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Enabling Floating Solar (FPV) Deployment: Policy and Operational Considerations

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Presentation Overview

- Overview of NREL's Floating Solar Research
- FPV Policy Considerations
- Hybrid FPV – Hydropower Considerations
- Future Research

NREL's FPV Research Activities

- FPV is becoming an increasingly competitive option;
- However, the technology is still nascent, and many potential adopters have questions about the underlying technology, benefits, its potential impacts, and how to analyze it appropriately.

Analysis

- How does FPV impact power system operations, and what benefits does it provide?
- What are the costs and benefits of co-locating FPV with hydropower?
- What tools can be developed for FPV analysis, or how can existing tools be used?

Implementation

- Identify FPV investment opportunities and technical potential in a given area.
- Conduct a techno-economic assessment of potential projects using NREL's established methodology.
- Identify unique regulatory and policy issues that need to be addressed for deployment.

Monitoring and Evaluation

- Monitor existing systems to document system output performance benefits.
- Validate and quantify the environmental benefits of FPV related to reduced water evaporation and reduced algal growth.

Technology Research

- Research and development of built-for-purpose PV and supporting systems for FPV
- Explore FPV system designs that reduce equipment weathering and erosion.

Figure. FPV Research and Analysis Topics

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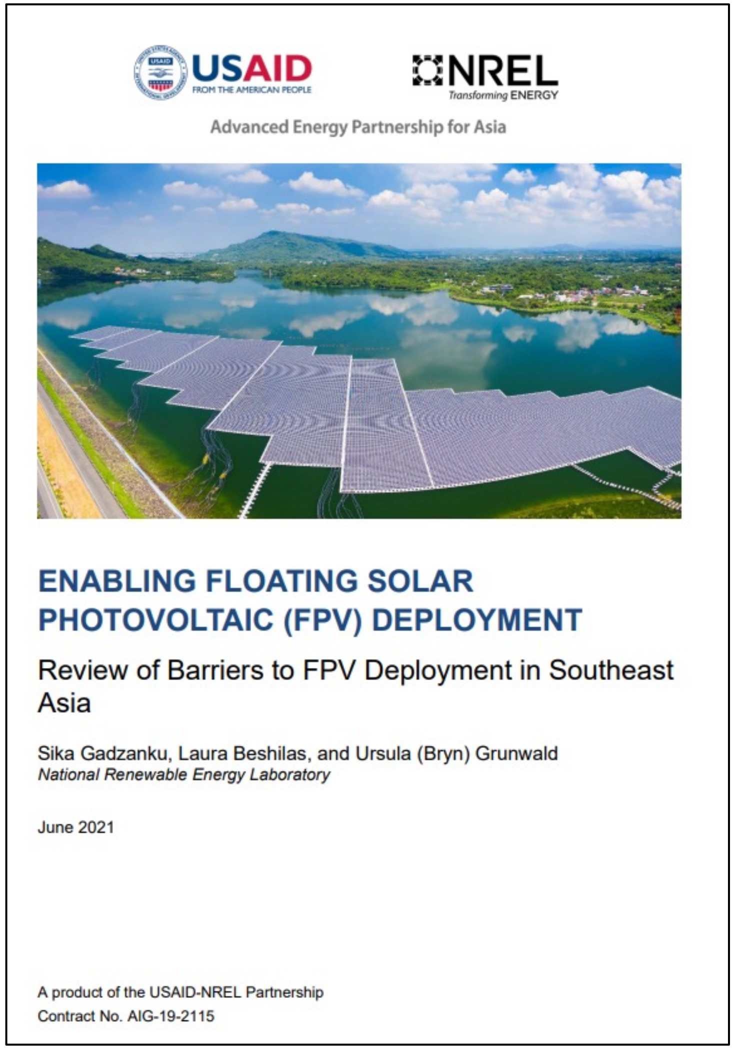
Southeast Asia Context Setting

- Why are countries considering FPV?
  - Ambitious renewable energy targets
  - Abundant solar and hydropower resources
  - Land-use benefits
  - Option to hybridize with hydropower generation
  - Ability to diversify power generation mix and decrease reliance on imported fossil fuels
- What are some considerations?
  - Potential policy drivers and barriers to deployment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ENABLING FLOATING SOLAR PHOTOVOLTAIC (FPV) DEPLOYMENT

Review of Barriers to FPV Deployment in Southeast Asia

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Source: https://www.nrel.gov/docs/fy21osti/76867.pdf

Examples: China, Japan, and South Korea

Relatively Mature FPV Markets:

- **China** supported FPV deployment on otherwise unusable land and artificial water bodies, as opposed to natural water bodies that may have a more complex environmental review process. The government encouraged renewable energy (RE) deployment, including FPV deployment, via national targets and regional requirements.
- **Japan** incentivized the deployment of FPV systems in land-constrained countries that had competing land-use needs for agriculture. This allowed populations to ease land-use pressures and align with policies that provided clean and affordable electricity. Japan also supported FPV deployment through multiple policy instruments including R&D support and funding pilot and demonstration projects.
- **South Korea** invested in growing a local, job-creating FPV industry as well and helped to avoid land-energy conflicts caused by land-based PV systems competing with other land-use needs.

Global Examples: India, Netherlands, and Taiwan

Emerging FPV Markets:

- **India** is supporting FPV deployment through generous incentives.
- **Netherlands** is providing direct financial and production-based incentives to help de-risk FPV systems. The country is also encouraging interagency cooperation to help reduce administrative hurdles to deployment.
- **Taiwan** offers a lesson on the need to carefully design incentives so as not to over-incentivize participation.

Takeaway: Enabling policies for FPV deployment must be coordinated with grid integration studies and proactive transmission planning to ensure that the grid is well-positioned to integrate large shares of solar generation. This is especially true for FPV systems and other emerging energy technologies, where the profitability of early projects is a key signal to developers.

Barriers

- Uncertainty about FPV ecological impacts may increase public opposition to projects and lengthen the environmental review process.
- Lack of public buy-in of FPV technology due to visual impacts and competing uses of water bodies could stall project development.
- Previous negative experiences with RE projects may lead to an unfavorable public opinion of FPV systems.

Best Practices to Consider

- Government support for additional research and development (R&D) and analysis on the environmental impacts of FPV systems could shorten the environmental review process.
- Prioritizing obtaining public buy-in and support through public outreach and engagement can avoid delays during the FPV project development process.
- Developing educational programs to inform the public about the benefits of FPV systems

Environmental and Cultural Considerations

Barriers

- Nonexistent or unclear rules on the ownership, market participation, and operation of hybrid hydropower-FPV plants may complicate and stall project development

Best Practices to Consider

- Clear regulatory processes on the ownership and market participation models and valuation methods for FPV hydropower hybrid systems
- Development of operational and engineering best practices and training of hydropower power plant operators could help ensure smooth operation of these hybrid systems.

Hybrid-Related Considerations

Case Study: What are the operational benefits of hybridizing FPV with hydropower?

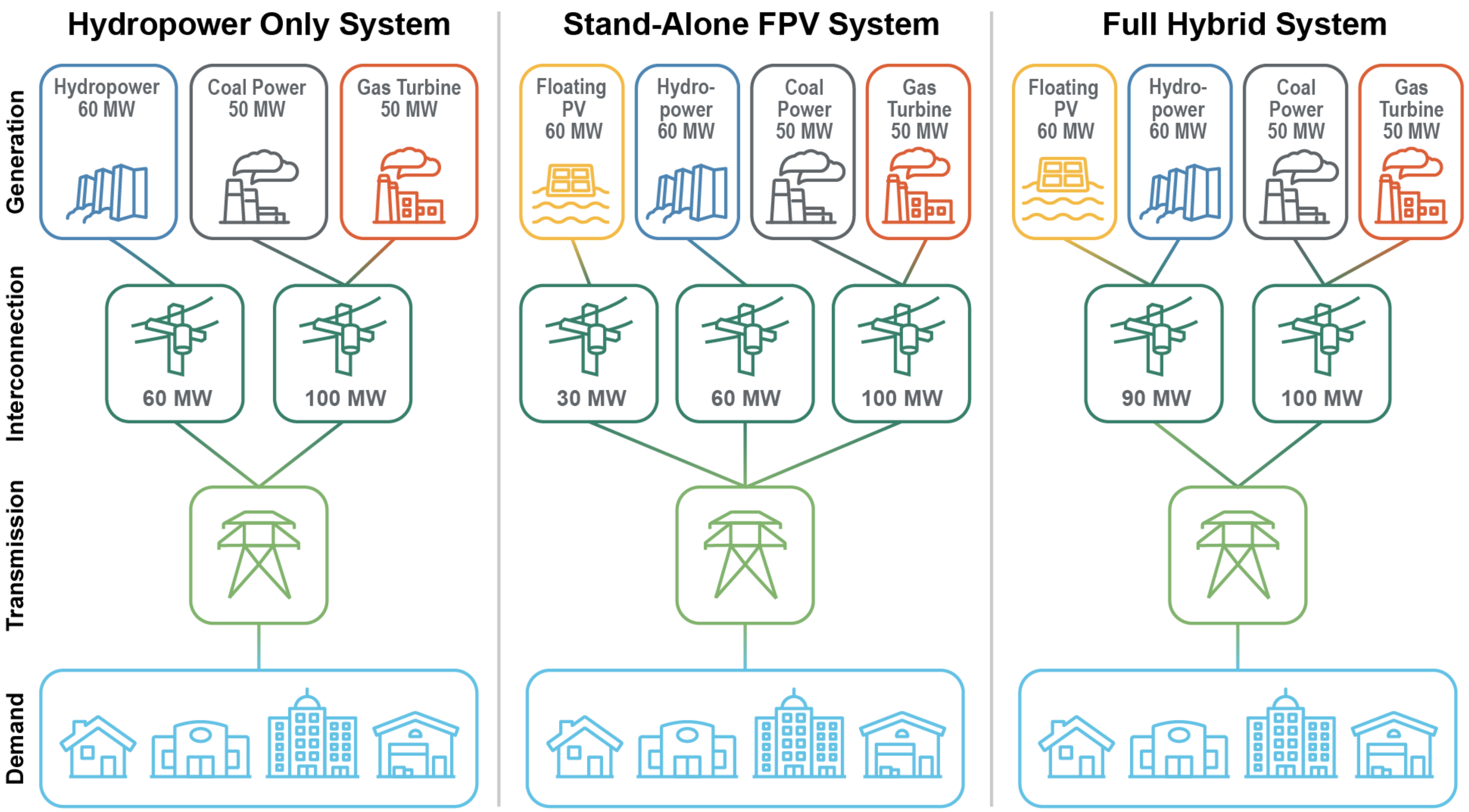

Fig. Example system configurations for the Hydro-Only (left), FPV Stand-Alone (middle), and Hybrid FPV-Hydropower (right) systems.

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How did we explore this research question?

engage

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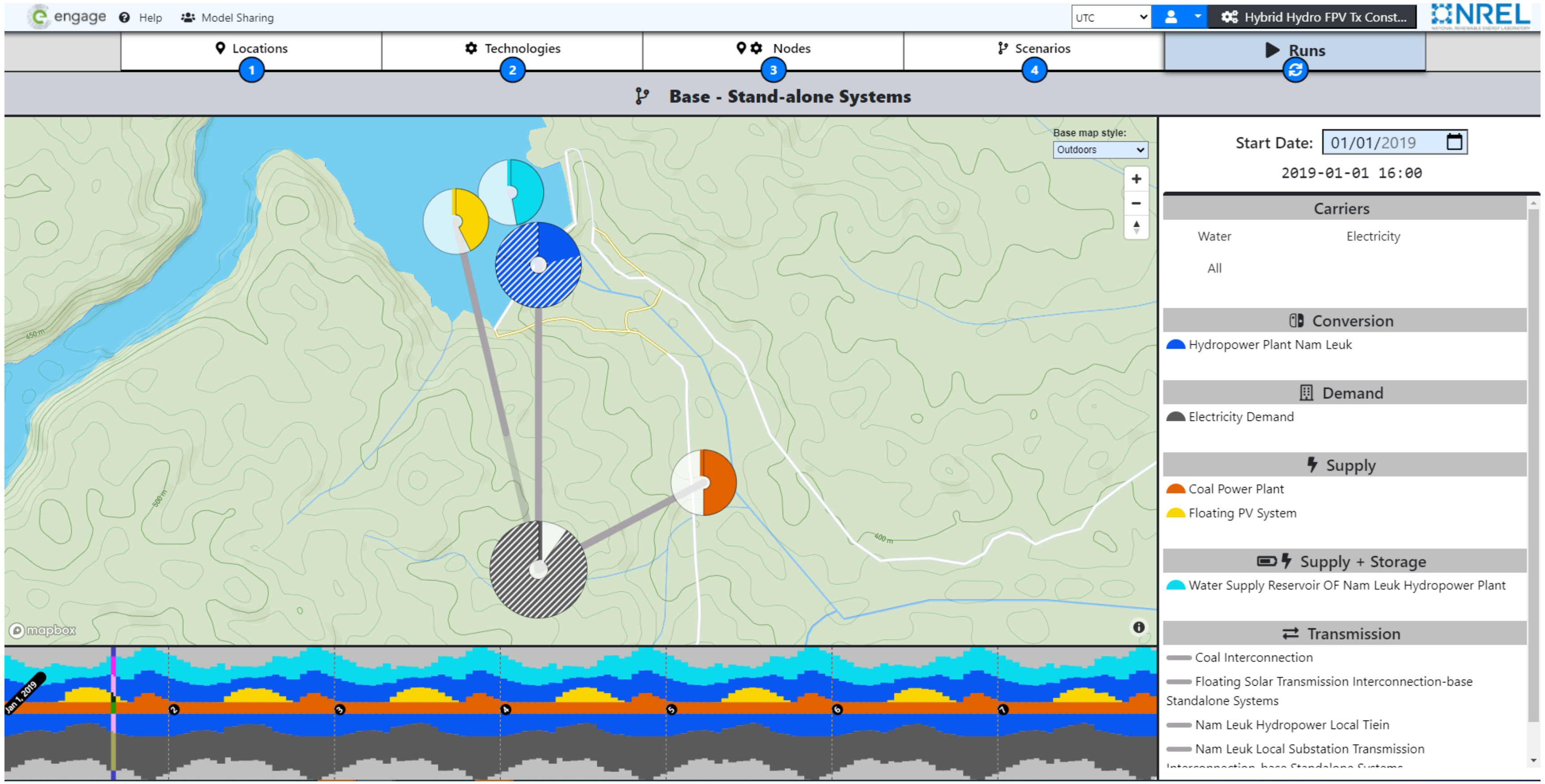
We used the Engage™ model, a web-based modeling platform that enables multi-energy-sectoral planning.

We quantified the differences in PV and hydropower generation.



For more information on Engage, visit: https://engage.nrel.gov/en/login/?next=/en/

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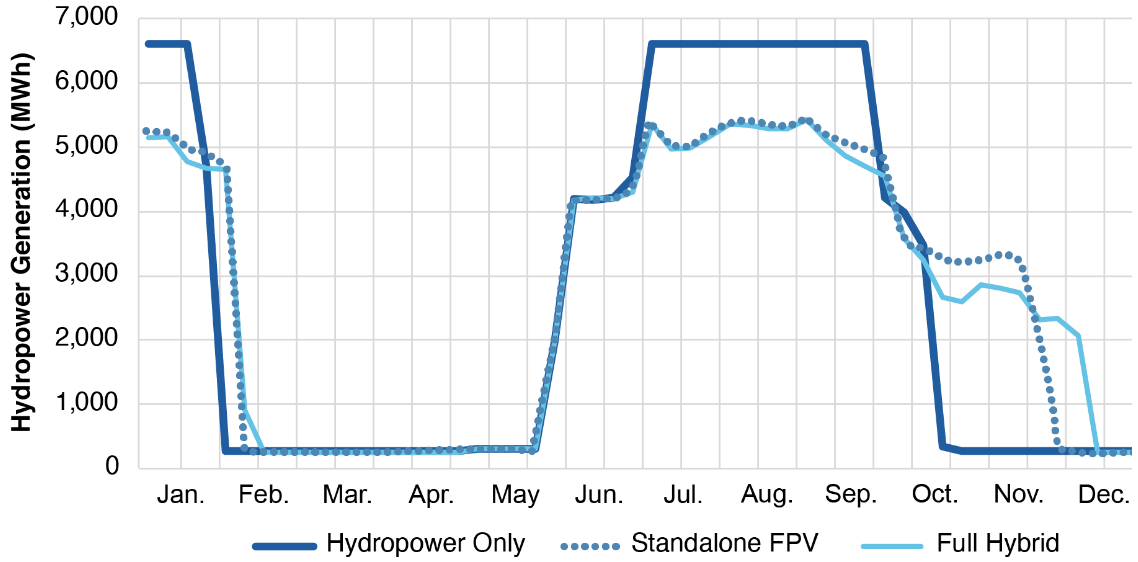
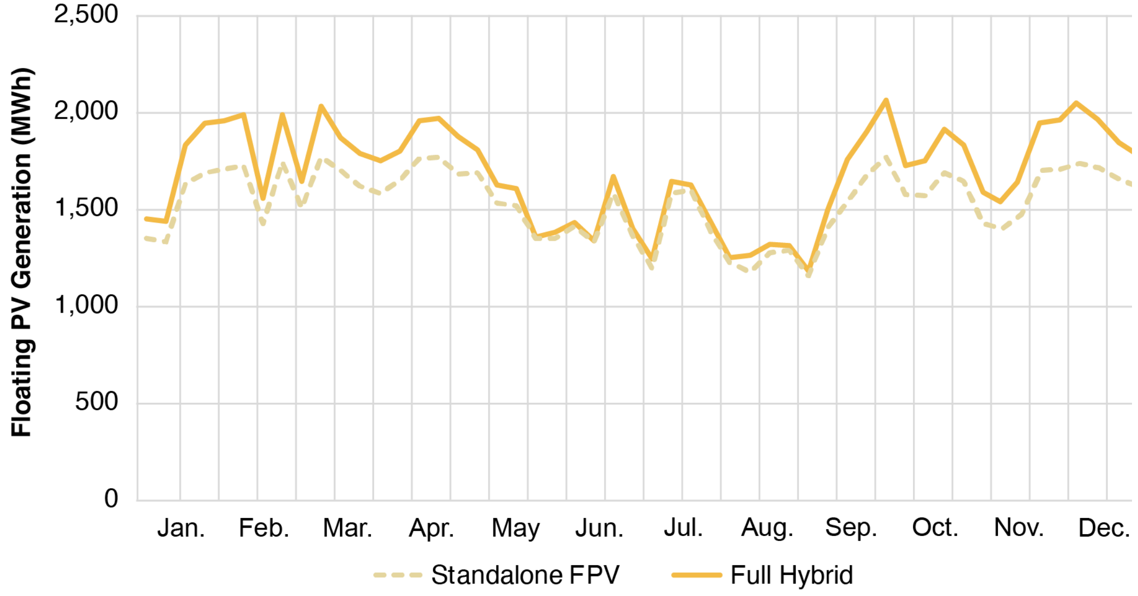
What were some of our findings?

Compared to a Stand-Alone FPV system, hybridizing FPV with hydropower helps:

- Lower PV curtailment when transmission constraints cause curtailment;
- Reduce dependence on other types of generation, such as gas-fired generation, by reducing PV curtailment;
- Conserve water by shifting hydropower generation to other periods of the year.





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Upcoming Work

Objectives:

This activity seeks to support Southeast (SE) Asian countries in transitioning to clean energy by assessing the technical potential of FPV in the region. This activity will use the best-in-class solar resource data for SE Asia provided through RE Data Explorer to:

- Assess the FPV potential across SE Asia
- Identify a short-list of FPV opportunities across the region that supports private sector investment in aid of the region's clean energy transition.

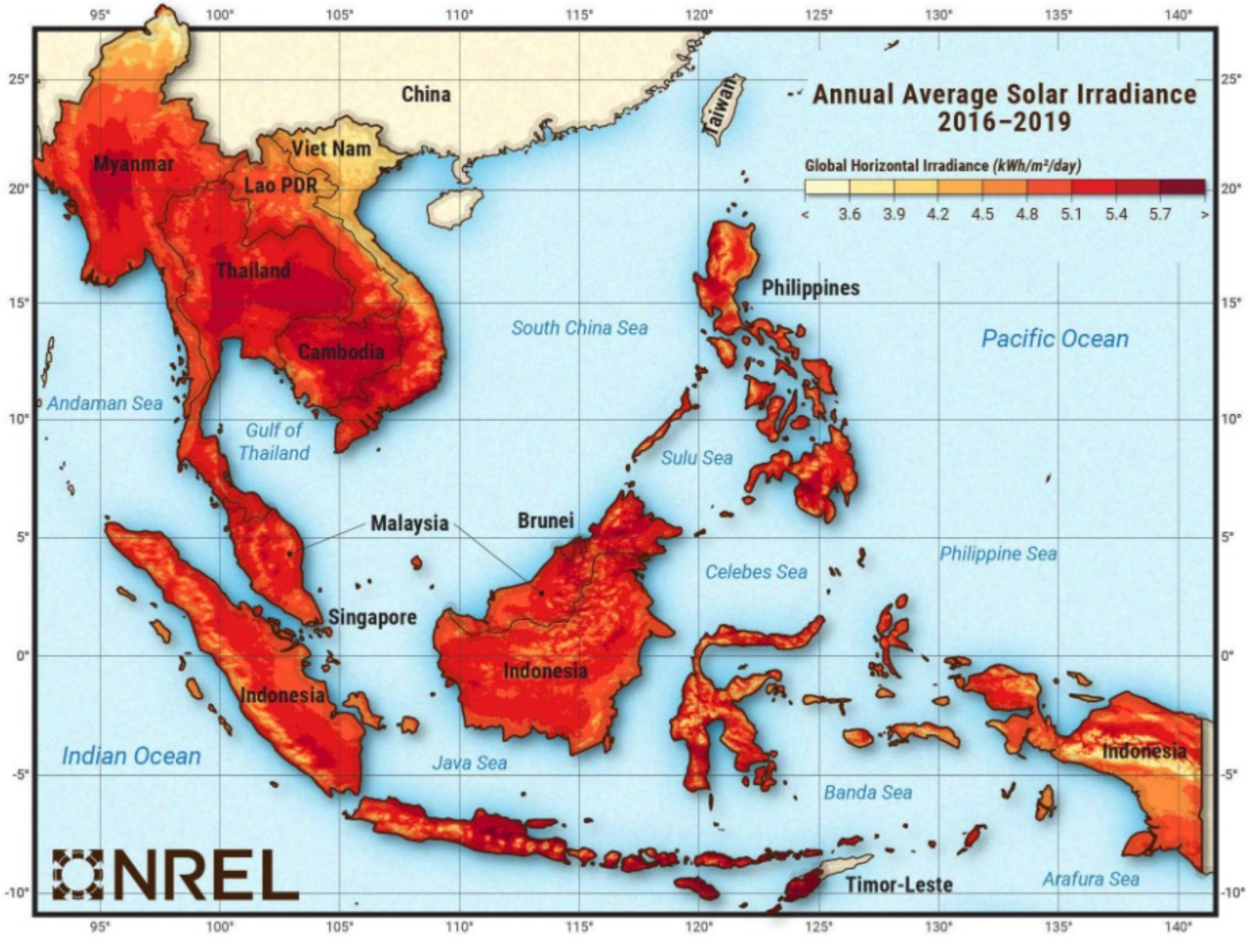

Figure 2. *The above figure depicts annual average Global Horizontal Irradiance (GHI)spanning 2016-2019 and is based on data collected by the Himawari-8 satellite and processed using the Physical Solar Model Version 3 (PSM-v3). Image by Billy J. Roberts, NREL*

Overall Takeaways

- Potential FPV adopters have questions about the underlying technology, its benefits, its potential impacts, and how to analyze it appropriately.
- More research is needed into the potential environmental and ecological impacts of FPV systems.
- Considering FPV – hydropower hybrids, our results suggest that the size of the FPV system relative to the hydropower system in a hybrid plant drives a trade-off between seasonal smoothing of hydropower generation and PV curtailment.
- Enabling policies for FPV deployment must be coordinated with broader long-term power sector planning efforts to ensure the grid is well-positioned to integrate large shares of solar generation. This is especially true for FPV systems and other emerging energy technologies, where the performance of early projects is a key signal to developers.

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Further Reading

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Thank you!

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Extra Slides

Barriers

- Subsidizing fossil fuels can create an uneven playing field, making it difficult for FPV systems to compete in the market.
- Economic policy uncertainty may stall private sector interest in FPV systems.
- Trained workforce shortages raise FPV deployment costs.

Best Practices to Consider

- Creating clear, complementary, transparent, and consistent incentives for energy development can reduce uncertainty for FPV projects and reduce project development cost.
- Consistent and targeted government support to FPV systems in the form of rebates, tax incentives, and competitive RE auctions could help de-risk FPV systems and attract private sector financing.

Economic Considerations

Barriers

- Uncertainty about water rights may delay FPV project development and increase costs.
- Lack of interagency cooperation and coordination may stall FPV deployment.
- Lengthy, expensive, and unclear environmental approval processes for FPV systems can make projects less financially appealing.

Best Practices to Consider

- Clear policies around water rights for FPV projects could reduce uncertainty during the project development process.
- Engaging with policymakers and financial institutions to increase awareness of FPV systems can lead to increased support for investing in R&D and deployment projects.

Regulatory Considerations