may consider setting a threshold to limit international carbon trading from domestic mitigation activities. This is to ensure that mitigation actions contribute to achieving NDC targets by 2030 and net-zero by 2050.

Another indicator of capitalising on carbon market opportunities is the establishment of a carbon credits exchange platforms in ASEAN countries. Countries such as Indonesia, Malaysia, Singapore, and Thailand have launched carbon trading platforms, with Viet Nam expected to follow suit in 2025. These platforms serve similar functions, including auctions and facilitating international and domestic carbon trading mechanisms. This marks a positive beginning, especially for countries planning a mandatory emissions trading scheme or carbon pricing with an offsetting mechanism.

11.3. Strengthening the Measuring, Reporting, and Verification System

Establishing a comprehensive measuring, reporting, and verification (MRV) system to generate accurate and reliable data is fundamental for any carbon-pricing instrument, including voluntary carbon credit mechanisms. Reliable baselines for emissions reduction projects under VCM and crediting mechanisms are essential for determining additionality and accurately quantifying emission reductions. Defining baselines for these projects can be complex and may require extensive data collection and analysis. Therefore, an effective MRV system not only enhances efficiency in managing emissions information but also serves as a database for establishing baseline information.

Most importantly, regardless of whether the energy sector is included in the carbon trading framework, an MRV system is helpful to policymakers when shaping climate change mitigation policy and measures. Therefore, establishing standard guidelines for MRV should be a priority. Advantages of doing this are:

i. establishing databases for carbon crediting mechanisms;
ii. accounting for the national GHG emissions inventory for United Nations Framework Convention on Climate Change reporting;
iii. tracking progress toward NDC and net-zero targets;
iv. evaluating the effectiveness of mitigation policies and measures; and
v. assessing the potential for carbon-pricing compliance.

11.4. Enhancing International Cooperation

Collaborating with international partners, including neighbouring countries and international organisations, to align Lao PDR's carbon market initiatives with global standards and best practices could enhance the country's credibility and facilitate access to international markets. For example, the Government of Lao PDR, the Government of Australia, and the Global Green Growth Institute are partnering to support the development of the carbon market in Lao PDR, aligning with the principles outlined in Article 6 of the Paris Agreement. Moreover, to bolster knowledge and capacity, the Governments of Lao PDR and the Republic of Korea, henceforth 'Korea', conducted a knowledge-sharing workshop focused on 'Establishing a Master Plan for Implementing a Carbon Trading System in Laos.' This workshop marks a crucial starting point for the potential revitalisation of carbon emissions trading between Korea and Lao PDR in the future. Furthermore, Lao PDR may encourage public and private sectors to explore potential collaborations with the Government of Japan through JCM projects by disseminating information on JCM's crediting mechanism and benefits gained from previous JCM projects.

In addition to bilateral cooperation, Lao PDR could capitalise on opportunities for capacity building and regional policy frameworks under ASEAN cooperation, for instance, actively participating in the development of guidelines and standards that benefit Lao PDR and the region. These developed guidelines and standards can be adopted according to the local context, which is not only more cost-effective, but also crucial to ensure Lao PDR remains competitive in the ASEAN energy market.

12. Regional and International Cooperation for Advancing Innovative Technology Transfer

It is key to identify factors propelling technology transfer and the intricate policy landscape essential for fostering a sustainable and low-carbon future in ASEAN countries including Lao PDR. The plausible enabling factors for advancing technology transfer underscore the significance of effective communication, motivation, research collaboration, and the pivotal role played by technology transfer offices (TTOs), incubators, and management support. These factors collectively contribute to the journey from laboratory innovations to market applications, emphasising the intricate interplay required for successful technology transfer.

The policy implications for technology transfer in ASEAN countries toward achieving net-zero emissions require a comprehensive framework encompassing strategic measures aimed at cultivating sustainable practices. The delineated policies cover renewable energy transitions, EE measures, decentralised energy systems, carbon-pricing mechanisms, sustainable transportation incentives, R&D support, international collaboration, capacity building, education, and adaptation and resilience policies. This holistic framework, if implemented cohesively, serves as a strategic guide to realise the net-zero emissions target, promoting sustainability within the region and contributing substantively to global climate change mitigation efforts, given technology transfer as an enabler.

Advancing technology transfer and attaining net-zero emissions targets in ASEAN countries demands a systematic integration of plausible enabling factors and strategic policy measures. This imperative underscores the need for a concerted effort from diverse stakeholders, including academic institutions, industry entities, policymakers, and the broader community. There are several key enabling factors for Lao PDR and other ASEAN countries to consider for successful technology transfer that will guide the region toward a more sustainable, resilient, and low-carbon future.

i. Strengthening collaboration and communication:
   - Lao PDR should advocate for the creation of collaborative platforms that facilitate effective communication and knowledge dissemination amongst academia, industry, and policymakers; and
   - Interdisciplinary collaboration is important to address intricate challenges and amplify the impact of technology transfer initiatives.

ii. Motivating engagement:
   - Targeted strategies should be implemented to augment motivation, recognising their pivotal role as drivers in technology transfer; and
   - Reward mechanisms, recognition programmes, and career development opportunities should be instituted for personnel actively engaged in technology transfer activities.

iii. Enhancing team competence:
   - There should be judicious Investment in continuous training programmes aimed at enhancing the competence of technology transfer teams within innovation alliances; and
   - Cross-functional teams should be promoted, amalgamating diverse expertise for a comprehensive approach to technology transfer.

iv. Optimising the technology transfer office and incubators:
   - Research-oriented and market-oriented TTOs should be reinforced, ensuring their proactive involvement in facilitating licensing activities; and
   - The catalytic potential of incubators should be harnessed for fostering new product development, economic growth, and the transition to a low-carbon economy.

v. Promoting management support:
   - There should be strong advocacy for robust management support for researchers involved in technology transfer, recognising its pivotal role in overcoming barriers; and
   - Technology transfer should be incorporated more into institutional management strategies.

vi. Investing in R&D:
   - Strategic investment in R&D should be prioritised for clean energy technologies, fostering innovation aligned with sustainability goals; and
   - Funding mechanisms should be initiated to support startups and research institutions dedicated to clean energy solutions.

vii. Fostering international collaboration:
   - Collaborative ties with international partners should be strengthened to promote joint research, technology transfer, and knowledge exchange; and
   - There should be active participate in global initiatives focusing on sustainable development and technology transfer for climate mitigation.

viii. Capacity building and education initiatives:
- Targeted policies for capacity building at institutional, industrial, and workforce levels should be developed and implemented; and
- Educational programmes and training initiatives should be expanded to equip the workforce with the requisite skills for transitioning to a low-carbon economy.

ix. Climate adaptation and resilience policies:
- Climate adaptation and resilience measures should be integrated into technology transfer policies, considering potential climate change impacts on energy infrastructure; and
- Comprehensive strategies to enhance the resilience of clean energy systems to changing environmental conditions should be developed.

x. Fiscal and Financial Incentives for Clean Energy Investments:
- Well-targeted fiscal and financial incentives should be provided,, including subsidies, grants, and low-interest loans, to attract private sector engagement in clean energy projects; and
- Financial incentives should be aligned with broader goals, emphasising the attainment of net-zero emissions and sustainable economic growth.

The successful integration of these strategies requires a collaborative and adaptive approach, marked by continuous monitoring and evaluation. This adaptive approach will ensure the refinement of policies based on evolving technological landscapes and socio-economic conditions.

13. The Development of Carbon Capture Utilisation and Storage

CCUS will be one of the avenues for Lao PDR to reach a carbon neutral future and enabling it will require substantial efforts. Several key directions could be adopted to develop CCUS technologies:

i. *Conduct a national carbon dioxide storage resource assessment*. To fully understand the total potential amount of CO_2 which can be stored in Lao PDR, an assessment should be conducted. At present, due to its limited data on the CO_2 storage resources in depleted oil wells and saline aquifers, Lao PDR will be overlooked as a potential storage site for CO_2. Collating the data will be the first step towards enabling CCUS projects and activities. However, this kind of study will require a substantial amount of investment, hence, cooperation schemes and international support will be required.

ii. *Develop regulatory frameworks for carbon capture and storage (CCS)/CCUS Activities*. Regulating CCS/CCUS projects and activities will be the next key step to provide greater certainty, which may attract more investment to enable the development of CCS/CCUS projects. The example of Indonesia can be emulated, where regulations began with enhanced oil and gas recovery activities (CCUS), which then expanded to storage in saline aquifers (CCS). Specific regulations on capture, transport, storage, MRV, and post-closure should also be addressed in the later stages of the development of a regulatory framework.

iii. *Pilot Project Development*. CCUS pilot projects will be crucial to demonstrate their economic viability and to improve the effective and efficient technology around CO_2 storage. The pilot project will also showcase and inform the community regarding the environmental benefits of CO_2 injections. The successful implementation of the pilot project will also signal investors to support and develop more CCUS projects in the country.

iv. *Financing CCUS*. To fully develop CCUS as a viable business, the price of emitting CO_2 needs to be higher than that of capturing and storing it. This can be done in several ways: increasing the price of emitting CO_2 (carbon pricing), prohibition or mandating mechanisms, reducing the cost to private sector investors of CCS (e.g. through capital grants or concessional finance), and increasing the revenue created through CCS (e.g. through payments per tonne of CO_2 stored or operational subsidies). In terms of financing CCUS technology deployment, Lao PDR can tap into multilateral development banks (e.g., The World Bank or ADB), VCMs, and sustainable financing such as green and climate bonds.

v. *Develop Interconnected CCUS Networks*. Connecting with ASEAN countries to develop a regional CCUS network will be beneficial, especially for countries with limited amounts of storage. In the long-term, Lao PDR should aim to tap into these networks to gain access to lower-cost CO_2 storage options. Cross-border mechanisms should be addressed at the national, bilateral, or regional level to enable this. It will, however, need high-level coordination and streamlining in terms of planning and development within the countries in the region.

14. Financing Sustainable Energy Infrastructure

Securing investment for financing energy infrastructure that is sufficient to support the transition from the current heavy reliance on fossil fuel towards a cleaner and more resilient energy system is one of the great challenges of our time. The solution must ensure a smooth energy transition that leaves no one behind and takes into consideration energy affordability, accessibility, and security, while simultaneously achieving the Paris Agreement goal of keeping temperature increases to well below 2° Celsius, preferably to 1.5° Celsius compared to pre-industrial levels. Fast-tracking energy finance for the energy transition is critical to ensure that countries can secure enough funds to finance their energy transformation. Annual investment in renewables and clean energy has grown steadily since the 2015 announcement of the Paris Agreement on climate goals. 'The ASEAN Renewable Energy Outlook 2021', published by the ASEAN Centre for Energy, estimates that the region will require around $360 billion of investment in the power sector alone, to achieve the targets of 23% renewable energy share in total primary energy supply, as well as a 35% share in installed power capacity by 2025. In 2023, an estimated $1.7 trillion was invested in renewables and clean technologies, while $1 trillion was invested in fossil fuels. The increasing share of investment in clean energy outpaced fossil fuel investment for the first time between 2016 and 2023. This new ASEAN trend reflects global investor sentiment towards cleaner energy systems. However, attention will need to be paid to how developing countries can finance the energy transition.

Lao PDR and ASEAN will need secure finances to support their sustainable energy infrastructure. Lao PDR has the potential to become a key player in the advancement of sustainable energy. This will help enhance energy security in the region and support the worldwide shift towards a sustainable future. It is generally accepted that tax revenue generated from the infrastructure expansion should be used to incentivise the investment around clean energy and technologies. It is further recommended that green credit guarantee schemes (GCGS) should play a crucial role in financing renewable energy and sustainable infrastructure through guaranteed schemes that share risk amongst stakeholders. Using domestic savings for investments is also highly encouraged to reduce dependence on foreign direct investment (FDI). FDI is, however, crucial and Lao PDR needs to have a sound investment environment to attract it. Below are key suggestions to achieve this.

14.1. Utilising the Spillover Effect in the Form of Tax Refunds to Private Investors

To increase the investment incentives crucial for funding sustainable energy development, the Government of Lao PDR will need to utilise the 'spillover effects' created by energy supplies and refund the tax revenues to investors of the energy projects. This is suggested since the government often regulates electricity tariffs, and private financial institutions struggle to finance these infrastructural projects.

There are three significant reasons why utilising the spillover effects will benefit Lao PDR. First, private investors are given further incentives to invest in sustainable energy initiatives by leveraging the spillover effect of energy projects such as tax revenues and business development. This leads to higher rates of return on investments, and projects that are more attractive to private investors. Second, utilising the effect will mitigate risks associated with sustainable energy investments. There is less risk to private investors by providing sources of additional revenue through increased sales and property tax revenue, making investment more attractive. Third, the spillover effect generated by sustainable energy projects potentially contributes to energy development in the region by creating jobs, increasing employment opportunities, and stimulating the business economy. Not only will this benefit the energy sector of Lao PDR, but it will also positively impact the overall economic stability in the long-term.

14.2. Green Credit Guarantee Scheme

The establishment of a tailored GCGS should reduce risk in investment and information asymmetry associated with sustainable energy projects. The GCGS is crucial to improve the creditworthiness of low-carbon projects which lack physical collateral and tend to have weak credit standings. Hence, the GCGS serves as a safeguard by covering a portion of the risk and facilitating access to private financial institutions' financing, increasing investor confidence in unlocking private capital for sustainable energy projects.

The green credit guarantee for low-carbon projects will reduce information asymmetry and the expected default losses because the credit guarantee corporation – the government – guarantees a portion of loan default. Therefore, banks want to lend money to those guaranteed low-carbon projects.

The GCGS covers the credit risk of green projects that suffer from a shortage of physical collateral or have weak credit standing in Lao PDR and other ASEAN Member States. By reducing the risks, this scheme helps private financial institutions finance projects. The boosted access to financing stimulates the flow of money from financial institutions to incorporated projects, thus eliminating obstacles to financing and funding sustainable energy projects. The GCGS is, therefore, an essential accelerator to create and promote renewable energy infrastructure projects in Lao PDR and other ASEAN Member States. To achieve financial sustainability for GCGS, several key points should be considered.

i. *Sufficient Capital*: GCGS must possess adequate capital to guarantee projects for the energy transition. This ensures that they can support a wide range of projects, providing the necessary financial backing to foster growth and development in the energy sector.
ii. *Independent Assessment Body*: The assessment body should operate independently from GCGS to ensure impartial evaluation of projects. This independence is crucial to maintain objectivity and fairness in the selection process.
iii. *Importance of Assessment*: The role of the assessment process is pivotal to select projects with higher creditworthiness and a greater likelihood of success. Accurate and thorough assessments help mitigate risks and ensure that only viable projects receive support.
iv. *Variable Guarantee Fees*: GCGS should vary guarantee fees based on the soundness and creditworthiness of projects. Projects demonstrating higher soundness and lower risk should be charged lower fees, incentivising quality and reliability in project proposals.
v. *Local Offices*: GCGS needs to establish local offices nationwide or in major cities. This local presence allows GCGS to have direct access to information and to closely monitor the progress of projects. It also facilitates better communication and support for regional initiatives, ensuring projects are on track and meeting their goals.

By addressing these points, GCGS can build a robust framework for financial sustainability, supporting the successful transition to sustainable energy solutions.

14.3. Maximising Non-Debt Financing

Regarding sustainable energy development, strategic initiatives to achieve long-term energy security and economic growth focus on diversifying financing sources and securing financial stability. Relying on external debt for energy generation makes Lao PDR vulnerable to global financial market changes and fluctuations in currency exchange rates. Additionally, the accumulation of foreign debt might create economic and political risks for the country. Lao PDR would develop its sustainable energy sector without heavy external borrowing by maximising non-debt financing modalities, such as FDI and remittances, and relying more on domestic savings. Notably, apart from financial capital, FDI often implies technology transfer, managerial expertise, and direct and indirect access to foreign markets; thus, it boosts the competitiveness of renewable energy. Remittances represent a stable source of income and, if channelled into sustainable energy projects, may substantially reduce the country's external debt. Additionally, the circulation of domestic finance and savings into investments will align with economic stability objectives by retaining capital within the country and stimulating economic activity.

There should be a focus on effective instruments such as green bonds and credit guarantee schemes to ensure an adequate level of finance and funding for development without the need to compromise the financial stability of Lao PDR. Green bonds are debt instruments dedicated solely to funding projects that offer environmental benefits, including renewable energy projects. Through expanding the green bond market, Lao PDR gains access to a new source of funding that supports its sustainability goals and is attractive to socially conscious investors. At the same time, credit guarantee schemes address the reluctance of private financial institutions to lend the necessary funds because of perceived risks. They function as an insurance policy against default on the loans covering renewable energy projects. To sum up, the integrated approach grants access to financial resources for renewable energy projects and increases the nation's economic resilience. Using various financial instruments from multiple sources reduces the dependence on volatile external debt markets and ensures adequate investment. By maximising the use of non-debt financing sources, such as FDI and remittances, and tapping into financial instruments, such as green bonds and credit guarantees, Lao PDR minimises the contribution of overseas finance to risks, decreases the impact of external debt, and secures the inflow of funds for energy projects. The integrated approach, therefore, enhances energy and environmental security and fosters long-term economic growth and financial stability.

14.4. Institutional Investors

Institutional investors such as insurance companies and pension funds hold large pools of capital and desire long-term investments with stable returns. Given that the investment requirement for renewable projects needs to be those that are long-term, have relatively stable cash flow, and adhere to sustainability goals, institutional investors appear well-suited to play a substantial role in financing them. As a result, investing institutional capital in the renewable energy sector represents a strategic option for Lao PDR to mobilise a considerable amount of capital during the energy transition. Collaboration between the government, financial institutions, and institutional investors is critical to realise the potential of institutional capital in financing renewable energy projects. These partnerships may come in different forms, such as joint ventures, co-investment arrangements, or specialised investment funds tailored to renewable energy infrastructure, which could be used to leverage the expertise and resources provided by institutional investors. Through this, project viability, mitigation of risks, and acceleration of deployment of renewable energy infrastructure could be made possible. Therefore, Lao PDR and other ASEAN Member States need to have more robust insurance companies and pension funds.

Furthermore, designing investment vehicles that cater to institutional investors' preferences and risk profiles is indispensable to attract participation. Typically, institutional investors prioritise stable returns, long investment horizons, and low levels of risk. Therefore, investment vehicles such as renewable energy funds, infrastructure bonds, or asset-backed securities may be deemed appealing to institutional investors by offering them exposure to renewable energy projects while addressing risk-return preferences. Incorporating and involving institutional investors is critical to securing long-term financial support for large-scale infrastructure projects. Institutional investors contribute to the financial sustainability of renewable energy ventures by providing stable, patient, capital thereby enhancing energy security and facilitating sustainable development goals. Moreover, their involvement can attract additional private capital, catalysing further investment in renewable energy projects and fostering a vibrant renewable energy market ecosystem in Lao PDR.

Although most recommended policies concern Lao PDR specifically, with a focus on their difficulty in attracting private investment for sustainable projects and the issue of limited energy supply due to regulatory barriers and lack of financial assets, the spillover effect can be implemented in other ASEAN nations. In the form of tax refunds, the spillover effect can be used to close financial gaps in energy sectors to attract investors to build financial blocks for infrastructure. Therefore, ASEAN countries expecting similar issues to Lao PDR can apply this policy to commit to sustainable expansion. Moreover, the recommended establishment of the GCGSs facilitates mitigating risks for green investments and enhances access to finance for sustainable energy projects. The scheme can present a blueprint across ASEAN for promoting green finance instruments as a tool for regional collaboration and supporting sustainable energy development. Furthermore, broader participation in institutional investors within ASEAN will promote stable and long-term sustainable energy initiatives in the region. The expertise, significant capital, and long-term investment horizons can contribute to the region's energy transition and foster energy supply security while simultaneously building a culture of sustainable energy practices.

Overall, the policies tailored to Lao PDR focus on expanding the energy sector through green finance mechanisms and strategic partnerships to bring in investment. Through showcasing the successful use of risk-mitigating financial instruments, incentivising green investments, and diversifying financial sources, Lao PDR can lead as an example for other ASEAN nations and collaborate with neighbouring nations to advance regional energy security and financial stability.

15. Capacity Building Needs

This White Paper outlines the priorities to establish energy security in Lao PDR. Capacity building is an ongoing affair rather than a one-time event. Further, capacity building does not come in a single format but is wide-ranging, taking varying forms at different times along a temporal path. While some technical skills needed can be identified in advance, implementation requires the agility to react and adapt to changing circumstances, both at the technical skills level and to changing social, political, and economic contexts. This is especially true of policies that are many years in the making, from design to fruition. Capacity building, therefore, has an inherent dynamic to it. It is neither a simple, predetermined checklist of trainings to be provided, nor an exercise detached from real-time feedback loops, affecting policy implantation.

Capacity building is more than specific skills needed to conduct particular technical tasks. It is needed through the whole policy ecosystem to support a desired outcome. Identifying technical skills needed for a specific task can often be done with ease. However, identifying the skills needed for the policy environment rather than the more scientific and technical training needs can be more difficult. Thus, for example, imparting knowledge about how to run an infrastructure facility must run in parallel with the need to ensure the facility compliant with local and national laws and regulations and international obligations. This requires a distinct set of skills and understanding.

Capacity building cannot be an afterthought but must be integral to the design and adoption of policy. While not a silver bullet to ensure policy success, it can contribute to forestalling pitfalls at a later stage. Thinking through the types of support likely to be needed is important because what may appear on paper to be an ideal policy, on a more thorough evaluation, may reveal a potential level of complexity and support that was not anticipated when the policy idea was first originated; ideal policies may not be practical policies if they demand levels of human (and capital) resources beyond the means available for implementation. This brings into focus further important aspects of capacity building planning. First, policy planning must include not only cost–benefit analysis of expected outcomes, but also the cost of capacity building support. Flowing from this, it may be necessary to develop different sets of options to support implementation. These options should be considered as part of the decision-making process. Such planning for capacity building helps ensure that an outcome being pursued has a reasonable chance of success, and available resources are equal to those required for implementation.

Capacity building takes various forms, is targeted towards different stakeholders, will need to be provided by different experts, and takes place at various times along the policy development/implementation lifecycle. The most common types of capacity building are:

i. policy-modelling/cost–benefit analysis support;
ii. domestic regulatory mapping: to understand which laws and regulations may need to be reformed, to implement new policies, or remove regulations acting as a barrier to more dynamic reform and regulatory compliance;
iii. international regulatory mapping, for example, of non-tariff measures that may be faced;
iv. advocacy: support for stakeholders to know how to effectively share their findings on a particular issue with each other;
v. provision of issue-specific technical training;
vi. developing implementation work plans;
vii. developing monitoring and evaluation frameworks;
viii. monitoring policy implementation;
ix. outreach and awareness-raising; and
x. lessons learned/comparative experiences.

Specific capacity building and training is suggested in each chapter this White Paper. There is no need to discuss each type of capacity building as their potential role and importance will become apparent when thinking through policy implementation in detail. However, it is beneficial to bear in mind the range of support that exists. From this menu of capacity building activities, certain amounts of knowledge and competency will already exist and be institutionalised amongst sets of stakeholders long experienced with working in a particular field. However, any new policy or effort to innovate is likely to necessitate increased numbers of people who need to be brought into the project circle. Thus, certain requisite skills, whether in relation to policy development amongst policy officials, or technical staff in relation to policy roll out, will need to be taught. Neither the resources, nor the time needed for this, should be underestimated.

With capacity building likely to be needed for a wide range and considerable number of stakeholders, including government officials, legislators, independent regulators, oversight agencies, state owned enterprises, private sector, and community groups, the burden of who is responsible for providing the capacity building to different target audiences must also be considered. This is why it is also incumbent on government, which establishes policy, to be aware not only of its own resource limitations, but also those of counterpart stakeholders who will play a vital role in the success of the policy.