INTEGRATED RESOURCE AND RESILIENCE PLANNING FOR LAO PDR: CAPACITY BUILDING PLAN

USAID CLEAN POWER ASIA

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INTEGRATED RESOURCE AND RESILIENCE PLANNING FOR LAO PDR: CAPACITY BUILDING PLAN

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Authors: Taylor Binnington, Stockholm Environment Institute
Jason W. Veysey, Stockholm Environment Institute

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ACRONYMS

DSM	Demand-side management
DWG	Demand Working Group
EDL	Électricité du Laos
EDL-Gen	EDL-Generation Public Company
EE	Energy efficiency
IRRP	Integrated Resource and Resilience Planning
IRP	Integrated Resource Planning
JICA	Japan International Cooperation Agency
LEAP	Long-range Energy Alternatives Planning system
Lao PDR	Lao People's Democratic Republic
MEM	Ministry of Energy and Mines
PDP	Power development plan
RE	Renewable energy
REZ	Renewable energy zone
SEI	Stockholm Environment Institute
SWG	Supply Working Group
USAID	United States Agency for International Development
VRE	Variable renewable energy

EXECUTIVE SUMMARY

This document describes a capacity building program on Integrated Resource and Resilience Planning (IRRP) for the Lao People's Democratic Republic (Lao PDR) electricity system. The program is designed to meet needs communicated to USAID Clean Power Asia by the Lao PDR Ministry of Energy and Mines (MEM) and Électricité du Laos (EDL). Intended to last 20 months, the program will guide a core group of participants from these institutions through an IRRP process using a number of activities and missions focused on devising low-regrets power development pathways: development plans that best satisfy a range of planning objectives given multiple uncertainties and possible futures. Analyses required to identify low-regrets pathways will be conducted in a long-term electricity planning model for Lao PDR developed under the capacity building program. The model will be built on the Long-range Energy Alternatives Planning system (LEAP) platform, and used by the core team to forecast energy demands and supply processes, as well as to explore a range of uncertainties and normative scenarios.

The capacity building program will be executed by the Stockholm Environment Institute (SEI) with the assistance of the USAID Clean Power Asia team. It takes a four-phased approach that tracks the analytical stages of a typical IRRP process. The phases and associated activities are summarized below.

Phase A: Preparation and Initiation sets the stage for a newly-formed IRRP capacity building core team to undertake energy system modeling tasks in later stages. Together with other stakeholders, the core team will identify a set of objectives, constraints, and metrics for evaluating power development options. This phase will also expose participants in the capacity building program to renewable energy zones (REZ) and their potential as an integrated electricity supply and transmission option.

Phase B: Demand Forecasting and Demand Resource Assessment will build competence with the LEAP toolkit, which a subset of the IRRP core team will use to develop a model of energy demands in Lao PDR. This smaller Demand Working Group (DWG) will also go on to examine energy efficiency and demand management resources, and envision other normative scenarios that may affect how the country's energy demands may evolve.

Phase C: Supply Resource Assessment will continue to build competence with LEAP, including any specialized analytical utilities developed for the IRRP process. The Supply Working Group (SWG) – another subset of the IRRP core team – will work to build a model of the energy supply system in Lao PDR, which they will then use to evaluate supply resources and consider the impacts of additional normative scenarios.

Phase D: Least-Regrets Pathways will link together the analyses conducted in each of the three prior phases to examine a number of different development pathways. These pathways will be tested under the range of normative scenarios identified earlier, using a large-ensemble scenario modeling approach. Emerging from this phase, participants in the capacity building program will be prepared to embark on the final stages of IRRP: developing an updated power development plan (PDP) for Lao PDR, including revisions to the country's renewable energy (RE) targets.

1. INTRODUCTION

By considering both supply and demand resources on an equal footing to reduce costs, Integrated Resource Planning (IRP) became the dominant model for electric utility planning in North America in the late 20th century (Swisher et al. 1997; Fisher and Luckow 2016). Its usefulness for identifying cost-optimal options for the power system helped it displace the ad-hoc planning style which had preceded it. In recent years, however, some key shortcomings of conventional IRP have been identified, including its typically limited examination of trade-offs among different planning objectives (not just cost minimization) and its inadequate handling of unanticipated, but potentially critical, events (Chupka et al. 2008; Scheller and Chikkatur 2014; Haydel et al. 2017). Responding to these issues, planners and researchers have augmented the IRP framework, creating the new paradigm of Integrated Resource *and Resilience* Planning (IRRP). IRRP differs from traditional IRP by systematically evaluating power development options against multiple objectives, and by more explicitly considering a broad array of uncertainties and risks. The IRRP approach tries to identify development pathways that perform well under a range of contingencies – "a sound future in an uncertain world," but not necessarily "an optimal future in a certain world." These development pathways are evaluated using *normative* scenarios, which provide a useful lens to explore the implications of different potential futures. Unlike exploratory scenarios, in which the future is mostly imagined to be a continuation of past trends, normative scenario analysis is a process by which planners envision multiple potential futures, asking what actions each would necessitate (Intergovernmental Panel on Climate Change 2001). The normative futures need not be extrapolated from current trends; instead, they can be used to consider low-probability but extreme events, desired outcomes, or other situations that may affect the energy system.

The electricity system in the Lao People's Democratic Republic (Lao PDR) is rapidly changing. In the five-year period between 2011 and 2016, installed electricity generation capacity grew nearly 150%, domestic electricity demand doubled, peak load increased 57%, and the rate of household electrification rose from 79% to 92% (Électricité du Laos 2017). Significant plans are being discussed to increase electricity exports and to add to the country's transmission network. Yet these developments are occurring against a backdrop of important uncertainties, and they raise potential challenges for various social priorities.

Climate change, for instance, poses emerging risks that electricity planners in Lao PDR must manage. Both current and planned future electricity generation in Lao PDR are dominated by hydro, creating a critical vulnerability to climate change-induced variation in rainfall. A changing climate may also increase competition for water resources and the frequency of extreme weather events. The rate of future electricity demand growth and the shape of consumer load curves – possibly influenced by emerging technologies such as electric vehicles – are another unknown, as are export prices and the evolution of variable renewable energy (VRE) technologies.

Electricity planning in Lao PDR is managed by the Ministry of Energy and Mines' (MEM) Department of Energy Policy and Planning and Électricité du Laos (EDL). The planning process involves a number of different tools and support by several other organizations including EDL-Generation Public

Company (EDL-Gen) and the Ministry of Planning and Investment (Abt Associates 2017). Past PDPs have not systematically considered energy efficiency (EE) and other demand-side resources, and they have not accounted for official RE goals. They have also been separated into PDPs for the domestic grid and for electricity exports, potentially missing synergies between domestic requirements and export opportunities.

Both the pace of change in Lao PDR's electricity system and the context in which it is occurring suggest that IRRP could make a valuable contribution to national electricity planning. Recognizing the potential, MEM, EDL, and USAID Clean Power Asia are engaged in a 20-month program of capacity building on IRRP. The program is led by USAID Clean Power Asia, including its subcontractor, The Stockholm Environment Institute (SEI), and focuses on supporting IRRP through training and technical assistance on IRRP concepts, methods, and tools. The intent is to guide MEM and EDL through an IRRP process, and to enable them to create a PDP following IRRP principles.

A typical IRRP process includes eight stages as noted below. Based on needs articulated by MEM and EDL, the plan for the IRRP capacity building program is based on the first six stages:

1. Gather data on energy demand and supply resources.
2. Set and prioritize planning objectives, constraints, and metrics.
3. Forecast energy service demands.
4. Evaluate energy demand resources.
5. Evaluate energy supply resources.
6. Combine demand and supply resources into "least-regrets pathways" to satisfy planning objectives, and explore major risks.
7. Develop and implement an action plan.
8. Monitor progress, update, and iterate on action plan.

The capacity building program is focused on the analysis required to develop an IRRP-based PDP (the final two stages are devoted to its implementation and follow-up). SEI has divided the program into four thematic phases that cover the first six IRRP stages.

- **Phase A: Preparation and Initiation:** SEI and USAID Clean Power Asia will assemble a core IRRP team and assign roles. Together with other stakeholders, the core team will identify a set of objectives, constraints, and metrics for evaluating power development options. SEI will also engage with stakeholders and other USAID Clean Power Asia partners to improve the characterization of renewable electricity options in Lao PDR through the initial identification of possible renewable energy zones (REZ).

- **Phase B: Demand Forecasting and Demand Resource Assessment**: The IRRP core team and SEI will work to develop a model of energy demands in Lao PDR. The model will be used to forecast electricity demand, and to explore the role of EE, demand-side management (DSM), and other normative scenarios in power planning.

- **Phase C: Supply Resource Assessment**: The IRRP core team and SEI will develop a model of energy supply in Lao PDR, including electricity generation and transmission resources and

sub-grids serving both domestic and international (export) loads. Training and educational activities will emphasize concepts such as the grid integration of VRE, optimal resource selection, and the relationship between generation and transmission investments. The supply contributions (and costs) of potential REZ from Phase A will be analyzed in conjunction with other supply options. As in Phase B, normative scenarios will be developed to explore uncertainties and important future risks.

- **Phase D: Least-Regrets Pathways:** The IRRP team and SEI will conduct integrated modeling of demand and supply resources to identify low-regrets power development pathways. Model runs will be evaluated based on their satisfaction of IRRP objectives under the range of normative scenarios formulated in Phases B and C. One or more preferred pathways will be identified, and SEI will support MEM and EDL as they use the results to develop a draft PDP. Modeling results may also be used to update Lao PDR's renewable electricity targets.

Table 1: Capacity Building Program Phases and Activities

Phase	Activity	
A	0	Baseline Capacity Assessment of Prospective IRRP Core Team Members and Establishment of Core Team
	A.2	Initial Data Request for Energy System Modeling
	0	Stakeholder Analysis and Mapping
	A.4	Identification of IRRP Objectives, Constraints, and Metrics
	A.5	First Quarterly Report
	A.6	Identification of RE Study Areas
	A.7	Identification of Candidate REZ
B	0	Assessing Existing Demand Modeling Tools
	B.2	Specifying Integration of Existing Demand Modeling Tools with LEAP
	B.3	Second Quarterly Report
	B.4	Software Training on Demand Modeling Using LEAP
	B.5	Constructing Baseline Energy Demand Model Using LEAP
	B.6	Defining and Modeling EE Scenarios
	B.7	Defining and Modeling DSM Scenarios
	B.8	Defining and Modeling Other Normative Demand Scenarios
	B.9	Phase B Capacity Assessment of IRRP Core Team Members
	B.10	Third Quarterly Report
C	0	Software Training on Supply Modeling Using LEAP
	0	Constructing Baseline Energy Supply Model Using LEAP
	C.3	Defining and Modeling Additional Energy Supply Resources
	C.4	Fourth Quarterly Report

Phase	Activity	
	C.5	Incorporating Transmission Analysis Into Supply Assessment
	0	Fifth Quarterly Report
	C.7	Defining and Modeling Other Normative Supply Scenarios
	C.8	Phase C Capacity Assessment of IRRP Core Team Members
D	**0**	Integrated Model Runs and Large-Ensemble Scenario Analysis
	D.2	Sixth Quarterly Report
	D.3	Selecting Low-Regrets Pathways
	0	Renewable Energy Target Setting
	D.5	Presentations to Supervisors and Final Capacity Assessment
	D.6	Incorporating Key Results From Load-Flow Analysis Into IRRP Model
	D.7	Remote Technical Support for Target-Setting and Finalizing IRRP
	D.8	Seventh Quarterly/Final Report

This document describes the IRRP capacity building program in detail. It covers objectives, activities, and outputs by phase as well as the program's anticipated timeline. Proposed in-person workshops and meetings (termed "missions") are highlighted in boxes. The plan presented here builds on a draft plan agreed with MEM and EDL at a workshop and meetings in November 2017.

2. PHASE A: PREPARATION AND INITIATION

2.1 OBJECTIVES

The first of the IRRP capacity building program phases will establish the IRRP core team – electricity planners at MEM, EDL, and potentially other agencies who will be the main participants in the program – and prepare the team to undertake analytical tasks in later phases. Electricity planning stakeholders will be identified, and their interests will be used to define IRRP objectives; a system for assessing and comparing scenarios to one another will be developed; and an ongoing process of collecting data needed to forecast energy demands and supply will be initiated. Phase A will also expose participants to the concept of Renewable Energy Zones (REZ) and include activities to identify potential REZs in Lao PDR.

Emerging from Phase A, participants in the program will have a coherent view of the energy stakeholder landscape in Lao PDR and a clearer picture of each group's interests. Members of the core team will understand the larger goals of the IRRP Capacity Building Plan and the merits of the IRRP process, as well as how they will plug into the process through their designated roles. By starting data gathering tasks and setting overall objectives for IRRP in Lao PDR, Phase A will feed directly into the three phases that follow.

2.2 ACTIVITIES AND OUTPUTS

Phase A includes several activities, summarized in the table below. An expanded description of each activity follows.

Table 2: Phase A Activities

Activity		Timeline
0	Baseline Capacity Assessment of Prospective IRRP Core Team Members and Establishment of Core Team	January 2018
A.2	Initial Data Request for Energy System Modeling	January – May 2018
0	Stakeholder Analysis and Mapping	February 2018
A.4	Identification of IRRP Objectives, Constraints, and Metrics	February 2018
A.5	First Quarterly Report	March 2018
A.6	Identification of RE Study Areas	March – May 2018
A.7	Identification of Candidate REZ	June 2018

A.1 Baseline Capacity Assessment of Prospective IRRP Core Team Members and Establishment of Core Team

To inaugurate the capacity building program, SEI will prepare a web-based survey to assess the initial capabilities of stakeholders who may be members of the IRRP core team. The survey will be distributed to technical staff at MEM, EDL, and other relevant organizations as recommended by MEM and EDL. Its purpose will be to help SEI gauge the level of experience of each respondent with IRRP concepts and software tools. Following the survey, SEI will propose membership for the IRRP core team to USAID Clean Power Asia, with all prospective members classified into one of two working groups based on their expertise and roles within their home organization. The *Demand Working Group* (DWG) will be composed of IRRP core team members with experience analyzing final energy demands, or access to data pertaining to final energy demands, while the *Supply Working Group* (SWG) will be composed of team members with experience or data access pertaining to energy supply processes, power generation, and electricity transmission. The groups' composition will be finalized after the IRRP Capacity Building Launch Workshop (Mission 1, below). Continuity in group membership and consistent participation by each member will be critical to the capacity building program's success. Many of the program's activities are arranged so they build on knowledge gained in previous activities, making gaps in participation inadvisable. While final nominations for the DWG and SWG will be the responsibility of MEM, SEI and USAID Clean Power Asia will encourage MEM to include an equal number of men and women in the working groups, to the extent possible.

A.2 Initial Data Request for Energy System Modeling

Based on its experience constructing national-scale energy models, SEI will prepare a Microsoft Excel workbook listing important quantitative data needed to build an IRRP model for Lao PDR. Data items will be grouped by theme (household energy demand, electricity transmission and distribution, cross-cutting data, etc.), assigned priority levels, and described in sufficient detail that the document can be understood by stakeholders who are not directly participating in the IRRP program. During the IRRP Capacity Building Launch Workshop (described below), SEI and participants will review the data request in detail. Following the workshop, DWG and SWG members will work with the USAID Clean Power Asia team to circulate the data request to relevant partner institutions in Lao PDR in accordance with procedures set out in the RE Data Management Plan developed and implemented with NREL and USAID Clean Power Asia support. In SEI's experience, data collection is an ongoing part of constructing an energy system model, so subsequent iterations on the initial data request are expected through Phases A, B, and C of the capacity building program.

Mission 1: IRRP Capacity Building Launch Workshop		
Where: Vientiane	*When: February 2018*	*Who: SEI, USAID Clean Power Asia staff, MEM and EDL representatives, and energy sector stakeholders*
The launch workshop will have two main components. For the first component (approximately a half-day), the USAID Clean Power Asia team will invite a wide range of energy and power sector stakeholders to provide input under Activities 0 and A.4. Participants should ideally include representatives from state-owned enterprises, the private sector and consumer groups, and other government entities, as well as academics and other donors. The remainder of the two-day workshop will be dedicated to the second component, in which only IRRP core team members are		

expected to participate. During this portion of the workshop, SEI will review the initial data request from Activity A.2, clarify the roles of the DWG and SWG within the core IRRP team, and engage them in data collection. SEI will also deliver a short, basic software training on the use of LEAP (the Long-range Energy Alternatives Planning system, SEI's energy system modeling software tool) for demand modeling, described under Activity B.4.

A.3 Stakeholder Analysis and Mapping

During the launch workshop, SEI will lead a set of facilitated discussions and small group exercises to identify relevant stakeholder groups and consider their respective interests in – and influence on – electricity planning. SEI will record input from the participants, with the outcomes of the stakeholder mapping used to prioritize IRRP objectives and identify conflicts during later activities and phases.

The success of IRRP depends integrally on stakeholder engagement. The capacity building program will involve stakeholders beyond the IRRP core team in selected activities, and SEI will encourage the core team to consult other stakeholders frequently to confirm assumptions and validate findings. This approach will strengthen the core team's analyses and promote a culture of stakeholder engagement among national electricity planners.

A.4 Identification of IRRP Objectives, Constraints, and Metrics

Also during the launch workshop, SEI will work with stakeholders to distill their respective interests into a set of objectives, constraints, and metrics for IRRP. These are defined as follows:

> **Objectives:** Planning goals of the IRRP process held by one or more stakeholders (e.g., improve the affordability of electricity for agricultural consumers).
>
> **Constraints:** Outcomes which must be avoided or limits which must be respected, because they are agreed upon by all stakeholders or are self-evidently unacceptable (such as the violation of a physical law) (e.g., fulfill contractual power export obligations to neighboring countries).
>
> **Metrics:** Measureable values that demonstrate the degree to which an objective is satisfied, or whether a constraint is violated. One or more metrics may be assigned to each objective or constraint (e.g., retail price of electricity paid by smallholder farms, indexed to its current value).

Objectives aimed at improving women's health or economic opportunity will specifically be considered, as will metrics that assess gender-differentiated impacts of power development options. Once a set of objectives and constraints is identified (with corresponding metrics), SEI will facilitate a discussion on how to prioritize different objectives and resolve conflicts. An important input to Activity A.4 will be prior work on energy planning objectives and attributes for Lao PDR performed under the USAID Smart Infrastructure for the Mekong program's Energy Alternatives Study.

A.5 First Quarterly Report

SEI will provide quarterly status reports on the IRRP capacity building program as it proceeds. The first of these will cover activities conducted under Phase A to date, including:

- Summary of the baseline capacity assessment (Activity 0).
- Initial IRRP data request (Activity A.2).
- Lists of members of the IRRP core team, DWG, and SWG.
- Summary report from the launch workshop (Mission 1), including a mapping of stakeholders (Activity 0) and a matrix of objectives, constraints, and metrics for IRRP (Activity A.4).

A.6 Identification of RE Study Areas

By concentrating RE deployment in areas with high resource potential, favorable conditions for transmission, and demonstrated developer support, REZs can improve the cost-effectiveness of renewable power (Lee, Flores-Espino, et al. 2017). While to date no REZs have been designated in Lao PDR, stakeholders at the USAID Clean Power Asia workshop in November 2017 expressed interest in exploring the REZ approach in the context of IRRP. The consensus was that potential REZs for solar, wind, and small hydropower should be considered as options in the IRRP supply analysis. To realize this aim, SEI will identify and characterize potential REZ in Phase A of the capacity building program, then work with stakeholders to include potential REZ in the supply, supply-demand, and transmission modeling in Phases C and D.

The definition of potential REZs will begin with Activity A.6, in which SEI will identify RE study areas – areas meriting further consideration as possible REZ. This work will take as its starting point an analysis of the technical potential for wind and solar power in Lao PDR recently conducted under the Energy Alternatives Study (Lee, Grue, et al. 2017). SEI will categorize the wind and solar potentials from this analysis based on proximity to existing transmission infrastructure and load centers. Depending on feedback from the IRRP core team and data availability, the potentials may be further filtered using other development exclusion or prioritization criteria that were not evaluated in the Energy Alternatives Study. At the same time, a geospatially explicit estimate of the potential for small, run-of-river hydropower will be prepared. This estimate will be based on published studies or a basic calculation of annual run-off and head derived from publicly available global datasets. The hydro potential will be filtered using the same exclusion/prioritization criteria as the solar and wind potentials, and it will also be categorized by distance to load and transmission lines.

Using the analysis to this point – combined resource potential, exclusion and prioritization criteria, distances to load and transmission – SEI will define draft RE study areas. A rough assessment of electricity production costs by area, resource type (solar/wind/small hydro), and resource class or quality will then be developed. The assessment will consider both generation and transmission costs and will be informed by estimates of levelized costs of electricity produced for the Energy Alternatives Study (Kiatreungwattana 2017) and subsequent analysis of solar LCOE developed by USAID Clean Power Asia staff. Final RE study areas will be identified taking into account the cost assessment and IRRP core team input.

A.7 Identification of Candidate REZs

SEI will next seek input from RE developers as well as MEM and EDL (on relevant regulations) regarding the commercial viability of the RE study areas. The intent is to refine the outputs of

Activity A.6, reducing the set of study areas to a smaller number of candidate REZs of demonstrated commercial interest. The process of filtering for commercial interest will be initiated during a consultative workshop on RE zone study areas (Mission 2); however, SEI recognizes that building sufficient assurance among stakeholders to induce RE project development will likely require efforts beyond the scope of the IRRP capacity building program. As a result, SEI will use the workshop to identify *likely* candidate REZ in order to proceed with the main capacity building agenda.

For each candidate REZ identified through the consultative workshop, SEI will estimate intra-annual variability of the zone's solar, wind, and small hydro resources. The variability will be specified at as fine a temporal resolution as available data allow (ideally hourly). Resource data from Lao PDR government agencies will be the primary source for this work and will be supplemented by publicly available global or regional datasets as needed. The candidate REZ defined in Activity A.7 will feed into activities under Phase C.

Mission 2: Consultative Workshop on RE Zone Study Areas and Demand Model Development		
Where: Vientiane	*When: May/June 2018*	*Who: SEI, USAID Clean Power Asia team, energy stakeholders, DWG, SWG*
The second mission that SEI will undertake to Lao PDR is planned for the end of May or in June 2018 (this mission may be combined with the first vulnerability assessment workshop). Like the launch workshop (Mission 1), this workshop will be divided into two segments. The first will be used as an opportunity to check in with the wider stakeholder community who are not directly part of the core IRRP team, and to gauge their commercial interest in developing each RE study area. During the workshop, SEI will draw on the input of public and private sector actors and project developers to convert RE study areas into candidate REZs (Activity A.7). During the second workshop segment, SEI will conduct the second of two training modules described under Activity B.3, and transition to a collaborative working session described under Activity B.5, working closely with members from the DWG.		

2.3 KEY DEPENDENCIES

Key dependencies or assumptions in the plan for Phase A are outlined in the following table.

Table 3: Key Dependencies for Phase A

Activity	Key Dependency
0 Baseline Capacity Assessment of Prospective IRRP Core Team Members and Establishment of Core Team	USAID Clean Power Asia team distributes web-based survey to relevant agencies and prospective stakeholders.

A.2 Initial Data Request for Energy System Modeling	DWG and SWG, potentially with assistance from USAID Clean Power Asia staff and consultants, distributes data request documents to relevant stakeholders following SEI's guidance.
A.6 Identification of RE Study Areas	The U.S. National Renewable Energy Laboratory provides SEI the source data on wind and solar technical potential developed for Lee et al. (2017).
	The IRRP core team provides SEI geospatially explicit data on existing and planned transmission infrastructure.
A.7 Identification of Candidate REZ	Lao PDR government partners provide any government-owned datasets showing intra-annual variability of solar, wind, and/or small hydropower resources.

3. PHASE B: DEMAND FORECASTING AND DEMAND RESOURCE ASSESSMENT

3.1 OBJECTIVES

In Phase B of the capacity building program, members of the DWG will work with SEI to construct a national-scale model of energy demand and to apply it to a variety of scenarios. Skills training is a core component of this phase, so participants will be instructed on methodological options for forecasting energy demand (including top-down econometric projections and bottom-up models based on the characteristics of specific technologies), data requirements, and model validation. In addition to skills development, Phase B will improve participants' awareness of demand resources (EE and demand management), including their performance, costs, and potential role in providing energy services for Lao PDR's electric grid. Finally, Phase B will introduce the notion of normative scenarios in the IRRP process, giving members of both the DWG and SWG freedom to think through likely impacts of different futures on the energy system.

3.2 ACTIVITIES AND OUTPUTS

Phase B includes several activities, summarized in the table below. An expanded description of each activity follows.

Table 4: Phase B Activities

Activity		Timeline
0	Assessing Existing Demand Modeling Tools	April 2018
B.2	Specifying Integration of Existing Demand Modeling Tools with LEAP	April – May 2018
B.3	Second Quarterly Report	June 2018
B.4	Software Training on Demand Modeling Using LEAP	February and June 2018
B.5	Constructing Baseline Energy Demand Model Using LEAP	June – August 2018
B.6	Defining and Modeling EE Scenarios	August 2018
B.7	Defining and Modeling DSM Scenarios	August 2018
B.8	Defining and Modeling Other Normative Demand Scenarios	August – October 2018
B.9	Phase B Capacity Assessment of IRRP Core Team Members	September 2018
B.10	Third Quarterly Report	September 2018

B.1 Assessing Existing Demand Modeling Tools

With cooperation from the DWG, SEI will review existing software tools used by MEM and EDL technical staff to forecast energy demands. During the review, SEI will record the strengths and weaknesses of the existing suite of planning tools, as well as key assumptions and sources of data embedded within the tools. Based on the objectives established during Activity A.4, SEI, IRRP core team members, and USAID Clean Power Asia will then consider whether and how existing tools should be used within the IRRP process. If existing tools are found to offer significant advantages or economy over demand modeling in LEAP, Activity B.2 will be undertaken to specify how to integrate the tools with LEAP supply modeling.

B.2 Specifying Integration of Existing Demand Modeling Tools with LEAP

This Activity will only be performed if existing tools are used for the IRRP demand modeling instead of LEAP. In that event, SEI will develop a specification for integrating the tools with the LEAP supply model to be developed under Phase C. Options include engineering a software interface between existing tools and LEAP, and manually transferring results from the existing tools to LEAP. Once the specification is complete, SEI and USAID Clean Power Asia will decide how to implement it and adjust this Capacity Building Plan as needed.[1]

B.3 Second Quarterly Report

The second quarterly report will cover activities since the first report, including:

- Overview of existing demand modeling tools and practices used in Lao PDR (Activity 0).
- Summary report from the consultative workshop (Mission 2), including a description of each candidate REZ identified during the workshop (Activity A.7).

B.4 Software Training on Demand Modeling Using LEAP

To prepare the IRRP team for further activities under Phase B, SEI will deliver two short programs of training on LEAP's energy demand modeling capabilities. The first will be provided during the February 2018 launch workshop (Mission 1), and the second will be delivered during the May/June 2018 consultative workshop on RE zone study areas and demand model development (Mission 2). The first workshop is intended to expose all members of the IRRP core team (both Demand and Supply Working Groups) to the LEAP software tool. The second workshop will emphasize the practical and advanced skills required by the DWG, as they proceed together with SEI to construct a LEAP model of final energy demands in Lao PDR.

B.5 Constructing Baseline Energy Demand Model Using LEAP

This activity aims to develop a baseline assessment of final energy demands in Lao PDR using LEAP. It will be started at the consultative workshop (Mission 2) and continued through remote collaboration between SEI and the DWG thereafter. The team will work together to specify historical energy demands in the IRRP LEAP model and to create a baseline demand scenario. Shortly after Mission 2, key delegates from the DWG team will embark on a study visit (Mission 3) to SEI's US Center to refine and finalize the baseline scenario.

[1] The balance of the current plan assumes that LEAP is used for the IRRP demand modeling.

Mission 3: Study Visit to SEI US Headquarters for Demand Working Group		
Where: Somerville	*When: August 2018*	*Who: SEI, DWG appointees*
In August 2018, SEI will host up to three members of the IRRP DWG (including at least one woman) at its Center in the United States, located outside Boston, Massachusetts. The study visit will last for one week, during which SEI will work with the IRRP team to finalize Activity B.5 and begin working through Activities B.6 and B.7, introducing Activity B.8 at the end of the week. The study visit will allow DWG teammates to interact closely with scientists in SEI's Energy Modeling Program and to meet the author of the LEAP software. In parallel, it will provide partners from Lao PDR a chance to present their country's planning experience and their progress through the IRRP process, during a "brown bag lunch" seminar held during the visit. Following the seminar, audience members from across SEI's diverse research themes will supply feedback and perspectives.		

Before and during the study visit, SEI and the DWG appointees will work to develop representations of all final demand sectors and major energy end-uses in each of the four regional electricity subgrids in Lao PDR, plus an additional notional subgrid for electricity exports. Though the focus of IRRP is on electric sector planning, the demand model will cover all fuels and energy sources. This choice ensures that the demand for energy services in Lao PDR is fully captured (including those end-uses that have historically not been electrified), permitting the analysis of fuel switching opportunities towards increased electrification.

With SEI's assistance, the DWG will need to make important methodological decisions during Activity B.5 about how to forecast each subgrid's energy demands. Together, SEI and the DWG will consider a range of options before selecting the most appropriate for Lao PDR's situation. If additional data inputs are needed for these projections, SEI will guide the DWG on another brief round of data collection and outline steps for updating the baseline forecast once they return to Lao PDR.

B.6 Defining and Modeling EE Scenarios

Also during the Mission 3 study visit, SEI and DWG team members will identify EE resources by reviewing Lao PDR EE policies, examining priority sectors or end-uses in the baseline model results, and considering other countries' experiences with EE. They will then collaboratively develop modeling data from national and international sources and implement a set of EE options in LEAP. To improve the model's transparency, SEI will show the DWG how each EE option can be included in the model using a dedicated scenario.

B.7 Defining and Modeling DSM Scenarios

During Mission 3 and concurrently with Activity B.6, SEI and the DWG will construct a set of scenarios in LEAP to explore DSM resources following the same procedure outlined for EE. Taking time to carefully assess demand-side options such as EE and DSM is an important part of integrated planning because it helps to identify alternatives to generation options. These alternatives can often satisfy requirements for energy services at least as well as new generation capacity, while better meeting other IRRP planning objectives. Activities B.6 and B.7 are also a way in which IRRP and the capacity building plan directly respond to the importance of considering gender issues. In a recent assessment of gender equality in renewable energy in the Lower Mekong region, USAID Clean Power

Asia found that resources other than large supply infrastructure are more likely to bring gender-based benefits, but historically have not been prominent in planning processes (Resurrección and Boyland 2017).

B.8 Defining and Modeling Other Normative Demand Scenarios

Wrapping up the study visit, SEI and DWG delegates will develop other normative scenario storylines that connect to the evolution of energy demands in Lao PDR. These storylines may be drawn from possible outcomes of climate change, changes in the population's standard of living, or other major economic or political shifts that could foreseeably affect energy demands. To model the impacts of each normative scenario, SEI will conduct basic research following the study visit and propose a methodology to the IRRP team (both DWG and SWG members) over a web-based conference call. The proposal will include a demonstration of how one of the methodologies would be implemented in LEAP, for an example normative scenario. Once modeling methods are agreed, SEI will guide the DWG through required data inputs for the other normative scenarios. The DWG will then undertake any supplemental data collection needed, reporting findings to SEI before the start of Phase D of the capacity building program.[2]

B.9 Phase B Capacity Assessment of IRRP Core Team Members

SEI will prepare a second web-based survey for members of the DWG, to assess their facility with LEAP and their progress towards the Phase B objectives. Results will be reported to USAID Clean Power Asia as part of Activity B.10.

In addition to the web-based assessment, delegates from the DWG who participated in the study visit (Mission 3) will be asked to lead a half-day workshop for the larger group of their DWG and SWG colleagues. Ideally, the workshop should be held within two weeks of the end of Mission 3. The purpose of the workshop will be for DWG members to transfer knowledge internally, with the delegates sharing lessons and key outcomes from the study visit and seeking input on the modeling that they performed while in the US. In SEI's experience, this type of permissive learning environment is an extremely effective way to build autonomy, competence, and trust in the chosen methodology. SEI will not attend the workshop and no formal capacity assessment mechanisms will be used to measure progress. However, a team members from USAID Clean Power Asia may be asked to attend to help facilitate and document the results of the workshop if needed, and to ensure there is participation from the whole IRRP core team.

B.10 Third Quarterly Report

The third quarterly report will cover activities since the second report, including:

- Discussion and a feedback summary of the "brown bag lunch" seminar from Mission 3.
- Record of EE and DSM scenarios implemented in the IRRP model (Activities B.6 and B.7).

[2] It is expected that key data inputs for normative scenarios related to climate change will come from the climate vulnerability analysis of the Lao PDR electricity sector that USAID Clean Power Asia is conducting in 2018. These inputs should not necessitate any supplemental data collection by the IRRP core team. On the demand side, the inputs will likely include projected changes in electricity demand and load in various climate scenarios. Supply-side inputs are described under Activity C.7.

- Narrative (non-quantitative) description of normative scenarios identified during Mission 3 which pertain to energy demands (Activity B.8).
- Key lessons from the intermediate web-based capacity assessment (Activity B.9).

3.3 KEY DEPENDENCIES

Key dependencies or assumptions in the plan for Phase B are outlined in the following table.

Table 5: Key Dependencies for Phase B

Activity	Key Dependency
0 Assessing Existing Demand Modeling Tools	Assumes ability to gain access to econometric demand modeling tools deployed under an earlier JICA project. This may require coordination with JICA or its technical consultants. May also require access to MS Excel spreadsheets, MicroFit, or earlier LEAP models developed by MEM.
B.5 Constructing Baseline Energy Demand Model Using LEAP	SEI assumes that the USAID Clean Power Asia team will provide all logistical assistance associated with IRRP core team members obtaining a US visa while in Lao PDR. SEI has appropriate facilities on its premises to host up to three members of the DWG.
B.8 Defining and Modeling Other Normative Demand Scenarios	In order to remotely facilitate a discussion on normative scenarios, SEI expects that the IRRP core team will be able to convene in a conference space with a sufficiently fast Internet connection to allow video chatting and sharing of the presenter's screen.

4. PHASE C: SUPPLY RESOURCE ASSESSMENT

4.1 OBJECTIVES

Similar to Phase B, one of the main goals of Phase C of the IRRP capacity building program is to equip members of the SWG with the skills needed to construct a national-scale model of energy supply, using LEAP and other accompanying utilities. Emerging from Phase C, participants will be familiar with different ways to model energy supply processes using both top-down and bottom-up methods, and will possess an in-depth understanding of cost-optimization modeling techniques for the electric power sector. They will understand the key strengths, limitations, and data requirements of cost-based electricity capacity and dispatch models, and be able to interpret their results. In addition to skills development, Phase C will improve participants' knowledge of supply resources within the power sector. They will be conversant with basic technical performance characteristics, costs and worldwide trends driving costs, and the potential roles of technologies in supplying energy to the Lao PDR grid. These lessons will be integrated in the supply-side model produced in the phase.

A separate objective of Phase C is to give IRRP team members a chance to provide feedback during the creation of new software utilities connected to LEAP. Some of the activities included in this phase will require the expansion of the IRRP modeling toolkit to include new features, giving practitioners in Lao PDR an opportunity to learn about different modeling paradigms and to guide the development process from a user's perspective. In this way, the IRRP model, as well as the IRRP modeling toolkit, will be designed collaboratively with practitioners in Lao PDR.

4.2 ACTIVITIES AND OUTPUTS

Phase C includes several activities, summarized in the table below. An expanded description of each activity follows.

Table 6: Phase C Activities

	Activity	Timeline
0	Software Training on Supply Modeling Using LEAP	October 2018
0	Constructing Baseline Energy Supply Model Using LEAP	October – November 2018
C.3	Defining and Modeling Additional Energy Supply Resources	November 2018 – January 2019
C.4	Fourth Quarterly Report	December 2018
C.5	Incorporating Transmission Analysis Into Supply Assessment	January – April 2019

0	Fifth Quarterly Report	March 2019
C.7	Defining and Modeling Other Normative Supply Scenarios	April – May 2019
C.8	Phase C Capacity Assessment of IRRP Core Team Members	May 2019

C.1 Software Training on Supply Modeling Using LEAP

The first activity under Phase C will be to train members of the IRRP core team on energy supply modeling using the LEAP toolkit. The training will be held during the first part of the energy supply concepts and modeling workshop (Mission 4) and will cover LEAP capabilities as well as underlying modeling theory (particularly related to optimization modeling). The training will be offered to participants from both the DWG and the SWG. This is so that members of each group can gain a working understanding of the supply-modeling capabilities of LEAP and an appreciation for its uses and limitations. Since the goal of the training is only to acquaint the DWG and SWG teams with energy supply modeling and cost-optimization in LEAP, the training exercises will be based on sample data.

Mission 4: Energy Supply Concepts and Modeling Workshop		
Where: Vientiane	*When: October 2018*	*Who: SEI, DWG, SWG*
In October 2018 (planned), SEI will visit Vientiane to deliver a five-day workshop to develop the energy supply modeling capacity of the IRRP core team, and to begin construction of an energy supply model for Lao PDR. The first two days of the workshop will be devoted to basic and intermediate concepts about the use of LEAP described in Activity 0. All members of the IRRP core team will be invited – both DWG and SWG. For the remainder of the workshop, SEI will work solely with the SWG to develop a baseline supply model for Lao PDR, moving into Activity 0. Advanced concepts will be introduced by SEI as needed, and the group will lay out a clear set of priorities for model development to be carried out by SEI and the SWG after the workshop.		

C.2 Constructing Baseline Energy Supply Model Using LEAP

Starting mid-week during the energy supply concepts and modeling workshop, this activity will develop an energy supply model covering both electricity generating capacity and dispatch. The model will be predicated on concepts of least-cost planning, which will serve as a foundation for developing a coherent baseline projection of capacity and electricity generation. It is important to note that this is a guiding principle only, and that supplementary objectives (those identified in Activity A.4) will also play a role in choosing low-regrets scenarios during Phase D. Initially, separate, disconnected models will be created for each of the four plus one Lao PDR subgrids, matching the regional disaggregation used to model energy demands under Activity B.5. Importantly, modeling undertaken in this activity will not cover existing and proposed transmission links – each of the subgrids will be examined in isolation. This isolated treatment will allow the core team to master basic supply modeling concepts before grappling with the complexities of modeling transmission. Model construction during Mission 4 will be led by SEI, with members of the SWG contributing data and guidance while working alongside SEI to develop inputs to the supply model. The electricity

capacity model will contain plant-level detail (or generator-level, if possible) for each of the four plus one subgrids, including performance and cost data for each plant or type of technology. The electricity dispatch model will feature hourly resolution, which is important to capture variations in load and RE availability. The SWG will develop a list of planned or baseline capacity improvements, including new construction and rebuilds/retrofits, as well as a list of candidate generation technologies. With SEI's help during the Mission 4 workshop, the SWG will include these plans and technology options in the supply model's baseline scenario. Using email and web-conferencing to coordinate, SEI and the SWG will complete any outstanding work on the baseline after the workshop.

C.3 Defining and Modeling Additional Energy Supply Resources

Also after the workshop, SEI will collaborate with SWG members in Lao PDR to model additional supply resources that are not represented in the baseline, but which could conceivably be deployed in the future to achieve the IRRP planning objectives. These may include energy storage technologies, distributed generation, and the candidate REZ identified in Activity A.7. Both the cost and technical performance of each option will be included in the model, based on national data sources supplemented with international defaults where needed. The SWG will lead model development tasks for this portion of the activity, making incremental adjustments to the IRRP model with SEI providing oversight over email.

Meanwhile, to improve the analysis of the technical performance of each candidate REZ, SEI will use spatiotemporal information developed for Activity A.7 to estimate how new capacity built in each candidate REZ could increase or decrease the reliability of its local domestic (or export) subgrid. This is an important element to consider when choosing among energy supply resources, and is needed to capture the full benefit of any transmission interconnection exploration during the next activity. It will require the creation of software utilities and some additional revisions to the LEAP tool, after which SEI will demonstrate the newly developed capabilities during a web-conference with the SWG.

C.4 Fourth Quarterly Report

The fourth quarterly report will cover activities since the third report, including:

- Summary report from the energy supply concepts and modeling workshop (Mission 4) including information about the development of the baseline energy supply model (Activity 0).
- Characterization of energy supply resources options identified (including key data inputs for each), and their implementation status in the IRRP model (Activity C.3).

C.5 Incorporating Transmission Analysis Into Supply Assessment

In this activity, the "generation only" analysis begun under Activity C.3 will be expanded to include a simplified representation of the transmission network. This task will be performed in a two-step process: first by defining scenarios (including equipment locations, costs, and performance) for the baseline transmission system, potential augmentation of the system to improve connectivity and export capacity, and interconnection of the candidate REZ; and second by implementing these transmission scenarios in the model, connecting the four plus one subgrids in a variety of potential configurations. Like the analysis described in Activity C.3, this will require the development of new

software utilities and further work on LEAP. Therefore, initially, SEI will undertake this work alone. Once the necessary software extensions are in place, appointed members of the SWG will undertake a study visit to SEI's US Center (Mission 5, below). During the visit, SWG members will work closely with SEI to add transmission data for each candidate REZ – and other energy supply resources – to the supply model.

Mission 5: Study Visit to SEI US Headquarters for Supply Working Group		
Where: Somerville	*When: April 2019*	*Who: SEI, SWG appointees*
In April 2019 (planned), SEI will host up to three members of the IRRP SWG (including at least one woman) at its Center in the United States, located outside Boston, Massachusetts. The study visit will last for one week, during which SEI will work with the IRRP team to implement spatial, cost, and performance information for transmission resources in the IRRP model (Activity C.5). The visit will allow SWG members to interact closely with scientists in SEI's Energy Modeling Program and to meet the author of the LEAP software, as their DWG colleagues will have done in Phase B. Similarly, SWG delegates will be asked to present their country's planning experience and their progress through the IRRP process during a "brown bag lunch" seminar held during the study visit. Following the seminar, audience members from across SEI's diverse research themes will provide feedback and perspectives. SEI and SWG delegates will also set aside one to two days during the study visit to develop normative supply scenarios as described under Activity C.7.		

C.6 Fifth Quarterly Report

The fifth quarterly report will largely focus on the expansion of the IRRP model's capabilities to cover transmission planning. It will include:

- Description of methodological choices used for transmission modeling, and an update on software utilities developed to support this modeling (Activity C.5).
- Discussion and a feedback summary of the "brown bag lunch" seminar from Mission 5.

C.7 Defining and Modeling Other Normative Supply Scenarios

To wrap up the Mission 5 study visit, SEI and SWG members participating in the visit will evaluate possible energy *supply* impacts of normative scenarios developed under Activity B.8. The group will then conceptualize new normative scenarios that may affect only the electricity supply sector, adding to the set of normative scenarios identified earlier. As with Activity B.8, SEI will use the period after the study visit to conduct basic research on how each of the normative scenarios may be included within the LEAP model, and will propose methodologies and examples to the SWG over a web-conference call. Once modeling approaches are agreed, SEI will guide the SWG through required data inputs, and the SWG will collect any supplemental data needed to model the scenarios. Since Activity C.7 should take place after the completion of the USAID Clean Power Asia climate vulnerability assessment of the Lao PDR electricity sector (which is expected to finish by September 2018), outputs from the assessment that are relevant to normative climate change scenarios will be compiled at this stage. In addition to the demand-side outputs noted under Activity

B.8, key supply-side outputs are expected to include climate-induced changes in the costs, availability, effective capacity, and efficiency of generation and transmission equipment. These projected values will be incorporated in the normative climate change scenarios in the LEAP model.

C.8 Phase C Capacity Assessment of IRRP Core Team Members

SEI will prepare a third web-based survey for members of the SWG, to assess their facility with LEAP and their progress towards the Phase C objectives. Results will be reported to USAID Clean Power Asia in a brief email memo.

In addition to the web-based assessment, delegates from the SWG who participated in the study visit (Mission 5) will be asked to lead a half-day workshop for their DWG and SWG colleagues. Ideally, the workshop should be held within two weeks of the end of Mission 5. The purpose of the workshop will be for SWG members to transfer knowledge internally, with the delegates sharing lessons and key outcomes from the study visit and seeking input on the modeling that they performed while in the US. Again, SEI will not attend the workshop and no formal capacity assessment mechanisms will be used to measure progress. However, a team member from USAID Clean Power Asia may be asked to attend to facilitate the workshop and document the results if needed, and to ensure participation from the whole IRRP core team.

4.3 KEY DEPENDENCIES

Key dependencies or assumptions in the plan for Phase C are outlined in the following table.

Table 7: Key Dependencies for Phase C

Activity	Key Dependency
C.5 Incorporating Transmission Analysis Into Supply Assessment	SEI assumes that the USAID Clean Power Asia team will provide all logistical assistance associated with IRRP core team members obtaining a US visa while in Lao PDR. SEI has appropriate facilities on its premises to host up to three members of the SWG.

5. PHASE D: LEAST-REGRETS PATHWAYS

5.1 OBJECTIVES

Phase D is the final step of the IRRP capacity building program, in which data collection, modeling, and scenario design from the previous phases will come together in an integrated way to produce an array of futures for Lao PDR's electricity system. The DWG and SWG will reunite to examine how the system may react under different normative scenarios, and the role which various demand and supply resources could play. Based on these analyses, one or more consensus least-regrets power development pathways will be identified: development plans that best satisfy the planning objectives given the uncertainties and possibilities embodied in the normative scenarios. Emerging from Phase D, members of the IRRP core team will be well-positioned to take on their own scenario analyses, adjust modeling assumptions, and proceed to the next stage of IRRP – developing and implementing an action plan.

SEI recognizes the importance of obtaining approval and agreement from senior officials at Lao PDR's regulatory and energy planning agencies. Thus, a further objective of Phase D is to connect the outputs of the capacity building program to management within MEM and EDL. This will ensure that highlights of the IRRP process and key lessons from its application in Lao PDR are brought before the relevant decision-makers.

5.2 ACTIVITIES AND OUTPUTS

Phase D includes several activities, summarized in the table below. An expanded description of each activity follows.

Table 8: Phase D Activities

Activity		Timeline
0	Integrated Model Runs and Large-Ensemble Scenario Analysis	May – June 2019
D.2	Sixth Quarterly Report	June 2019
D.3	Selecting Low-Regrets Pathways	July – August 2019
0	Renewable Energy Target Setting	August 2019
D.5	Presentations to Supervisors and Final Capacity Assessment	August 2019
D.6	Incorporating Key Results From Load-Flow Analysis Into IRRP Model	September 2019
D.7	Remote Technical Support for Target-Setting and Finalizing IRRP	September 2019
D.8	Seventh Quarterly/Final Report	September 2019

D.1 Integrated Model Runs and Large-Ensemble Scenario Analysis

In a facilitated discussion held over a web-conference call, SEI will guide the DWG and SWG through an exercise to estimate the likelihood of each normative scenario identified in Activities B.8 and C.7 (or the *range* of likelihoods, for normative scenarios describing a continuous range of different futures). Taking these likelihoods into account, SEI will execute a large ensemble of model runs of the integrated energy system, exploring all demand and supply resource options against a wide backdrop of normative scenario permutations. The model itself will be run on SEI's servers in order to generate inputs for group discussion during the pathways workshop (Mission 6, below).

D.2 Sixth Quarterly Report

The sixth quarterly report will cover activities since the fifth report, including:

- Narrative description of normative scenarios identified during Mission 5, and modeling approaches agreed upon by SEI and the IRRP core team (Activity C.7).
- Key lessons from the intermediate web-based capacity assessment (Activity C.8).
- Inputs and likelihood estimates for each normative scenario, and a plan of execution for the large ensemble analysis (Activity 0).

D.3 Selecting Low-Regrets Pathways

During the pathways workshop, SEI will hold a facilitated dialogue with the IRRP core team to review the results from the large-ensemble scenario analysis and consider the trade-offs which arise among competing objectives. The team will then identify a set of low-regrets development pathways for the Lao PDR electricity system.

Mission 6: Pathways Workshop		
Where: Vientiane	*When: August 2019*	*Who: SEI, USAID Clean Power Asia team, IRRP core team, senior officials from MEM and EDL*
In August 2019 (expected), SEI will visit Vientiane to conduct a workshop on identifying low-regrets development pathways for the Lao PDR electricity system. SEI will present the theoretical basis for large-ensemble scenario analysis, and highlight important indicators and visualizations emerging from the integrated runs of Activity 0. SEI will also quantify progress made towards each planning objective, using the metrics identified in Activity A.4. By mid-week, together with the IRRP core team, SEI expects to finalize a selection of low-regrets pathways to be presented to MEM and EDL management. The IRRP team will then be divided into groups (each composed of members of both the DWG and SWG), and each group will be assigned a particular pathway which they will analyze in greater detail for Activity D.5.		

D.4 Renewable Energy Target Setting

Using the results of the integrated modeling runs, IRRP team members will examine shares of RE in the electricity mix emerging from each scenario pathway. Treating these RE shares as an output of integrated planning, rather than as a standalone IRRP objective, will give planners motivation for setting evidence-based renewable targets. The review of RE deployment in each pathway will also

consider the degree of exploitation of the candidate REZs. This will provide further evidence on the zones' viability to inform subsequent action planning for generation and transmission. Members of the IRRP core team will feature preliminary RE targets for each low-regrets pathway during their presentations in Activity D.5.

D.5 Presentations to Supervisors and Final Capacity Assessment

For the conclusion of the pathways workshop, the IRRP core team will divide into groups and develop presentations to brief senior decision-makers and management within MEM, EDL, and other planning authorities if needed. Each group will deliver its presentations at an afternoon "mini-conference," during which SEI will also detail the process of IRRP and summarize the capacity building program goals. In the presentations, each group will summarize one assigned low-regrets pathway identified earlier in the week (see Mission 6 text box). Presentations should focus on how the team arrived at the pathway by progressing through each element of IRRP. They should include an explanation of how different IRRP objectives are satisfied, an accounting of any tradeoffs encountered, and a description of demand and supply resources and financing required. The mini-conference will provide decision-makers with an opportunity to ask questions about the process or about the recommended low-regrets pathways, while also demonstrating to stakeholders how each of the multiple planning objectives from Activity A.4 is satisfied in the integrated energy system pathways. Following the presentations, SEI, stakeholders in attendance, IRRP team members and their managers will attempt to identify one or more preferred (i.e., least-regrets) pathways, using a discussion-based consensus approach.

SEI will use the group presentations from the mini-conference as the basis of the final capacity assessment, which SEI will deliver to USAID Clean Power Asia in a memo. The memo will contrast results from each of the prior web-based capacity assessments, commenting on how well the final presentations demonstrate participants' understanding of IRRP principles, capacity to use software tools, and ability to go on to apply these lessons in a PDP.

D.6 Incorporating Key Results From Load-Flow Analysis Into IRRP Model

Load-flow analyses are used to probe the ability of the power system to react to short-duration stresses, such as faults or surges. Conducting this kind of analysis is an important part of ensuring the reliability of the grid. A proper load-flow study requires a highly resolved model – both spatially and temporally – of the power network and all of its components. The IRRP model co-developed under the capacity building program will not have such detail. However, the results from the IRRP model, such as projected installed capacity, electricity dispatch, and transmission requirements to serve demand, can be used as inputs into an auxiliary load-flow model. In this way, a load-flow assessment could be used as a secondary check on the least-regrets pathway(s) identified in Activity D.5, to verify whether technical and operational constraints of the power system (perhaps not identified under Activity A.4, but uncovered during a load-flow analysis) are violated. If so, SEI will collaborate remotely with the SWG to provide recommendations for how issues can be resolved in the IRRP model.

D.7 Remote Technical Support for Target-Setting and Finalizing IRRP

In the weeks following the pathways workshop, SEI will transition the IRRP model to its home with MEM and/or EDL. Through web-conferencing and email support, SEI will work with the IRRP core

team to resolve questions and respond to feedback provided during the pathways workshop presentations. SEI will also explain logistical best practices for hosting and maintaining the model file, for linking citations and data sources, and for ensuring that technical staff at MEM and EDL have access to a robust IT environment that they can use to further develop and update the model. SEI will continue to be available to provide technical and strategic input as the IRRP team moves to develop an action plan and finalize RE targets based on the IRRP analysis, and will offer to review the draft PDP before its submission.

D.8 Seventh Quarterly/Final Report

In the final quarterly report of the capacity building program, SEI will summarize the remaining activities completed since the last report and present high-level conclusions about the program's impact. The report will provide an overview of Mission 6 outcomes and include a description of agreed low-regrets pathways and implications for RE targets and REZs. SEI will also comment on the presentations given by the IRRP core team to senior management, and assess any additional capacity building needs. The report will outline steps taken/to be taken by the SWG to incorporate results from an external load-flow analysis into the IRRP model.

As part of the final report, SEI and USAID Clean Power Asia will consult with members of the IRRP core team for their feedback on the capacity building program, reviewing their accomplishments over the past nearly two-year period. With their permission, testimonials from participants will be included in the body of the report. Finally, SEI will consolidate these experiences to establish a set of improvements to this Capacity Building Plan, setting the scene for subsequent applications of IRRP capacity building in other Lower Mekong countries.

5.3 KEY DEPENDENCIES

Key dependencies or assumptions in the plan for Phase D are outlined in the following table.

Table 9: Key Dependencies for Phase D

Activity	Key Dependency
D.6 Incorporating Key Results From Load-Flow Analysis Into IRRP Model	SEI will not conduct a load-flow analysis of its own. However, SEI can support other partners performing such an assessment, and will use the results of any load-flow modeling to revise the IRRP model as needed.

6. LOOKING BEYOND THE IRRP CAPACITY BUILDING PLAN

This document lays out a phased curriculum to orient key technical staff at MEM and EDL to the principles and practice of IRRP. It prescribes a series of activities and missions for the IRRP capacity building program. Together, these milestones will guide members of the IRRP core team towards developing a PDP that is economically efficient, inclusive of stakeholders' interests, and robust to contingency events and long-term changes that could adversely affect the power system in Lao PDR.

The goals of the capacity building program are to build technical skills and shape planners' thinking, but also to develop a useful modeling product that participants truly own. While this requires hard work and commitment for the duration of the program, MEM and EDL will have full control of the modeling products developed during the program's execution. This also means it will be their shared responsibility to use and maintain these resources. As currently envisioned, SEI's formal role in the development of a PDP will end in September 2019, but SEI will remain responsive to questions and can provide technical guidance after that.

With its rapid electrification and aggressive power exporting goals, Lao PDR is in the midst of important changes in its energy system. A successful, managed transformation will require careful application of technical expertise and foresight. Upon completion of the IRRP capacity building program, members of the Demand and Supply Working Groups can return to their agencies as thought-leaders, equipped with an analytical tool and skills that they can use to ensure the benefits of the transition are sustainable and shared by everyone.

ANNEX A: TIMELINE FOR IRRP CAPACITY BUILDING PROGRAM

The IRRP Capacity Building Plan will be carried out during Year 2 and Year 3 of the USAID Clean Power Asia program, extending into September 2019. In the following Gantt chart (Table 10), the time required to deliver each major activity is shown using one or more colored blocks corresponding to the phase under which the activity falls.

The Capacity Building Plan calls for six missions. For four of the missions, SEI will visit Vientiane, to deliver a consultative workshop or a training, or to work closely with members of the IRRP core team. The remaining two missions are study visits, during which a small number of delegates from the DWG and SWG will visit SEI in the US. Each mission is listed separately at the bottom of the chart, and the activities that it overlaps with are shown using shaded boxes.

Table 10: Timeline for Activities and Missions

Activity	Description	Year 2 of Project (2018)									Year 3 of Project (2018/2019)											
		JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
A.1	Baseline Capacity Assessment of Prospective IRRP Core Team Members																					
A.2	Develop Initial Data Request for Energy System Modeling																					
A.3	Stakeholder Analysis and Mapping																					
A.4	Identify IRRP Objectives, Constraints, and Metrics																					
A.5	First Quarterly Report																					
A.6	Identify and Assess Technical Potential of RE Study Areas																					
A.7	Identify Candidate Renewable Energy Zones																					
B.1	Assess Existing Demand-Modeling Tools																					
B.2	Specify Integration of Existing Demand-Modeling Tools with LEAP																					
B.3	Second Quarterly Report																					
B.4	Software Training on Demand Modeling Using LEAP																					
B.5	Construct Baseline Energy Demand Model Using LEAP																					
B.6	Define and Model EE Scenarios																					
B.7	Define and Model DSM Scenarios																					
B.8	Define and Model Other Normative Demand Scenarios																					
B.9	Phase B Capacity Assessment of IRRP Core Team Members																					
B.10	Third Quarterly Report																					
C.1	Software Training on Supply Modeling Using LEAP																					
C.2	Construct Baseline Energy Supply Model Using LEAP																					
C.3	Define and Model Energy Supply Resources																					
C.4	Fourth Quarterly Report																					
C.5	Incorporate Transmission Analysis into Supply Assessment																					
C.6	Fifth Quarterly Report																					
C.7	Define and Model Other Normative Supply Scenarios																					
C.8	Phase C Capacity Assessment of IRRP Core Team Members																					
D.1	Integrated Model Runs and Large-Ensemble Analysis																					
D.2	Sixth Quarterly Report																					
D.3	Selecting Low-Regrets Pathways																					
D.4	Renewable Energy Target Setting																					
D.5	Presentations to Supervisors and Final Capacity Assessment																					
D.6	Incorporating Key Results from Load-Flow Analysis Into IRRP Model																					
D.7	Remote Technical Support for Target-Setting and Finalizing IRRP																					
D.8	Seventh Quarterly/Final Report																					
Mission 1	IRRP Capacity Building Plan Launch Workshop																					
Mission 2	Consultative Workshop on RE Zone Study Areas and Demand Model Development																					
Mission 3	Study Visit to SEI – US Headquarters for Demand Working Group																					
Mission 4	Energy Supply Concepts and Modeling Workshop																					
Mission 5	Study Visit to SEI - US Headquarters for Supply Working Group																					
Mission 6	Pathways Workshop																					

ANNEX B: REFERENCES

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