THE JAPAN – U.S. – MEKONG POWER PARTNERSHIP

Accomplishments Report

Marking 5 years of cooperation

to advance clean, modernized, and interconnected power systems in the Mekong subregion

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Deloitte & Touche, LLP

National Association of Regulatory Utility Commissioners Pacific Northwest National Laboratory The U.S. Department of Commerce, Commercial Law Development Program The U.S. Department of the Interior International Technical Assistance Program The U.S. Department of State's Bureau of Energy Resources' Power Sector Program USAID Laos Energy Security Program USAID Southeast Asia's Smart Power Program United States Energy Association

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EXECUTIVE SUMMARY

THE NEED FOR CLEAN, SECURE, AND AFFORDABLE POWER

Southeast Asia has seen rapidly rising economic growth over the past two decades, with nearly all countries in the region doubling the size of their economies since 2000. Electricity demand has risen in parallel, largely using fossil fuels, and leading to a 35 percent increase in carbon emissions regionally per the International Energy Agency. The Mekong subregion countries of Cambodia, the Lao People's Democratic Republic (PDR), Thailand, and Vietnam face unique vulnerabilities given the importance of the Mekong River to economic activity and the region's reliance on hydropower. Like all nations, these four countries must balance rising electricity demand and economic growth with their respective clean energy goals and commitments to minimize environmental impacts and lower greenhouse gas emissions. National policymakers, energy regulators, and electric utilities face difficult tradeoffs as they design energy systems and power markets capable of providing clean, secure, and affordable power for their citizens.

AN INTERNATIONAL PARTNERSHIP TO SUPPORT THE MEKONG SUBREGION'S CLEAN ENERGY TRANSITION AND POWER MARKET DEVELOPMENT OBJECTIVES

In 2019, U.S. and Japanese Foreign Ministers established the Japan-U.S.-Mekong Power Partnership (JUMPP), an initiative of the Mekong-U.S. Partnership, to support Cambodia, the Lao PDR, Thailand, and Vietnam in their pursuit of energy, security, and enhanced regional power market interconnectivity.

Mekong Subregion Clean Energy Objectives

Cambodia: 70% of installed capacity from renewable energy by 2030

The Lao PDR: 75% hydropower capacity, 11% other renewables by 2030

Thailand: At least 50% renewable electricity generation by 2037

Vietnam: 30.9-39.2% of installed capacity from renewable energy by 2030; 67.5-71.5% by 2050

Through JUMPP technical cooperation, advisory support, regulatory exchanges, and technical and analytical studies, the six partner governments have strengthened collaboration and are advancing national and regional Mekong policy goals related to **clean energy deployment, cross-border power trade,** and **electricity market development.** This publication celebrates the five-year anniversary of the partnership and highlights key accomplishments.



Solar facility - Thailand. Under JUMPP, partner governments work to facilitate access to clean, secure, and affordable power in the Mekong subregion.



IMPACT

Across JUMPP's three pillars of Clean Energy Integration, Power Market Development and Investment, and Cross-Border Power Trade, technical cooperation has resulted in the following outcomes in the four Mekong partner countries:

CLEAN ENERGY INTEGRATION

- In September 2024, Cambodia released a request for bidding for its first **125 MWh** battery energy storage system (BESS) pilot project. Following the success of this initial project, additional BESS projects are planned for subsequent phases. The BESS facility will be used to support grid stability as Cambodia integrates variable renewable energy (VRE) into its power system.
- The Lao PDR updated national guidelines for inspection, testing, and commissioning of energy projects in 2024 to incorporate solar, wind, and other VRE projects through the development of inspection manuals and technical guidance documents for substation and transmission infrastructure.
- Thailand established a renewable energy forecasting center in 2023 to enhance power system stability as it integrates more renewables.

- Vietnam launched a **renewable energy control center** in 2020 to improve its monitoring and forecasting abilities given the country's rapid increase in solar and wind, resulting in more grid reliability and increased use of renewables.
- Vietnam updated its electricity **grid code** with specific requirements, enabling greater grid stability and transparency for operators.

POWER MARKET DEVELOPMENT AND INVESTMENT

- Support for Thailand on its transition from a single-buyer market to a competitive electricity market will enhance peer-to-peer electricity exchange among individual buyers and independent power producers. Competitive electricity markets provide more accurate power pricing and price transparency to market participants, thereby incentivizing private investment.
- Thailand released its third-party access framework in 2022 based on multiple regulatory workshops and expert reviews of the draft framework with more than 50 clean power producers in Thailand. This framework opens access to Thailand's power grid to commercial suppliers of clean energy.



- Thailand's Energy Regulatory Commission announced a new utility green tariff in 2023, which JUMPP advised on through shared examples of green tariffs from the United States and Canada. JUMPP continues to advise Thailand's energy regulator on two utility green tariffs.
- Since 2019, JUMPP has supported Vietnam's regulator on retail power market reform and consumer choice and advised on proposed corporate contract models to procure clean energy. In 2024, Vietnam released its direct **power purchase agreement (PPA)** framework, enabling greater private sector procurement of clean energy.

CROSS-BORDER POWER TRADE

• Cambodia, the Lao PDR, and Thailand are developing a regional cross-border power trade pilot project to enable near-term electricity trade on existing electric power transmission infrastructure based on years-long stakeholder dialogues, trainings, and technical analysis.



Regional representatives from the four Mekong subregion countries visit PNNL to learn about variable renewable energy modeling and forecasting.

Key Defintions

Grid Code: A set of technical requirements for connecting and using a transmission system and grid infrastructure. The growth of VRE has necessitated countries worldwide to update their grid codes to help maintain grid reliability.

Power purchase agreement (PPA): A commercial agreement to purchase electricity between a buyer and supplier of energy. The purchaser or "offtaker" buys power from a project developer at a negotiated rate for a specified term without taking ownership of the system. The project developer builds, operates, and maintains the system. PPAs provide security to both project developers and consumers by guaranteeing revenue streams and thereby offsetting investment risk, and by guaranteeing dispatch of electricity.

Renewable energy control center: Renewable energy control centers forecast output of, monitor, and control VRE. As power systems integrate greater shares of VRE, these functions are critical for maintaining grid stability.

Third-party or open access frameworks: When electric utilities allow others to use their grid (transmission and distribution power lines and facilities) to move power from one point to another on a nondiscriminatory basis.

Variable renewable energy (VRE): Energy technologies that rely on a renewable fuel source, such as wind and solar, and do not deplete based on use. Unlike traditional power plants, which run on fuel sources such as coal, oil, or gas, VRE output fluctuates based on weather conditions. Countries can couple VRE with storage technology to allow power dispatch when the availability of renewable resources is low (e.g., reduced sunlight). VRE, without energy storage, is "non-dispatchable," meaning operators cannot adjust output like with traditional fossil fuel generating units.

JUMPP BY THE NUMBERS

Through a wide range of technical assistance projects, trainings, visits, and exchanges, and the sharing of expertise and capacity-building tools, JUMPP has driven tangible impact for Cambodia, the Lao PDR, Thailand, and Vietnam in the initiative's first five years by:

100 Delivering more than <u>100</u> distinct, technical cooperation activities and projects to the four partner governments, including energy investment forums, trainings, workshops, and technical capacity exchanges.

Strengthening the renewable energy integration capacity of <u>12</u> national power market authorities and oversight institutions in the four governments.

Supporting the development and/or adoption of <u>13</u> legal, regulatory, and commercial reforms, including a new financial and accounting framework for regulators in Thailand and an electricity tariff revision in Cambodia.

50

12

13

Hosting $\underline{7}$ U.S. study tours where nearly $\underline{50}$ Mekong power market authorities connected with U.S. electricity regulators and electric power grid operators to share leading practices in the U.S. electricity sector.

60

Delivering more than <u>60</u> technical assessments and reports to support clean energy deployment, national power market development, clean energy investment, and cross-border electricity trade among JUMPP partner governments.

1,000

Training more than <u>1,000</u> Mekong officials on clean energy policy, regulations, and grid integration; topics include battery energy storage, smart and advanced metering infrastructure, electric vehicle (EV) charging infrastructure, and others.

42

Providing professional development and mentorship to <u>42</u> women engineers through JUMPP's Women in Renewable Energy in Southeast Asia (WIRES) program focused on clean energy.



In less than $\underline{2}$ years, negotiating and implementing a JUMPP Action Plan that identified and prioritized capacity-building needs and donor support for JUMPP technical engagement.



JUMPP'S CORE PILLARS

Clean Energy Integration

JUMPP supports countries with integrating renewable energy, such as wind and solar, and decarbonizing their power sectors. JUMPP activities assist the four Mekong countries' electric utilities to improve power grid operations and investment planning, helping to ensure grids of the future can reliably integrate new, variable power sources into their energy mix while maintaining stable power grids.

Market Development and Investment

JUMPP supports market reforms as they seek to establish more competitive electricity markets. Independent experts help Mekong energy ministries, regulators, and electric utilities design, develop, and manage electricity markets. This includes pricing, legal and regulatory frameworks, technical norms for clean energy grid connections,

"JUMPP paved the way for us to integrate more and more renewable energy in the system for energy security and for improving system stability by seeking new technologies for grid support such as battery energy storage and pumped hydro storage."

Dr. Sovannarith Leng, Électricité du Cambodge

and agreements between clean energy suppliers and buyers to attract private investment in the power sector and enable the long-term development of a regional electricity market.

Regional Power Trade

JUMPP supports the long-term development of a regional Mekong power market for greater energy security, power grid resilience, increased renewable energy uptake, and commercial opportunities in the exchange of power. Experts assess technical standards and regulations, analyze infrastructure capacity, and support coordination on future regulatory and grid planning for trading power across borders.



Staff from the Lao PDR Ministry of Energy and Mines discuss a road mapping exercise during a 2023 workshop on power pool planning, smart grids, and renewable energy integration in Bangkok, Thailand.



Through a multi-year series of technical assistance activities, the four Mekong subregion countries are progressing toward establishment of cross-border pilot projects that will increase regional power trade and grow the market for renewable energy.

LEADING ORGANIZATIONS AND IMPLEMENTING PARTNERS

With financial support from the U.S. and Japanese governments, expert partners implement technical cooperation activities requested and prioritized by the Mekong partner governments. These JUMPP implementing partners bring expertise in clean energy and energy systems, legal and regulatory frameworks, power markets, clean energy procurement, and cross-border power trade, providing independent advisory support and technical capacity building to the partner governments. Guided by each country's clean energy and regional power-trading targets, JUMPP activities strengthen institutional and regulatory frameworks, electricity sector governance, and regional cooperation.

"We have more perspective in deploying wide-area monitoring and control applications [because of PNNL's training in this area]."

Quang Nguyen, Vietnam National Electricity System and Market Operation Company Limited (NSMO) Deputy Director, Power System Analysis and Planning Department



Participants from the Mekong subregion countries at the November 2024 JUMPP Technical Advisory Group (TAG) meeting.

Lead Organizations

- The U.S. Department of State's Bureau of Energy Resources' Power Sector Program: The U.S. government lead for JUMPP, the Power Sector Program provides a wide range of technical support to create solvent, reliable, transparent, and sustainable power sectors in countries across the globe through a combination of direct contracting; peer-to-peer exchanges with U.S. regulators and grid operators; and agreements with U.S. government agencies, energy laboratories, and other independent experts and partners.
- Japan International Cooperation Agency (JICA): Japan's international development agency, JICA, is engaged in more than \$1.2 billion worth of programs in Cambodia, the Lao PDR, Thailand, and Vietnam, focusing on promoting climate action, economic connectivity, and quality infrastructure growth.

Participating Governments

- Mekong Subregion Governments of
 Cambodia, the Lao PDR, Thailand, and
 Vietnam: Mekong governments engage directly
 with the U.S. Government, the Government
 of Japan, and JUMPP implementing partners
 to facilitate the partnership's activities. The
 following key energy entities (or equivalent
 entities) are the primary recipients of
 JUMPP technical assistance and represent
 their countries in partnership dialogues and
 exchanges:
 - Electric utilities: Électricité du Cambodge, Électricité du Laos, the Electricity Generating Authority of Thailand, and Electricity Vietnam;
 - Energy ministries: Cambodia Ministry of Mines and Energy, the Lao PDR Ministry of Energy and Mines, Thailand Ministry of Energy, and Vietnam Ministry of Industry and Trade;
 - Energy regulators: Electricity Authority of Cambodia, Energy Regulatory Commission of Thailand, and Electricity Regulatory Authority of Vietnam.



Implementing Partners

- Commercial Law Development Program (CLDP): A division of the U.S. Department of Commerce, CLDP, led by a team of lawyers with industry experience, draws upon a network of regulators, judges, policymakers, and business leaders to support Mekong subregion countries with power sector policy and legal reforms.
- **Deloitte:** An international professional services firm, Deloitte brings a deep bench of technical and regulatory specialists to advance a wide range of activities and leads a major, multi-year initiative within JUMPP to pilot market-based, cross-border power trade.
- U.S. Department of the Interior (DOI) International Technical Assistance Program (ITAP): The DOI-ITAP foreign assistance program leverages domestic and international expertise to support technical capacity building in more than 70 countries worldwide, fostering a global network of public and private sector partners.
- National Association of Regulatory Utility Commissioners (NARUC): As a memberbased organization, NARUC leverages the expertise of state energy commissioners and staff, sharing leading practices in electric utility regulation and pricing with technical staff, system planners, and regulators.
- Pacific Northwest National Laboratory (PNNL): One of the U.S. Department of

Energy's 17 National Laboratories, PNNL draws on its staff of expert scientists, power systems engineers, and data architects to assist grid operators and planners with clean energy integration.

- U.S. Agency for International Development's (USAID) Laos Energy Security (LES) Program: A USAID bilateral technical assistance program, LES supports capacity building activities for the Lao PDR's Ministry of Energy and Mines and Électricité du Laos on power system planning, clean energy policy implementation support, and utility operations improvement.
- USAID Smart Power Program (SPP): The USAID Regional Development Mission for Asia's flagship clean energy program, SPP, supports a wide range of regional technical assistance activities by leveraging in-country technical staff while also delivering tailored bilateral support (i.e., support to a single country) to the Lao PDR.
- U.S. Energy Association (USEA): A nonprofit organization comprised of more than 100 energy organizations spanning public and private sectors, including utilities and regulators, USEA convenes stakeholders for study tours, workshops, and conferences to deepen the regional dialogue around power sector development.



Nam Ngum hydropower facility - near Vientiane, the Lao PDR. Hydropower is a major source of electricity supply in the Mekong subregion. Japan–U.S.–Mekong Power Partnership (JUMPP): Accomplishments Report



The global transition to a VRE-rich resource mix impacts each segment of the power sector value chain, including the **grid operators** who dispatch generation and monitor transmission system reliability; **wholesale power markets**, whose rules govern power pricing; and **distribution utilities**, who must contend with two-way power flows

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and new demand from electrified transportation. JUMPP addresses partner challenges across the power sector value chain – from the generators and high voltage lines that transmit bulk power, to the lower voltage networks that distribute power to homes and businesses for consumption.

JUMPP ACTIVITIES

Implementing partners deliver individual assistance to one country or regional assistance to multiple countries on topics of mutual interest. Assistance takes the form of technical reports, virtual and inperson trainings, study tours to the United States, and regional working-level meetings. Each activity supports one or more of JUMPP's three key pillars and addresses power sector objectives prioritized by each country. Individual country activities allow for capacity building on national priorities based on their unique energy mix and technical capacity, while regional activities allow for advancing mutual goals and strengthening the regional power market.

TECHNICAL ADVISORY GROUP (TAG) MEETINGS

JUMPP TAG Meetings provide a forum for highlevel discussions between senior Mekong power sector officials, the governments of the U.S. and Japan, and JUMPP implementing partners. These meetings highlight previous JUMPP activities and their impact, provide a forum for discussing future technical assistance priorities, and examine current power sector challenges, both regional and country specific. The information exchange enabled through TAG meetings is crucial to the partnership's continued success, allowing participants to provide critical feedback to implementing partners and to re-frame near- and medium-term power sector priorities. Discussions within the TAG have served to build consensus on key action items, such as the alignment of participants around a high-level roadmap to increase cross-border electricity trade over existing transmission infrastructure.

A key milestone accomplished by the TAG was the development of the <u>JUMPP Action Plan</u>, released in 2023. Through the development of the plan, partners identified and implemented more than 40 high-priority technical assistance activities.

"It is my honor to have been a part of such a meaningful initiative [WIRES] and I am appreciative of the opportunity to advance my knowledge in the renewable energy field. I look forward to and will endeavor to leverage this experience to contribute to the sector."

Trang Truong Deputy Director, EPC Management Board at PECC2

Participants in the JUMPP WIRES Program, which provided professional development and mentorship to 42 women engineers.

IN-PERSON AND VIRTUAL TRAININGS AND WORKSHOPS

Trainings and workshops strengthen understanding of technical areas, including leading international practices on electricity regulations, clean energy integration, and grid operations and resource planning. These events provide the opportunity for detailed discussions with experts or industry peers. For example, technical experts have trained grid operators virtually and in-person on new modeling software, technologies, and operational practices to integrate VRE into power grids using country-specific data, case studies, and advanced models to demonstrate best practices. Implementing partners have also conducted workshops with U.S. and international regulators on electricity market pricing, distributed generation, and power market frameworks to share lessons learned from around the world.

TECHNICAL REPORTS

Technical reports provide the opportunity for extensive research into priority areas identified by JUMPP governments. These reports leverage proprietary data from utilities and regulators to provide contextualized analysis and recommendations. Reports have featured an analysis of energy storage options based on location-specific utility data, renewable energy planning roadmaps, and EV strategies modeling energy consumption and planning data.

"[Through this workshop,] I got to know the limitations of each party in the negotiations and what is hidden behind PPA negotiations."

Survey Respondent, CLDP workshop on best practices for developing bankable PPAs.

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REGULATORY REVIEW

Regulatory reviews offer JUMPP governments an opportunity to enhance laws and policies in a way that advances clean energy deployment, transparent governance, and efficient system and market operations. Experts review and provide recommendations on proposed regulatory changes, such as on wholesale electricity market design, PPAs for renewable energy and storage, and policy frameworks. Partner country frameworks, such as Thailand's third-party access framework, have incorporated feedback and recommendations.

STUDY TOURS

Study tours are visits to the United States, which expose foreign power market authorities and officials to advanced U.S. clean energy and grid technology while facilitating interaction with peer power sector experts. Mekong officials meet with U.S. electric utilities, grid operators, private companies, and government regulators at control center site visits to observe real-time electrical grid management. Study tours have also featured visits to BESS sites, hydropower facilities, and renewable energy plants. USEA led a study tour for Vietnam's National Electricity System and Market Operation Company Limited (NSMO) staff on electricity market management systems, convening the Vietnamese delegation and U.S. grid operators to share lessons learned and best practices for assessing real-time electricity data needs. Likewise, NARUC led a study tour for regulators, introducing Mekong officials to U.S. state regulators to learn about strategies for managing the impacts of VRE on grid stability.

A delegation from the U.S. Department of State's Bureau of Energy Resources visits Thailand's Renewable Energy Forecast Center, which opened in 2023. Several technical assistance activities throughout JUMPP's first five years have shared methodologies for renewable energy forecasting.

1 PILLAR 1 ACCOMPLISHMENTS CLEAN ENERGY INTEGRATION

JUMPP countries are increasing use of clean energy assets while also working to maintain electric grid stability. Activities under the Clean Energy Integration Pillar build technical capacity on managing resource deployment and power system planning with increased renewables.

REGIONAL IMPACT

- A peer review for regulators on **regional transmission planning** featured an assessment of how increased levels of wind and solar affect how much electricity the power system can transmit and how reliable the power will be. The experts' feedback directly informed Mekong regulators' grid planning given the projected number of increases in electrical interconnections.
- A U.S. study tour with grid operators on renewable energy integration in control centers highlighted the importance of power system modeling – such as forecasting energy demand at varying time intervals, projecting supply from renewable sources, and how to digitize control center functions to automate processes related to dispatching clean energy. Many JUMPP country grid operators

received **training on different power system modeling tools** and software for renewable energy planning, which they incorporated into procedures at their control centers.

Trainings on wheeling charges, or charges
 related to the transport of power between
 different systems, and VRE grid integration,
 delivered in cooperation with leading regional
 entities from the Association of Southeast
 Asian Nations (ASEAN) and the United
 Nations, supported negotiations related to
 the Lao PDR-Thailand-Malaysia-Singapore
 power grid interconnection.

COUNTRY-SPECIFIC IMPACT

 A market study on BESS for Cambodia informed the country's first BESS procurement. Cambodia plans to incorporate 2,000 megawatts (MW) of wind and solar into the grid by 2030 accompanied by 1,000 MW of storage. The market study provided key input to decision-makers on least-cost pathways for Cambodia to achieve its renewable energy integration goals, quantifying the amount of BESS needed to reduce the gap between energy supply and demand.

- A series of workshops, trainings, and technical analysis with the Lao PDR enabled development of a suite of technical and commercial frameworks to manage VRE project development from inception through to commissioning and directly supports the interconnection of a 600 MW wind farm currently under construction. Key frameworks customized for solar, wind, and biomass projects included basic design guidelines, feasibility study guidelines, grid connection requirements, and testing and commissioning procedures.
- A JUMPP assessment of BESS technical requirements for a competitive grant resulted in an investment from Honeywell to build a 7.5 megawatt hour (MWh) battery storage system in a 50 MW solar farm in southeastern Vietnam. This \$2.96 million pilot will demonstrate how BESS can co-locate with a VRE system to reduce power losses, curtailments, and integrate additional solar into the grid.
- A series of technical trainings and reports helped **establish a renewable energy control center in Vietnam.** With analysis from Deloitte and ongoing support from PNNL, the national grid operator established the Renewable Energy Control Center in 2020, allowing for advanced resource planning and renewable energy integration. The country has since added **16 gigawatts (GW)** of solar capacity – a key component of Vietnam's decarbonization strategy.
- A series of technical reports and workshops for Thailand's Metropolitan Electricity Authority (MEA) supported the **pilot phase of its smart meter rollout program.** The reports provided strategic guidance for the pilot, business case analysis, and a data management model intended for direct use in monitoring EV and energy usage. This technical cooperation also helped prepare MEA for the planned installation of more than one million smart meters by the end of 2027.

- Analysis and trainings on methodologies for incorporating high penetrations of VRE resources enabled Vietnam to adopt JUMPP recommendations to update its national grid code. Vietnam made additional distribution grid code updates, incorporating recommendations from a JUMPP technical report on voltage regulation that will improve power system stability and allow power plants to remain stable and grid connected during disruptions.
- Matching grants provided by USAID to private sector entities and non-governmental organizations (NGOs) in the Lao PDR funded pilots of solar-powered pumping systems, offering farmers in remote areas an alternative, sustainable energy source, and funded an expansion of the EV charging network, making long-distance EV travel more feasible and supporting the transition to cleaner transportation.

"The latest grid code has taken into account the recommendations and results of this support. Some applications have been implemented, such as...monitoring of online system inertia."

Quang Nguyen, NSMO Deputy Director, Power System Analysis and Planning Department

Transmission line - Nha Trang, Vietnam. JUMPP partners have recommended updates to national grid codes to support deployment of renewable energy.

2 PILLAR 2 ACCOMPLISHMENTS MARKET DEVELOPMENT AND INVESTMENT

Activities under Pillar 2 support the creation of competitive retail electricity markets, build stakeholder capacity in regulating and pricing electricity, and share best practices in power trading regulations. These market development activities promote greater investment in the power sector, support stable electricity pricing, and enhance competition in power markets, thereby expanding access to cheaper power.

REGIONAL IMPACT

- A proprietary roadmap to establish a regional electricity market using data from Cambodia, the Lao PDR, and Vietnam outlined key steps for creating a cooperative regional framework to expand regional power trade. Recommendations highlighted power market rules, licensing regulations, and electricity pricing methodologies needed for an eventual regional power market.
- Workshops on PPAs conducted by legal experts with regulators and utility officials from Thailand and the Lao PDR provided information on how to tailor PPAs to renewable energy and emerging technologies and allowed operators to understand

regulators' constraints through a simulated negotiation. The workshops directly led to bilateral follow-on work with the Electricity Generating Authority of Thailand reviewing PPA clauses for other generation sources.

• A 2024 regional investment conference in Cambodia convened more than 160 stakeholders from government, clean energy developers, lending institutions, and Mekong subregion officials to facilitate investment opportunities and share detailed power development planning information directly with renewable energy developers, technical experts, and investors.

COUNTRY-SPECIFIC IMPACT

- Based on multiple regulatory workshops and expert reviews of frameworks with more than **50 clean power producers** in Thailand, the national regulator **released its thirdparty access framework in 2022**, which allows more customers to buy clean power directly from suppliers.
- Review of a PPA template in Cambodia supported future updates to commercial agreements for renewable energy and energy

storage. The PPA reviews allow Cambodia to incorporate essential language based on international standards to attract more investment for clean energy generation.

- A series of technical reports and workshops on the **expansion of Vietnam's wholesale electricity market** enabled Vietnam's regulator to oversee the shift to a more competitive market with additional suppliers and incorporate more clean energy generation. This capacity building supports the newly independent grid operator's status as it decoupled from the national utility in 2024, representing a significant step toward establishing a retail market.
- A series of workshops and regulatory reviews on frameworks contributed to Vietnam's release of its **direct PPA policy** and enabled greater private sector procurement of clean energy.
- The Lao PDR received a roadmap for establishing a market for renewable energy certificates, which are financial instruments awarded to renewable energy generators for production of electricity. Similar to carbon credit markets, these certificates will enable the Lao PDR to attract more private sector demand for clean energy. USAID and JICA will support development of a the Lao PDR renewable energy certificate issuing authority and development of a domestic renewable energy certificate market strategy, as outlined in the roadmap.

Staff from Électricité du Cambodge, the Electricity Authority of Cambodia, and the Cambodia Ministry of Mines and Energy engage in a 2024 workshop on best practices for developing bankable power purchase agreements in Phnom Penh, Cambodia.

3 PILLAR 2 ACCOMPLISHMENTS REGIONAL POWER TRADE

JUMPP aims to develop long-term strategies for regional power trade, or the import and export of excess electricity between neighboring countries. Connecting neighboring grid systems results in more secure energy access and facilitates higher volumes of VRE while providing economic growth opportunities for the region.

Currently, cross-border trade in the region remains relatively static due to long-term contracts restricting power exchange. Consequently, generators wishing to connect to cross-border transmission lines and sell power freely to buyers face limitations.

JUMPP activities have helped countries align on incremental technical and institutional changes that will enable and incentivize cross-border electricity flows. JUMPP provides a wide range of technical support to help the four Mekong partners learn how U.S. regional transmission organizations manage similar issues and is building consensus among JUMPP partners on a regional regulatory approach and shared technical standards to facilitate more crossborder power exchanges. The technical and regulatory changes JUMPP countries are working toward, if adopted, will expand the renewable energy generation market, maximize use of existing grid infrastructure, and allow for access to more affordable electricity.

JUMPP implementing partners have supported the growth of cross-border power exchange through multilateral government cooperation across 27 engagements and reports.

REGIONAL IMPACT

- Cambodia, the Lao PDR, and Thailand aligned on a new approach to trading power on existing transmission infrastructure, supporting regional energy security and lowering electricity costs. This initiative, featuring technical and economic modeling, works toward the adoption of shared technical requirements and methodologies for power trade on selected cross-border transmission lines, circumventing the typical long-term process of aligning countries around a harmonized regional grid code.
- The Lao PDR is updating its regulations and guidelines for wind and solar integration based on technical reports and trainings. Current guidelines only cover hydropower, limiting the Lao PDR's clean energy export potential. This work supports the interconnection of a 600 MW wind

farm currently under construction, which will allow the Lao PDR to export more electricity to neighboring countries.

- The assessment of the use of dynamic line ratings (DLR) on several existing interconnection points in Thailand, including on an existing cross-border Lao PDR-Thailand transmission line, provided operators better visibility into transmission line conditions, such as overheating and obstacles to power flow. Incorporating DLR will be a key step in allowing regional power trade over existing transmission infrastructure.
- Guidance for conducting cross-border transmission feasibility studies – an essential but financially challenging first step to transmission project development – will facilitate grant-financed feasibility studies of transmission infrastructure needed to support cross-border power trade. The advisory support ensures consistency in methodology across regional development and government partners.

• A Pathfinder Data Sharing Project, endorsed by regional energy ministers in 2024, will provide uniform reporting of bilateral and multilateral power exchange between Mekong and ASEAN power trading partners, enabling regional stakeholders to track power trading progress and trends on an annual and eventually monthly basis.

"I think JUMPP did a lot of great work in terms of [cross-border trade]. The pilot project between Lao, Cambodia, and Thailand is a good example. If this work comes into reality, it will inspire Mekong countries to accelerate this process."

Dr. Thongsavanh, Électricité du Laos

Participants from all four JUMPP participating Mekong subregion countries at a November 2024 workshop on cross-border trade held in Vientiane, the Lao PDR. Partners established a foundation for developing a model to allow greater regional grid integration and successful adoption of a standardized regional grid code.

LOOKING AHEAD

Since 2019, JUMPP governments have strengthened national regulations to encourage more clean energy investment, improved technical capacity to manage greater renewable energy use while maintaining electricity stability, improved renewable energy forecasting and power system planning capabilities, and made strides in further integrating the regional power market. In 2022, U.S. Vice President Kamala Harris highlighted JUMPP and pledged to seek additional funding for the partnership, emphasizing the U.S. commitment to energy security and economic development in the Mekong subregion. Senior U.S. and Japanese officials regularly underscore their commitment to the Mekong subregion's economic development and energy transition through JUMPP and other partnerships.

The Mekong subregion governments have ambitious decarbonization goals. Rooted in a desire to improve livelihoods, provide affordable and sustainable electricity, decarbonize and interconnect power systems, and foster economic development, JUMPP is a successful model of cooperation.

Vietnam NSMO staff visit PNNL's Electricity Infrastructure Operations Center for a training on control center operations and reliability analysis in 2022.

TIMELINE

August 2019

The governments of the United States of America and Japan launch JUMPP and release the "Joint Statement on the Japan-U.S. Mekong Power Partnership (JUMPP)."

December 2019

Vietnam's NSMO opens a renewable energy control center.

November 2021

The six governments establish the JUMPP Technical Advisory Group (TAG) to coordinate technical assistance priorities for the four Mekong subregion countries.

*January 2022 TAG Meeting

*April 2022 TAG Meeting

May 2022

Thailand releases its third-party access framework. Once implemented, the framework will enable more customers to buy clean power directly from distributors.

*June 2022 TAG Meeting

April 2023

Participating governments jointly announce the JUMPP Action Plan at the April 2023 Friends of the Mekong Senior Officials' Meeting.

*April 2023 TAG Meeting

May 2023

Hybrid **50 MW solar-BESS pilot** announced in Vietnam following grant from U.S. Mission.

June 2023

PNNL launches the WIRES mentorship program on behalf of the U.S. Department of State with female engineers and clean energy experts from the four JUMPP countries.

June 2023

The U.S. Department of State's Bureau of Energy Resources' Power Sector Program implementer Deloitte holds individual technical dialogues with Cambodia, the Lao PDR, and Thailand to begin selection of cross-border transmission lines for a pilot regional power market.

August 2023

The Electricity Generating Authority of Thailand opens its renewable energy forecast center.

*October 2023 TAG Meeting

November 2023

Cambodia, the Lao PDR, and Thailand finalize selection of crossborder transmission lines on which to pilot a regional energy market.

December 2023

WIRES program concludes, supporting mentorship for **42 women** and technical research projects related to the energy transition in their countries.

February 2024

Thailand announces its new utility green tariff, marking a key step in attracting corporate demand for clean energy.

April 2024

On behalf of the U.S. Department of State's Power Sector Program, USEA convenes the Clean Energy Investment Conference in Phnom Penh attended by more than 160 individuals, with remarks from Cambodia's Minister of Energy and a Bureau of Energy Resources Assistant Secretary. The conference saw **63 organizations** across the private and public sectors and highlighted clean energy investment opportunities in the Mekong subregion.

*April 2024 TAG Meeting

July 2024

Vietnam approves direct PPA policy, allowing for more corporate procurement of clean energy.

*August 2024 TAG Meeting

August 2024

Vietnam's grid operator, NSMO, formerly known as the National Load Dispatch Center, officially separates from the national utility and merges with the Ministry of Industry and Trade, representing a significant step in moving toward a competitive retail market for electricity.

September 2024

ASEAN energy ministers endorse the implementation of a Pathfinder Data Sharing Project, which will enable standardized and transparent reporting of bilateral and multilateral power trade across the ASEAN Power Grid (APG). The project will enable APG stakeholders to track power trading progress on an annual and ultimately monthly basis.

Cambodia releases a request for bidding for its first **125 MWh BESS** pilot project.

November 2024

The State Department's Power Sector Program and partner Deloitte convene a workshop in the Lao PDR with Cambodia, the Lao PDR, and Thailand on interconnection grid codes and electric transmission power flow methodology to expand cross-border trade on identified interconnector pilot projects.

*November 2024 TAG Meeting

GLOSSARY

Battery energy storage system (BESS): An electrochemical device that charges (or collects energy) from the grid or a power plant and then discharges that energy at a later time to provide electricity or other grid services when needed.

Clean energy: Technology that relies upon energy resources that do not produce greenhouse gas emissions. This includes solar, hydro, geothermal, bioenergy, and nuclear power.

Distributed generation: Small-scale electricity infrastructure that generates electricity at or where it is used. Examples include rooftop solar panels.

Energy security: The uninterrupted availability of energy at an affordable price to minimize negative consequences from energy use, including efficiency, environmental, social, and geopolitical factors.

Grid code: A set of technical requirements for connecting and using a transmission system and grid infrastructure. The growth of VRE has necessitated countries worldwide to update their grid codes to help maintain grid reliability.

Power purchase agreement (PPA): A commercial agreement to purchase electricity between a buyer and supplier of energy. The purchaser or "offtaker" buys power from a project developer at a negotiated rate for a specified term without taking ownership of the system. The project developer builds, operates, and maintains the system. PPAs provide security to both project developers and consumers by guaranteeing revenue streams and thereby offsetting investment risk, and by guaranteeing dispatch of electricity.

Regional (or cross-border) power trade: Power trade between one or more jurisdictions, typically countries. Crossborder power trade supports key national objectives such as improved grid resilience, increased energy access, lower electricity costs, renewable energy targets, and economic development and cooperation.

Regional power market: The cross-border transaction of power whereby electricity prices change at given intervals based on regional market conditions.

Renewable energy: Energy that comes from unlimited, naturally replenished resources (e.g., the sun, tides, and wind). Renewable energy can be used for electricity generation, space and water heating and cooling, and transportation.

Renewable energy control center: Renewable energy control centers forecast output of, monitor, and control VRE. As

systems integrate greater shares of VRE, these functions are critical for maintaining grid stability.

Retail market: After electricity is bought by entities in the wholesale market, it can be sold to end users in the retail market. In electricity sectors with retail markets, consumers have options for purchasing electricity; they can choose from their local utility or competitive retailers. These resellers purchase electricity through wholesale electricity markets before they resell it to consumers.

Smart grid: Smart grids are power production and distribution systems that allow for two-way flow of electricity and communication. These systems are ultimately designed to deliver sustainable, cost-effective, and secure electricity supply.

Smart meter: Smart meters provide two-way communication between customers and utilities and help utilities maintain more reliable electrical service.

Third-party access: When electric utilities allow others to use their grid (transmission and distribution power lines and facilities) to move power from one point to another on a nondiscriminatory basis.

Utility green tariff: Utility green tariffs are optional programs in regulated electricity markets offered by utilities and approved by state public utility commissions that allow larger commercial and industrial customers to buy renewable electricity from a specific project through a special rate.

Variable renewable energy (VRE): Energy technologies that rely on a renewable fuel source, such as wind and solar, and do not deplete based on use. Unlike traditional power plants, which run on fuel sources such as coal, oil, or gas, VRE output fluctuates based on weather conditions. Countries can couple VRE with storage technology to allow power dispatch when the availability of renewable resources is low (e.g., reduced sunlight). VRE, without energy storage, is "non-dispatchable," meaning operators cannot adjust output like with traditional fossil fuel generating units.

Wholesale electricity market: Like other commodities, electricity is bought and resold multiple times before being delivered to the end-use customer. These transactions form the wholesale electricity market. Suppliers that sell electricity to retail consumers or other large-scale consumers purchase energy through a wholesale market.

Sources: FERC, National Grid, PJM, U.S. Department of Energy

