



Advanced Energy Partnership for Asia

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

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- 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, its benefits, its potential impacts, and how to analyze it appropriately.

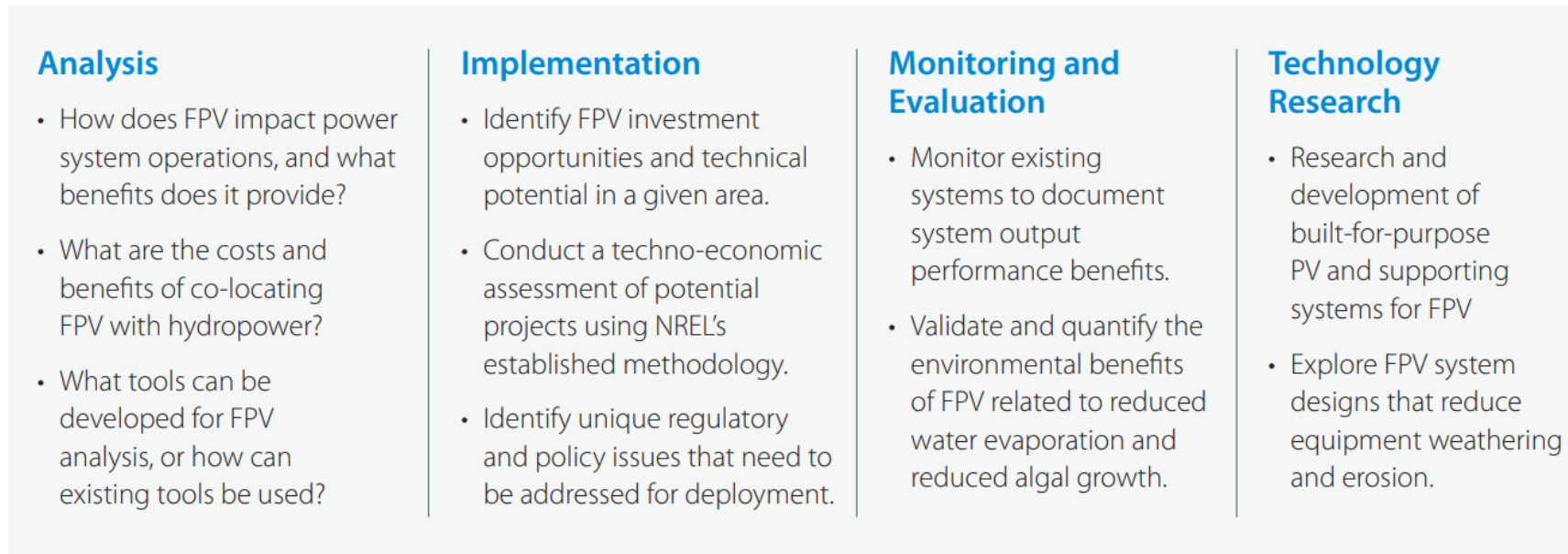
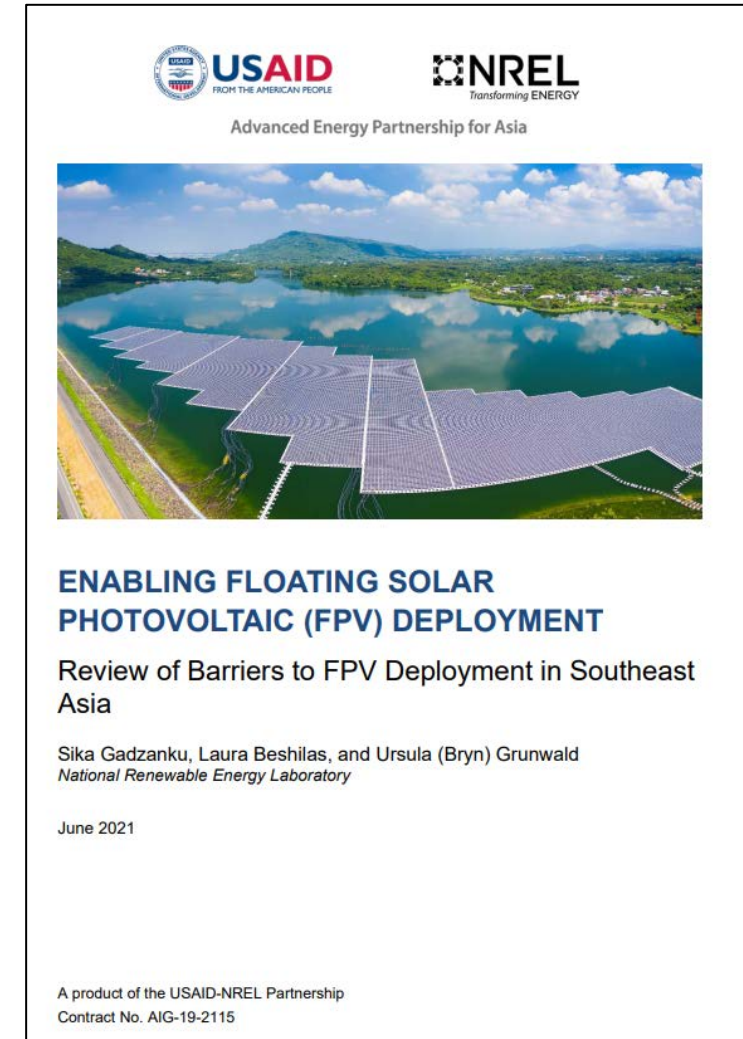


Figure. FPV Research and Analysis Topics

- 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



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

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.

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

- 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

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?

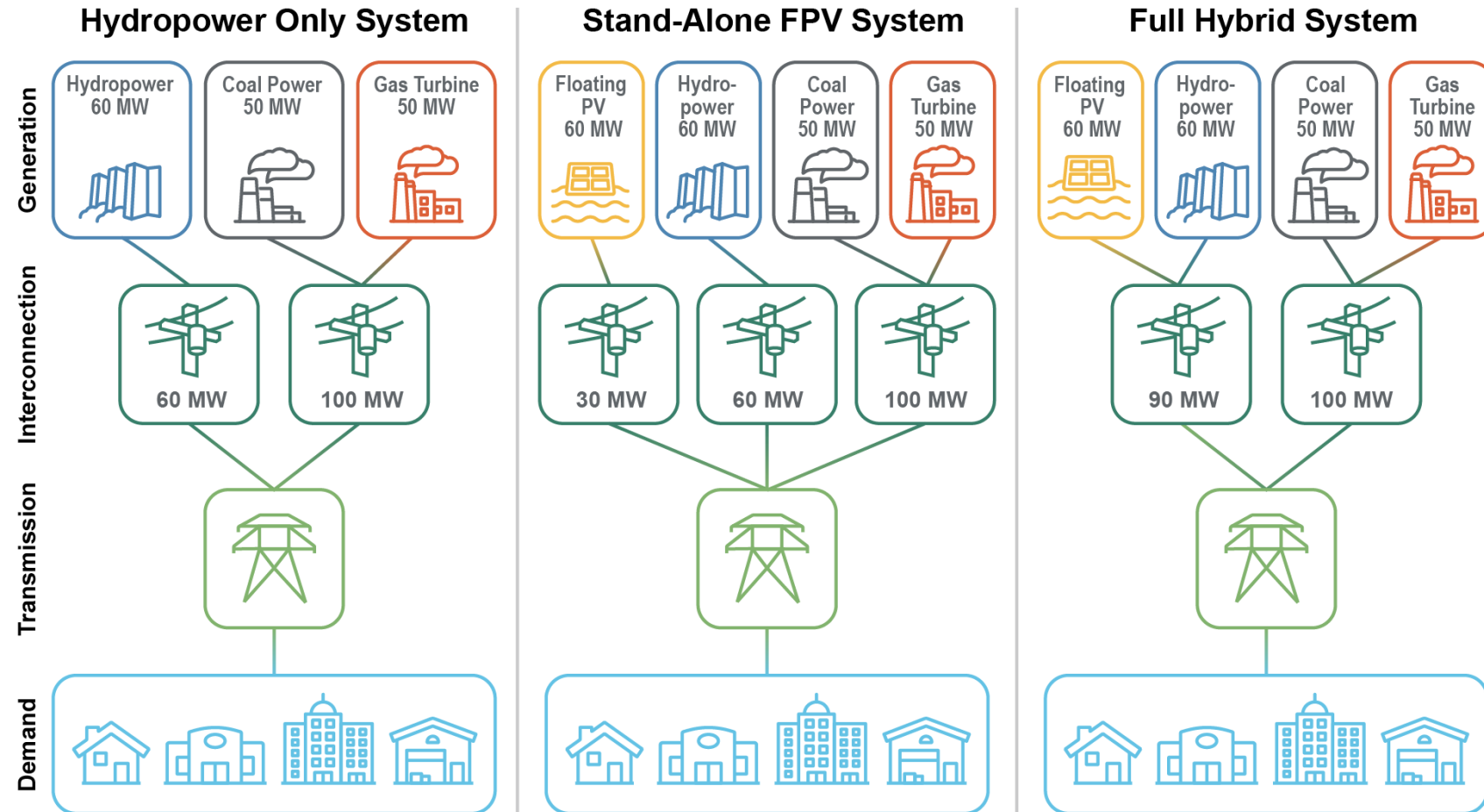
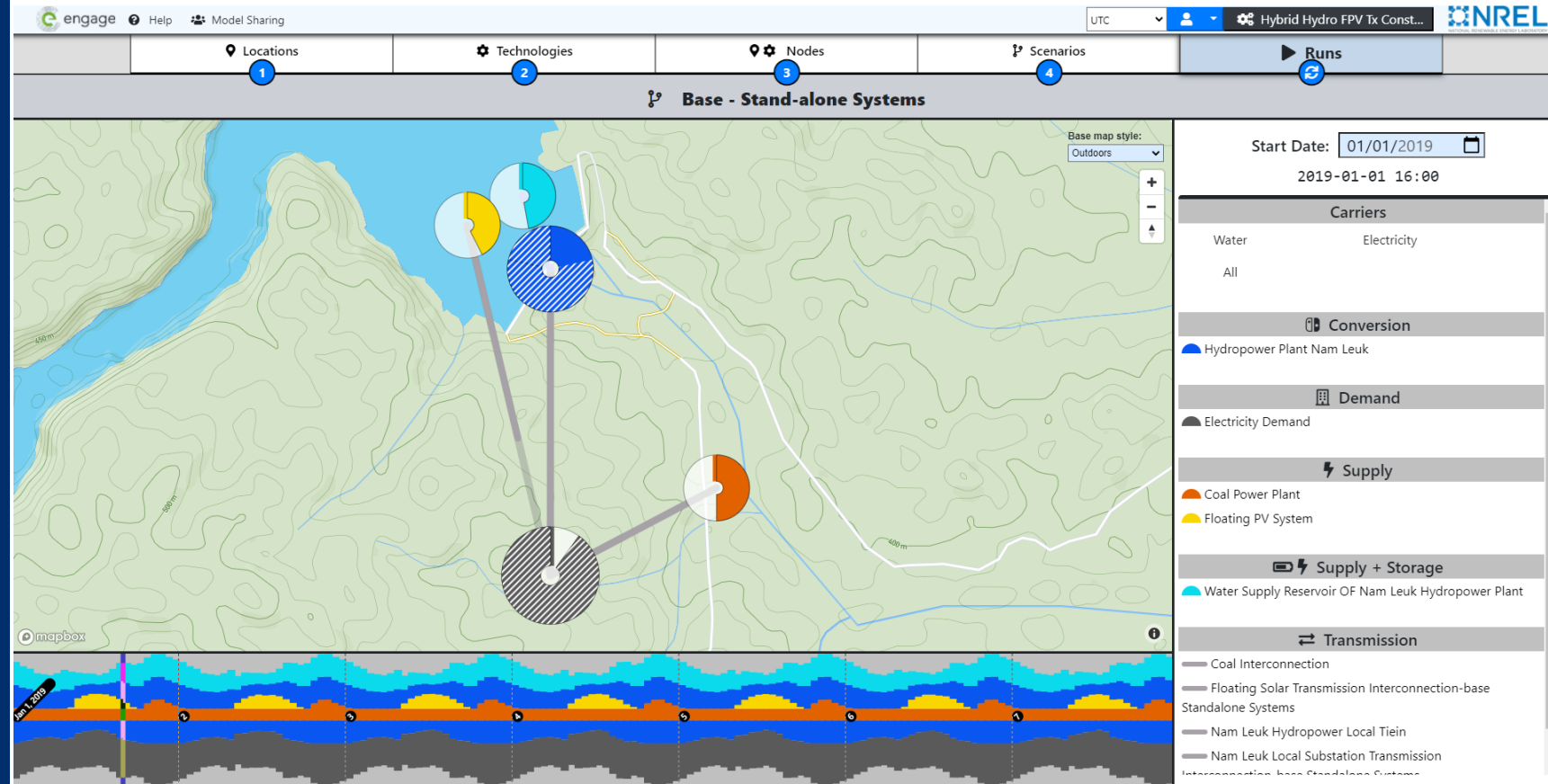


Fig. Example system configurations for the Hydro-Only (left), FPV Stand-Alone (middle), and Hybrid FPV-Hydropower (right) systems.

How did we explore this research question?

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.



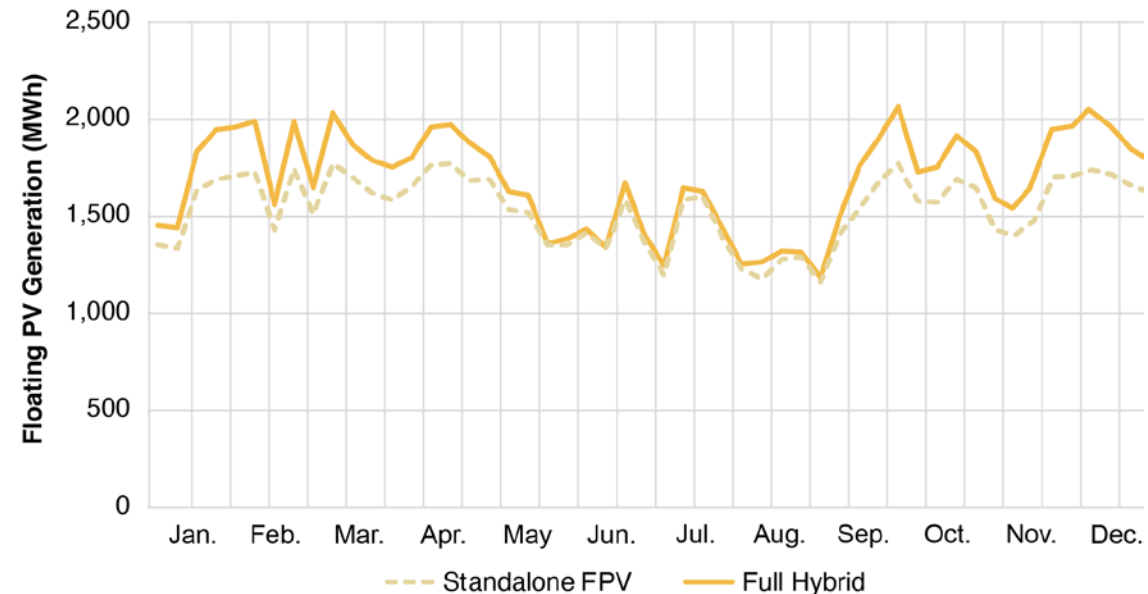
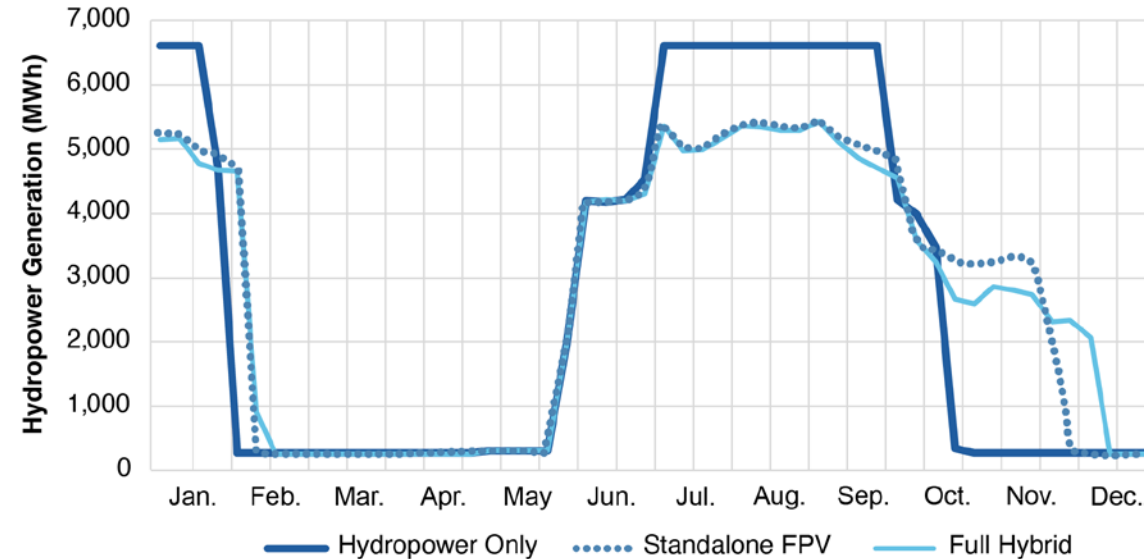
For more information on Engage, visit: <https://engage.nrel.gov/en/login/?next=/en/>

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.

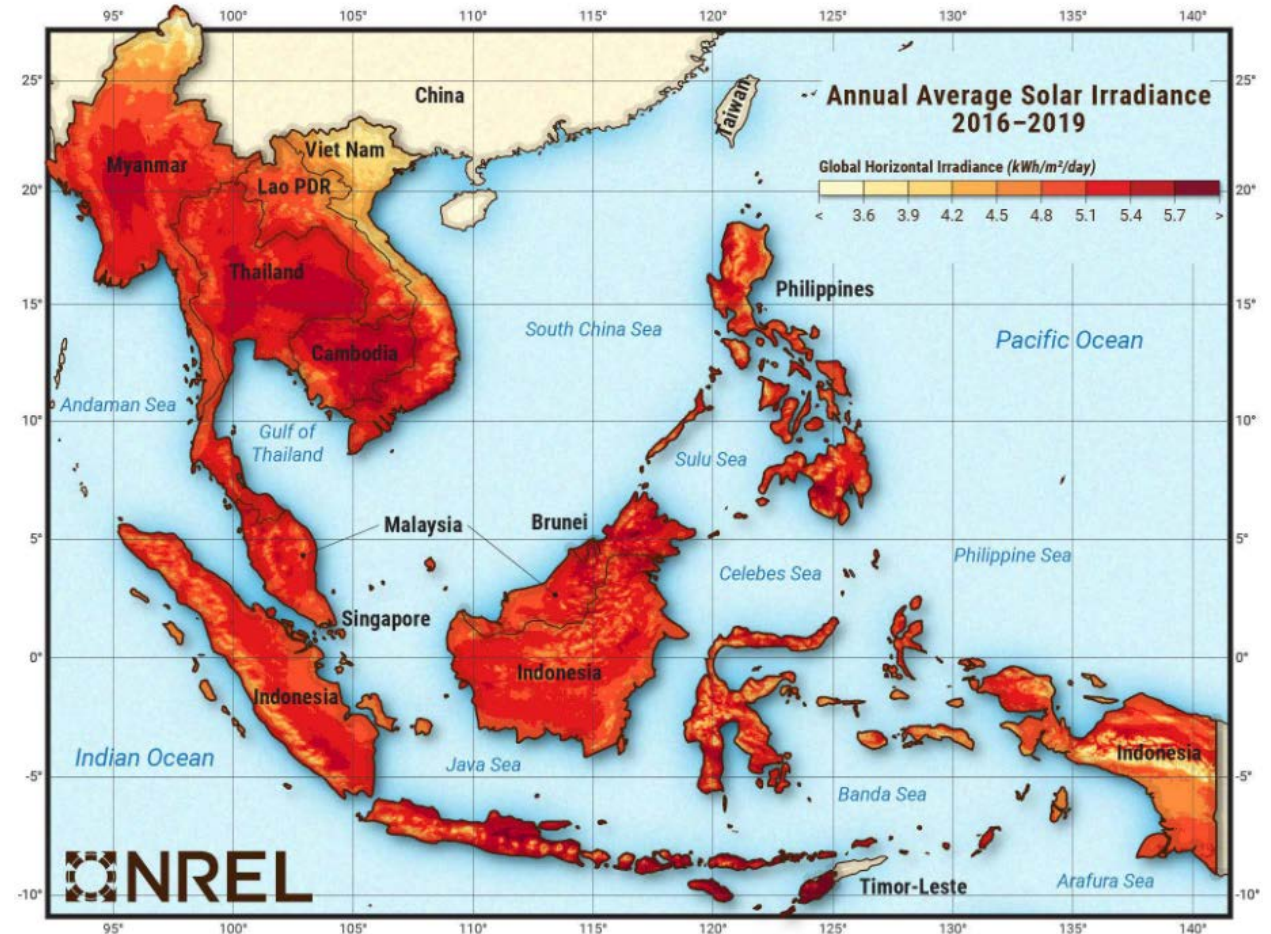


Figure 2. The above figure depicts annual average Global Horizontal Irradiance (GHI) spanning 2016-2019 and is based on data collected by the Himawari-8 satellite and processed using the Physical Solar Model Version 3 (PSM-v3). Image by Billy J. Roberts, NREL

- 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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