



ENERGY STORAGE: WHAT, WHEN, WHY, WHERE AND HOW?

Three-day training for utilities, system operators, and policymakers

October 28-30, 2019

Novotel Bangkok Ploenchit Sukhumvit
566 Phloen Chit Rd, Bangkok

Workshop Partners



Overview

Many power systems are integrating large shares of variable renewable energy (VRE, i.e., wind and solar) and planning for more. Meanwhile, the costs of energy storage technologies (lithium-based battery systems in particular) are rapidly declining, strengthening the economic case for deploying these technologies. However, many of the details and nuances around the roles and values of emerging storage technologies remain clouded by marketing, popular media attention, and misperceptions about the role of energy storage in the transmission and distribution grid.

This training will provide a comprehensive overview of energy storage technologies and will equip participants with knowledge and emerging international best practices to confidently and effectively evaluate pathways for energy storage deployment. Most of the training will be technically focused in order to address questions, concerns, myths and misperceptions about the role of energy storage in a high-RE power system.

This training is sponsored by the United States Agency for International Development (USAID) and implemented by the US Department of Energy's National Renewable Energy Laboratory (NREL). The training also represents a component of USAID's Greening the Grid program.

Objectives

The purpose of this three-day training is to provide participants the fundamental knowledge and resources needed to make informed decisions on policies, regulations, and deployments of energy storage technologies. In addition to energy storage topics, the training will provide an overview of grid integration concepts and approaches, including market design considerations, international best-practices, and lessons-learned for cost-effective grid integration. It will also weave case studies and practice sessions throughout the three-day training.

As a result of this training, participants will be able to address:

- **Challenges:** Identify the unique challenges and opportunities associated with energy storage technologies in high VRE power systems;
- **Solutions:** Articulate how storage technologies impact power system flexibility, which is an important concept for understanding the broader context of VRE integration. Identify policies, regulations, and operational practices that enable power systems to make use of different value streams from storage (e.g., peak shaving, operating reserves, transmission and distribution upgrade deferral, etc.);
- **Case studies:** Identify real-world examples of storage technology deployment
- **Application:** Synthesize concepts and best practices into system-specific action plans for improving the policy and regulatory environment for energy storage technologies.

Audience

The primary audience for this training workshop includes power system operators, utilities, and regulators from across the Asia-Pacific region. Policymakers with a technical focus will also benefit from this training.

Facilitators

Jen Leisch, USAID

Thanawat Keereepart, USAID Clean Power Asia

Speakers

Jaquelin Cochran, NREL

Carishma Gokhale-Welch, NREL

Ilya Chernyakhovskiy, NREL

Thomas Bowen, NREL

Leon Roose, HNEI

Craig Hart, IEA

Language

The training will be delivered in English.

Additional Resources

For more information and advance reading about grid integration issues, please see the resources at <http://greeningthegrid.org>.

Day I

Time	Session Title and Subject Matter	Speaker
8:30-8:45am	Registration	
8:45-8:55am	Opening Remarks and Welcome	Amanda Van den Dool, USAID Patana Sangsriroujana, EGAT Thailand
8:55-9:10am	Introduction and Icebreaker <ul style="list-style-type: none"> • Participant introductions • Understand training agenda, handouts, and training objectives 	Jennifer Leisch, USAID Thanawat (Yok) Keereepart, Clean Power Asia
9:10-9:30am	Context Setting: Introduction to Key Grid Integration Concepts, Challenges, and Opportunities in Asia	Jaquelin Cochran, NREL
9:30-10:00am	Interactive Session: Energy Storage in Asia <ul style="list-style-type: none"> • Interactive group activity in which participants have the opportunity to identify unique <u>challenges</u> and <u>opportunities</u> associated with VRE integration • Each group will select one representative to provide a read-out at the end of the session 	Workshop participants
10:00-10:30am	Principles of Energy Storage <ul style="list-style-type: none"> • Motivation: Why are we focusing on storage? Is storage needed to integrate VRE? • Introduce framework of the flexibility supply curve • Storage definitions, technologies, use cases, and examples • Cover the whole spectrum of energy storage • Introduce the concept of value stacking • Q&A 	Ilya Chernyakhovskiy, NREL
10:30-11:00am	Group Photo, Coffee Break, “Millionaire”	‘Millionaire’ facilitated by Jen Leisch, USAID
11:00-11:30am	From Planning to Implementation: Snapshots of Energy Storage Deployments <ul style="list-style-type: none"> • Pique participant interest with a series of high-level case studies of real-world energy storage systems • Spend some time on the context for each example (pilot project? merchant project in wholesale market? utility owned? etc.) • Q&A 	Leon Roose, HNEI Marc Matsuura, HNEI

Time	Session Title and Subject Matter	Speaker
11:30-12:00pm	Role of utility-scale scale battery storage projects <ul style="list-style-type: none"> Review specific services that utility-scale storage technologies can provide and tend to provide in practice, and how mechanisms such as grid codes, market rules and contracts enable the provision of these services Q&A 	Ilya Chernyakhovskiy, NREL
12:00-1:00pm	Lunch and ‘Millionaire’	‘Millionaire’ facilitated by Jen Leisch, USAID
1:00-1:30pm	Representing Energy Storage in Grid Integration Studies in Asia	Craig Hart, IEA
1:30-2:00pm	When Is Storage Needed? Planning for Storage Deployment <ul style="list-style-type: none"> Understand the role and value of analysis in power system long-term planning Identify analysis tools and metrics to evaluate storage value in planning analysis Understand how to evaluate the capacity value of storage resources for the bulk power system Q&A 	Jaquelin Cochran, NREL
2:00-2:30pm	Planning and Analysis Case Study <ul style="list-style-type: none"> Planning for Utility Scale Storage in Hawaii 	Leon Roose, HNEI
2:30-3:00pm	Coffee Break and ‘Millionaire’	‘Millionaire’ facilitated by Jen Leisch, USAID
3:00-3:30pm	Procurement of Utility Scale Storage <ul style="list-style-type: none"> Options for the procurement of storage How to compensate for storage services Key considerations and insights from storage procurement experiences 	Ilya Chernyakhovskiy and Carishma Gokhale-Welch, NREL
3:30-4:15pm	Interactive Group Session: Mapping Flexibility Priorities and Storage Needs <ul style="list-style-type: none"> Reflect on needs and opportunities for grid-scale storage to contribute to power system flexibility in your country Go to the sticky wall What mechanisms are needed, or should be improved (policies, etc) What current planning processes are in place that include storage considerations? What new tools/data are needed? 	Workshop participants
4:15-5:00pm	Panel Session and Day 1 Wrap Up <ul style="list-style-type: none"> Q&A session: Cochran, Roose, Hart, Chernyakhovskiy 	Facilitated by Jen Leisch, USAID

Time	Session Title and Subject Matter	Speaker
	<ul style="list-style-type: none"> Reflect on energy storage: what are the key points, what are your needs, and what opportunities do you see? 	

Workshop Reception
Novotel Hotel, Sky Lounge (29th floor)
7:30pm - 9:30pm

Day 2

Time	Session Title and Subject Matter	Speaker
9:00-9:20am	Arrival, Recap of Day 1	Jen Leisch, USAID
9:20-9:50am	Getting to 100%: The Role of Storage in High-RE Power Systems <ul style="list-style-type: none"> Explore the relationship between storage and renewable energy generation under high-penetration VRE scenarios 	Jaquelin Cochran, NREL
9:50-10:30am	Case Study: Techno-economic Analysis of Utility-Scale Battery Storage in Vietnam	Mr. Nguyen Anh Tuan, NLDC Dr. Surachai, Chulalongkorn University
10:30-11:00am	Coffee Break and 'Millionaire'	'Millionaire' facilitated by Jen Leisch, USAID
11:00-11:20am	Case Study: Energy Storage in Power System Operations of Thailand	Pattarawut Charatpangoon, EGAT Thailand
11:20-12:00pm	Interactive Session Continued from Day 1 <ul style="list-style-type: none"> Continue to identify key storage needs Identify analytical tools and data for storage planning and procurement Finalize utility scale storage roadmap and next steps 	All Participants
12:00-1:00pm	Lunch and 'Millionaire'	'Millionaire' facilitated by Jen Leisch, USAID

Time	Session Title and Subject Matter	Speaker
1:00-1:30pm	The Emerging Roles of Distributed Energy Resources in Power Systems of the Future <ul style="list-style-type: none"> • Drivers of DER deployment • Review customer and utility perspectives on behind-the-meter storage storage-plus-DPV programs • Review potential objectives for enabling distributed solar deployment 	Jaquelin Cochran, NREL
1:30-2:00pm	Introduction to Distributed and Behind-the-Meter Storage <ul style="list-style-type: none"> • Review use cases and potential services offered • Review major steps to behind-the-meter storage program development, with a focus on setting programmatic and regulatory objectives 	Thomas Bowen, NREL
2:00-2:30pm	Case Studies <ul style="list-style-type: none"> • Review of U.S. market for behind-the-meter storage • Deep dive on California and Hawaii <ul style="list-style-type: none"> ○ Compensation mechanism, technical configurations, metering requirements, interconnection processes • Hornsdale Power Reserve, South Australia <ul style="list-style-type: none"> ○ How storage participates in the ancillary services market 	Carishma Gokhale-Welch, NREL
2:30-3:00pm	Coffee Break and ‘Millionaire’	‘Millionaire’ facilitated by Jen Leisch, USAID
3:00-3:30pm	Designing Appropriate Compensation Mechanisms for DPV-plus-Storage Deployment <ul style="list-style-type: none"> • Review metering & billing arrangements, retail tariff and sell rate design • Review strategies to customize compensation mechanisms by segmenting retail customer base • Provide case studies of tariff offerings 	Thomas Bowen, NREL
3:30-4:15pm	Interactive Group Session and Exercise <ul style="list-style-type: none"> • Worksheet and group exercise focused on distributed behind-the-meter storage resources • Identify roles for behind-the-meter storage in your country 	Workshop participants
4:15-5:00pm	Panel Session and Day 2 Wrap Up <ul style="list-style-type: none"> • Q&A session: Dr. Surachai, Cochran, IEA, EGAT, Bowen 	Facilitated by NREL and table leads

Day 3

Time	Session Title and Subject Matter	Speaker
9:00-9:20am	Arrival, Recap of Day 2	Jen Leisch, USAID
9:20-9:50am	Deep Dive: Technical Configurations, Metering Requirements, and Interconnection Processes <ul style="list-style-type: none"> • Provide overview key technical requirements to-be-designed for a behind-the-meter storage program, including interrelated nature of design decisions • Discuss typical roles and responsibilities of policymakers, regulators, utilities, and standards boards in supporting behind-the-meter storage deployment 	Thomas Bowen, NREL
9:50-10:30am	Exercise: Design of a Behind-the-Meter Storage Program <ul style="list-style-type: none"> • Participants will choose one aspect of behind the meter storage deployment and design a country-specific program focused on policies, regulations, pilot projects, procurement, and compensation 	Workshop participants
10:30-11:00am	Coffee Break and ‘Millionaire’	‘Millionaire’ facilitated by Jen Leisch, USAID
11:00-11:30am	Innovative Behind-the-Meter Storage Business Models <ul style="list-style-type: none"> • Review select cases and associated business models for behind-the-meter storage, including aggregation schemes • Discuss various ownership and financing models for behind-the-meter storage projects 	Thomas Bowen, NREL
11:30-12:00pm	The Emerging and Future Role of Electric Vehicles on the Grid	Craig Hart, IEA
12:00-1:00pm	Lunch and ‘Millionaire’	‘Millionaire’ facilitated by Jen Leisch, USAID
1:00-1:30pm	On the Grid Edge: Distributed Energy Resource Impacts on the Bulk Power System	Jaquelin Cochran, NREL
1:30-2:30pm	Planning, Analysis, and Tools for Evaluating Distributed Storage <ul style="list-style-type: none"> • What are the key questions that need to be answered? • Overview of analysis framework and tools • SAM demonstration 	Carishma Gokhale-Welch, NREL
2:30-3:00pm	Coffee Break, Event Evaluation, and ‘Millionaire’	‘Millionaire’ facilitated by Jen Leisch, USAID

Time	Session Title and Subject Matter	Speaker
3:00-3:30pm	Behind the Meter Roadmap	Carishma Gokhale-Welch, NREL
3:30-4:30pm	Country Roadmap Presentations and Feedback <ul style="list-style-type: none"> • Two groups (~four countries each) • Present either Utility or Distributed Roadmap • Feedback from colleagues and experts 	Workshop participants
4:30-5:00pm	Panel Session and Workshop Wrap Up <ul style="list-style-type: none"> • Q&A session: Hart, Cochran, EGAT, Bowen, Gokhale-Welch 	Facilitated by NREL and table leads