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# LAO POWER SECTOR VULNERABILITY ASSESSMENT AND RESILIENCE ACTION PLAN

*Executive Summary*

USAID CLEAN POWER ASIA

May 27, 2019

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# LAO POWER SECTOR VULNERABILITY ASSESSMENT AND RESILIENCE ACTION PLAN

## EXECUTIVE SUMMARY

## USAID CLEAN POWER ASIA

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# EXECUTIVE SUMMARY

The Lao People's Democratic Republic (Lao PDR) recognizes that access to reliable, secure, and affordable electricity is essential to powering economic growth and development and to becoming a major regional power provider. The Lao power sector is at risk from an array of natural, technological, and human-caused hazards, which may interrupt the provision of electricity or lead to a chronic undersupply of power. A resilient Lao power system could thrive under changing conditions and withstand, respond to, and recover rapidly from the impacts of hazards. To address these risks, policy-makers, planners, and system operators of the Lao PDR have conducted a power sector vulnerability assessment (VA) and resilience planning process to safeguard their systems. The Lao PDR now has the opportunity to develop comprehensive policies and implement actions that increase its power sector resilience incrementally over time.

The United States Agency for International Development (USAID) partnered with the Lao PDR government to support this resilience planning process. A power sector resilience planning team (Resilience Team) composed of experts from Abt Associates, the USAID's implementing partner for the USAID Clean Power Asia program, and the U.S. Department of Energy's National Renewable Energy Laboratory (NREL), with the support of USAID and USAID Clean Power Asia staff and consultants, led a process consisting of two activities:

1. **Vulnerability Assessment:** A comprehensive assessment of the Lao PDR power sector's vulnerability<sup>1</sup> to climate and non-climate natural hazards<sup>2</sup> and to human and technological hazards.
2. **Resilience Action Plan:** A resilience planning activity to develop strategies that address the high-risk vulnerabilities for the Lao PDR power sector. Power sector resilience is the ability of the power sector to anticipate, prepare for, and adapt to changing conditions and withstand, respond to, and recover rapidly from disruptions through adaptable and holistic planning and technical solutions.

These activities relied on extensive engagement of a VA Advisory Group composed of high-level power sector decision makers from the Ministry of Energy and Mines, Électricité du Laos, and EDL-Generation Public Company as well as a VA Stakeholder Group and a Resilience Stakeholder Group consisting of representatives from various ministries and relevant organizations.

This report details the process used to conduct the VA and resilience action plan and the outcomes of those processes. The sections below discuss the process and key outcomes of the power sector VA and Resilience Action Plan.

<sup>1</sup> **Vulnerabilities** are defined as weaknesses within infrastructure, processes, and systems, or the degree of susceptibility to various hazards. Different measures can be taken to reduce vulnerability or improve adaptive capacity to hazards to the power sector.

<sup>2</sup> **Hazards**, in this work, are anything that can damage, destroy, or disrupt the power sector. Hazards can be natural, technological, or human caused. Hazards are not typically within the control of power system planners and operators. They can include wildfires, hurricanes, storm surges, cyberattacks, and more.

# POWER SECTOR VULNERABILITY ASSESSMENT

The Resilience Team assessed the Lao PDR power sector’s vulnerability to climate and non-climate natural hazards and to human and technological hazards. This VA involved extensive stakeholder engagement with the VA Advisory Group and a broader, more diverse VA Stakeholder Group.

In August 2018, the Resilience Team met with the VA Advisory Group to identify the most important hazards to the Lao power sector and to determine an appropriate scope for the VA. Then, in a three-day VA workshop, the Resilience Team and the VA Stakeholder Group collaborated to assess hazards to the sector, describe their impacts, and identify and assess priority vulnerabilities. Through this VA process, the VA Stakeholder Group and the Resilience Team determined that extreme precipitation, flooding, landslides, and extreme temperatures pose the greatest risks to power sector activities and expose important vulnerabilities. Stakeholders determined that the highest-risk vulnerabilities associated with these hazards include:

- Power system rules, regulations, and technical standards do not meet current and changing environmental conditions in Lao PDR.
- Dam construction does not follow design specifications.
- Installation does not follow design specifications.
- There is a lack of compliance with codes in design.

Table ES-1 lists the highest-risk vulnerabilities that the team identified in the VA workshop. The vulnerabilities identified in the VA then served as an input to the resilience action planning process.

**Table ES-1. List of highest-risk vulnerabilities and risk scores**

Risk Score*	Vulnerability (and Vulnerability Number)	
High	Power system rules, regulations, and technical standards do not meet current and changing environmental conditions	V29
	Dam construction does not follow design specifications	V13
	Installation does not follow design specifications	V21
	Lack of compliance with codes in design	V12
Medium-High	Corruption leads to code violations <sup>3</sup>	V16
	System operations are not flexible enough to respond to changes in demand and supply	V20
	Demand forecasting is not responsive to changing load conditions	V17
	Heavy power sector reliance on hydro generation	V7
	Inadequate domestic generation capacity requires costly energy imports	V31
	Hydro generation reservoir is too small for drought conditions	V22
	Large industry (mining, cement, and economic zones) constitutes approximately 40% of demand and revenue	V5
	Poor coordination between dam operators	V15
	Transmission infrastructure located in wildfire prone areas	V23
	Transmission equipment located in zones prone to flooding	V18
Transmission equipment located in zones prone to landslides	V14	

<sup>3</sup> Although the Stakeholder Group agreed that “Corruption leads to code violations” is one of the high-risk vulnerabilities in the power sector, members agreed to map this vulnerability to other strategies, noting that they did not have the authority to address this issue directly through resilience strategies. Therefore, the Advisory Group or other high-level decision makers may need to address this issue in a different setting.

Risk Score*	Vulnerability (and Vulnerability Number)	
	Transportation impacts occur with power sector impacts	V26
	Unreliable and or inadequate meteorological, hydrological, and climate change data for decision making	V32

\*For additional details on these Risk Scores vulnerabilities for the Lao PDR refer to Vogel et al. (2018)

## POWER SECTOR RESILIENCE ACTION PLAN

The Resilience Team led the development of a power sector resilience action plan (resilience action plan) that provides strategies to address the high-risk vulnerabilities identified in the VA.

This report reviews the high-risk vulnerabilities that stakeholders identified in the VA and discusses the resilience actions to address these high-risk vulnerabilities in detail.

In November 2018 the Resilience Team engaged the VA Advisory Group in reviewing the high-risk vulnerabilities and determining criteria for the evaluation of resilience strategies. The VA Advisory Group selected a final set of four criteria that the Resilience Stakeholder Group would later use to evaluate resilience strategies. A Resilience Stakeholder Group workshop, which included 26 stakeholders from the Lao PDR power sector, convened after the VA Advisory Group meeting to identify resilience strategies to address the high-risk vulnerabilities for the Lao PDR. The outputs of this workshop formed the basis of the power sector resilience action plan for the country.

This resilience action plan is not the final step to improving Lao power sector resilience. Immediate, medium-term, and long-term steps (listed below) that build on this action plan will enable decision makers to address high-risk vulnerabilities and improve power sector resilience for the long term. The resilience actions will be incorporated into ongoing Integrated Resource and Resilience Planning (IRRP) and Lao PDR plans to disseminate the outputs of this report to a wider group of stakeholders.

As power sector decision makers work to implement these actions, they may wish to consider the value of developing comprehensive resilience policies and strategies that would improve technical and organizational capacity for implementing and managing additional future actions. Policies and strategies can establish the range of appropriate and feasible options for addressing high-risk vulnerabilities; assign responsibilities to key power sector actors; and detail government oversight and enforcement mechanisms that ensure implementation of these actions.

This resilience action plan categorizes activities to increase resilience into immediate, medium-term, and long-term steps. The resilience action plan identifies four key, grouped power sector resilience actions:

1. Develop and Implement Resilient Power System Policies
2. Improve Power System Flexibility
3. Improve Coordination across Hydropower Dam Operations
4. Facilitate Better Sedimentation Management in Hydropower Watersheds.

Figure ES-1 shows a proposed timeline for the implementation of these grouped actions, organized according to the immediate actions, within the first 12 months, and the medium term, i.e. years 2 and 3.

- Immediate steps are actions to be taken within the first 12 months of plan implementation that will form a solid foundation for medium- and longer-term resilience solutions.
- Medium-term steps focus on the actions in years 2-3. Building resilience requires coordination between the power sector and the broader community. Many of the medium-term steps build on the foundation set in earlier steps and involve a more diverse stakeholder group in developing power sector resilience through community outreach, education, and involvement.
- In the longer term, there is a need to build on the stakeholder engagement and capacity developed in earlier stages to ensure a resilient Lao PDR power sector in perpetuity. This includes analyzing and updating the resilience strategies on a regular basis to include new and changing technology, climate, and economic realities and to address changes in environmental and political conditions and changes in the power system.

New lessons and innovative power sector resilience strategies will evolve and emerge as the Lao PDR and other countries build experience addressing high-risk power sector vulnerabilities. It will be crucial for Lao PDR to continually evaluate its vulnerabilities and incorporate novel resilience strategies under a continual power sector planning framework. Extensive engagement of diverse stakeholders will help identify, evaluate, and implement the most appropriate new strategies and lessons in the planning process. The ongoing IRRP activity is an opportunity for the Lao PDR to ensure that resilience strategies from this and future resilience action plans are incorporated into the country's power sector planning framework.

The remainder of this report details the process used to conduct the VA and resilience action plan and the outcomes of those processes.

- **Section 1** introduces the VA and power sector resilience action planning process
- **Section 2** provides a background to the Lao PDR social and economic setting, power sector, and regional climate, climate impacts, and projected climate change.
- **Section 3** summarizes the methodology applied in this process.
- **Section 4** presents the outcomes of the VA.
- **Section 5** presents the resilience action plan.
- **Section 6** proposes potential next steps in developing a resilient Lao power sector.

Figure ES-1. Timeline for Implementation of Key Resilience Action

Action 1. Develop and Implement Resilient Power System Policies				
Activity 1.1 Develop standard operating procedures and continuity of operation plans for extreme events - including staffing plans, prioritized re-powering of networks, and aid agreements with neighboring countries				
Activity 1.2 Develop climate projections and geospatial data for hydropower				
		Activity 1.3 Develop standards and enforcement mechanisms for power reliability		
		Activity 1.4 Improve community readiness for extreme events that may impact the power sector		
Activity 1.5 Improve enforcement of dam design and construction codes - including planning for expected hazards (such as floods, high winds, landslides) where these cannot be avoided				
Activity 1.6 Include resilience provisions within annual operating budgets of relevant agencies				
Action 2. Improve Power System Flexibility				
Activity 2.1 Consider multiple demand and supply scenarios for power system growth in the power development plan and related planning activities				
Activity 2.2 Reduce dependence on hydropower through diversification of energy mix				
Activity 2.3 Introduce Flexibility Solutions into Power System Operations				
Activity 2.4 Improve power system planning for future scenarios including education for dispatch scenarios, weather forecasting for variable renewable energy, and knowledge of demand forecasting methods				
Activity 2.5 Develop and implement a demand side management program to reduce peak electricity demand (such as time-of-use tariffs, industry and large customer programs, or public awareness and educational campaigns)				
Activity 2.6 Establish a binding contract or agreement within an interconnection procedure to ensure commitment of new large electrical customers such as large industrial loads				
Action 3. Improve Coordination across Hydropower Dam Operations				
Activity 3.1 Establish protocol for data collection at all hydropower dams including data types, collection frequency, and data format for sharing				
Activity 3.2 Mandate data sharing between hydropower dam operators				
Action 4. Facilitate Better Sedimentation Management in Hydropower Watersheds				
Activity 4.1 Develop incentive and enforcement structures to ensure that users and/or areas that are upstream from hydropower dams protect watersheds located upstream from hydropower dams				
		Activity 4.2 Create educational campaign and community awareness for watershed protection upstream from hydropower dams		
Months 1-6	Months 7-12		Months 13-18	
			Months 19-24	
			Beyond Month 25	