How To Conduct a Long-Term Planning Study

Guidelines for Power System Planners

What Is a Long-Term Planning Study?

A long-term planning study is a process of inquiry—often supported by modeling tools—that helps answer questions for decision makers about expected power system investment requirements and the impact of potential policy, regulatory, or market changes on these requirements. The study considers the technical and/or economic impact of different investment pathways in the face of uncertainty (e.g., demand growth, technology costs and performance, and policies) and can form the basis of integrated resource plans or power system master plans.

What Can a Planning Study Do for You?

A long-term planning study builds confidence and consensus among stakeholders about drivers for investment needs and how the power system may evolve. It can also identify the policy, regulatory, infrastructure, and power system operational interventions needed to achieve desired targets (e.g., for clean energy deployment or decarbonization) in a cost-effective manner and without compromising system reliability.

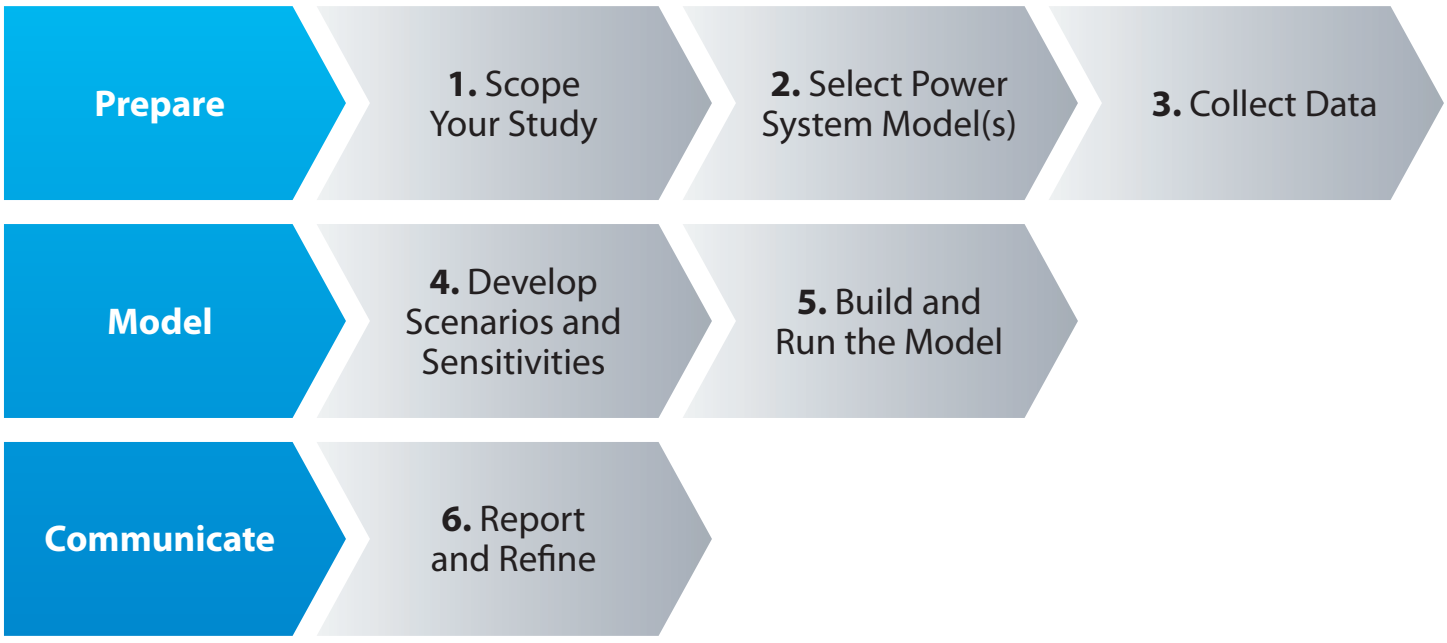

Figure 1. Process to conduct a planning study

What Is the Process to Conduct a Planning Study?

1. Scope Your Study

Before beginning the study, it is important to identify the study's objectives, needs, and the knowledge gaps you aim to address. This is also a time to identify and build support from relevant stakeholders whose future decisions may be informed through the planning study including policymakers, regulators, utilities, and industry and consumer groups. Plan for how to involve different stakeholder groups at various stages throughout the planning study, build support and buy-in from these groups, and meaningfully listen to and incorporate their feedback. For example, a modeling working group composed of technical experts can be a valuable resource to provide feedback on input data, model methodologies, and initial results and can be expected to meet frequently during the model development process. A technical review committee, including experts with a more diverse background, can provide broader perspective on what certain outcomes mean for consumers, the environment, and other sectors of the economy, and would meet less frequently. Effectively utilizing stakeholder input is essential to the development of a high-quality plan.

In addition to topics that are of interest to power system stakeholders, the questions answered with a long-term planning study depend, in part, on available modeling tools, data, and know-how of the modeling team. Based on the study objectives, good practice is to draft a list of tools, data, and expertise you expect to need and identify areas where additional support may be required and the impact this may have on the project's timeline and budget.

Outcome: a proposal that includes the study's background, key audiences, objectives, needs, geographic and temporal focus, expected outcomes and benefits, and roles and responsibilities of relevant stakeholders throughout the planning study.

2. Select Your Power System Modelling Tool(s)

The study objectives will determine the power system modelling tool(s) required. Long-term planning studies typically require a capacity expansion model, an optimization tool used to identify cost-effective investments to meet power system requirements. Depending on the project scope, other models may be required for activities like demand forecasting, production cost modeling, resource adequacy assessments, and power flow and dynamic stability simulations.

When selecting a modeling tool, it is important to reflect on the questions you are trying to answer, as well as data requirements, software costs, and the hardware and software requirements to run the model. If existing options are not appropriate (i.e., they are too data-intensive or are not set up to answer the study's questions), the modeling team may need to add new features to existing models or even build their own. If multiple tools are being used, the modeling team should identify how data will flow between different tools and what, if any, conversions may be required to link different tools.

Outcome: a modeling workplan that identifies the modeling tool(s) to be used, model inputs and outputs, and workflow between different tools.

3. Data Collection

Long-term planning studies require data on the existing power system as well as projections of how system conditions and technology cost and performance characteristics may change in the future. Obtaining the relevant data and assumptions may be a straightforward exercise, but can also be challenging, time-consuming and costly, depending on the context. Assessing data requirements and potential costs early in the study can help avoid unforeseen delays and unintended budget overruns. Data gathering begins with listing all data needs for the study—based on the study scope and model(s) being used—and identifying potential sources for each data requirement. The stakeholder group created during the scoping phase can be instrumental here as both a direct source of input data and in helping to find new data sources.

Outcome: all input data required for modeling activities under the study scope.

4. Develop Scenarios and Sensitivities

No one can say with certainty how a power system will evolve over time. Study scenarios represent possible investment paths under different assumptions about how system conditions and the policy/market environment might evolve. Sensitivities help test uncertainties around key input assumptions such as demand growth and technology cost and performance. Together the study scenarios and sensitivities help inform the drivers for different investment paths and identify "no regrets" options for investment which are robust against known uncertainties for the future.

The stakeholder group can provide valuable input on potential changes and uncertainties in the power sector to guide the design of study scenarios and sensitivities. The selection of scenarios and sensitivities will also depend on data availability and the needs and capabilities of the model(s) being used.

Outcome: a list of modeling scenarios and sensitivities that capture the range of future conditions for the power sector and major uncertainties around key assumptions.

5. Build and Run the Model

At this stage, the modeling team should have all the data and tools required to build a long-term planning model that is fit-for-purpose for the planning study. Additional training may be required on modeling in general or on the specific software tool(s) being used. Developing a planning model is an iterative process, requiring multiple rounds of consultation and refinement. The modeling team should develop multiple checks throughout the model development process to ensure: (1) inputs are being interpreted correctly; and (2) the model is representing the system as expected. It can be helpful to test a range of model inputs or constraints to ensure the model behaves as expected. In cases where multiple models are being linked (e.g., capacity expansion and production cost models), testing is also needed to ensure that data flows between the models occur correctly.

A modeling working group can be useful to review initial modeling results and recommend changes or additional testing followed by additional review from a broader technical review committee. The modeling team should be able to explain any unexpected results or major system changes. Achieving this level of understanding typically requires running multiple iterations of the model beyond the primary list of study scenarios and sensitivities, as well as forensic efforts to explain unexpected modelling results and identify errors as they arise. Once the modeling team feels confident in the input assumptions and results, the next step is to revisit the study's objectives and confirm the model outputs can answer the initial questions and provide insights that are actionable and productive.

Outcome: a working planning model vetted by a technical review committee and results for all study scenarios and sensitivities.

6. Report and Refine

The final output of a planning study is typically a technical report and dataset that summarizes the study's objectives, inputs, methods, and key findings. The primary audience for this report may include energy ministries and regulatory commissions that have approval authority over new investments. In addition, other supplemental materials such as presentations, fact sheets, and press releases can be useful to communicate the study outcomes to a broader audience. Prior to publishing a final report, the study team can solicit external feedback from stakeholders outside of the technical review committee to identify any areas where further model refinement or scenarios are needed.

The report and results should address the concerns or questions posed by the stakeholder group in the initial scoping phase and give decision makers increased confidence about how the power system may evolve.

Outcome: a technical report and/or supplemental material summarizing the study objectives, inputs, methods, and key findings.

Learn More

Find out about NREL's power system planning activities in India: Supporting India's States with Renewable Energy Integration.

Please contact SouthAsiaSupport@nrel.gov with any questions.

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