# Eastern Interconnection Analysis and Planning
# Overview and Scope
# DE FOA-0000068



**Working Draft August 27, 2009**

**Project High-Level Description**

The Eastern Interconnection Analysis and Planning Project (the "Project") will be conducted in response to the U. S. Department of Energy Funding Opportunity Number DE-FOA 0000068 ("FOA"). This application is being submitted by a multi-party consortium formed by a coalition of regional planning authorities - those entities listed on the North American Electric Reliability Council (NERC) compliance registry as Planning Authorities (PA) representing the entire Eastern Interconnection. This group of regional planning authorities intends to establish the Eastern Interconnection Planning Collaborative (the "Collaborative").

As outlined in this proposal, the Collaborative will conduct a process which:

- Builds upon existing models of the bulk power system and refines them as necessary to support inter-regional analysis of the combined regional plans for the entire Eastern Interconnection.
- Incorporates the current local and regional plans for the entire Eastern Interconnection.
- Performs analysis of the regional plans on an Interconnection-wide basis to identify greater opportunities for efficiencies.
- Provides an open and transparent stakeholder process to identify specific resource expansion scenarios to be studied. The stakeholder input from public workshops and other stakeholder forums will be taken into consideration by a multi-constituency stakeholder steering committee, that includes at least a one-third representation of state officials.
- Performs analysis for the scenarios recommended by the stakeholder steering committee and endorsed by the states on an inter-regional basis for the entire Eastern Interconnection including the identification of potential transmission infrastructure enhancements to address those scenarios.
- Provides policy makers and regulators with current, complete, and technically sound information, vetted and reviewed with stakeholders, relating to potential transmission impacts associated with state, provincial, and national energy objectives and an opportunity for policy makers and regulators to identify, in a timely manner,options to achieve those objectives.
- Develops draft summaries and reports on the findings for use in an open stakeholder review and comment process.
- Publishes final summaries and reports after considering the input received from the stakeholder process and provides the results of the analyses to the DOE, in accordance with the requirements of the FOA, as well as to the regional planning processes for consideration in enhancing regional plans.

The Collaborative is unique in that it represents a-first-of-its-kind effort by the Planning Authorities to formally review existing expansion plans and future scenarios on an interconnection-wide basis in the Eastern Interconnection. Analyses undertaken will inform policy makers and stakeholders regarding future expansion options and also the potential implications of changes which may result from proposed legislation or other policy initiatives.

**Statement of Project Objectives**

A. OBJECTIVES

The objective of the Project is two-fold:

1. Establish processes for aggregating the modeling and regional transmission expansion plans of the entire Eastern Interconnection and perform inter-regional analyses to identify potential conflicts and opportunities between regions. This Interconnection Wide analysis will also serve as the reference case for modeling various alternative grid expansions based on the scenarios developed by stakeholders. The existing Regional Plans serve as an appropriate reference case because they:
    a. Are developed through processes that include both "bottom-up" and regional coordination processes intended to meet all current state, provincial, and federal regulatory and reliability requirements including the integration of renewable, low carbon, and demand-side resources.
    b. Represent extensive underlying analysis, have been well vetted within each region, and have been determined by each PA to meet NERC reliability criteria**.**
    c. Provide comprehensive expansion plans which are in progress toward implementation.
    d. Can readily be adapted to implement opportunities to increase inter-regional compatibility or expansion efficiencies.
2. Perform scenario analysis as guided by broad stakeholder input and the consensus recommendations of the multi-constituency Stakeholder Steering Committee (SSC) to aid states and other stakeholders in assessing inter-regional options and policy decisions.

Phase I (To be completed prior to 6/30/2011)

- Aggregate modeling and integrate regional expansion plans. Provide inter-regional assessments of transmission system capabilities for the year 2020 in the planning horizon, Identify potential constraints and quantify the ability to move power between regions through reliability and economic analyses. Identify opportunities for potential transmission enhancements to regional expansion plans to increase the ability to move power or reduce costs and communicate to regional planning processes.
- Establish a multi-constituency SSC process for providing consensus guidance on scenario selections. Provide macro-economic analysis and high-level transmission analysis to assist the SSC in the selection of scenarios for further analysis. Provide grid enhancement and resulting production cost analysis and assess the associated impacts of scenarios selected for the year 2020 in the planning horizon. Develop inter-regional expansion model(s) to include resource options of interest consistent with the guidance from each state and the SSC, and evaluate through reliability and economic analyses. Communicate results to States, other stakeholders, and regional planning processes**.**

Phase II (To be completed prior to 6/30/2013)

- Develop lessons learned from Phase I and refine Phase I analysis accordingly.

- Update aggregate modeling and integrate regional expansion plans. Provide inter-regional assessments of transmission system capabilities for the year 2022 in the planning horizon, subject to guidance from the multi-constituency SSC. Identify potential constraints and quantify the ability to move power between regions through reliability and economic analyses. Identify opportunities for potential transmission enhancements to regional expansion plans to increase the ability to move power or reduce costs and communicate to regional planning processes.
- Refine, augment, and narrow scenarios as determined by the SSC process for providing consensus guidance on scenario selections. Provide macro-economic analysis and high-level transmission analysis to assess the associated impacts of scenarios selected for the year 2022 in the planning horizon, subject to guidance from the multi-constituency SSC. Develop inter-regional expansion model(s) to include resource options of interest consistent with the guidance from each state and the SSC, and evaluate through reliability and economic analyses. Communicate results to States, other stakeholders, and regional planning processes.
- Summarize alternative transmission expansion options incorporated into the 2013 expansion plans.

B. SCOPE OF WORK

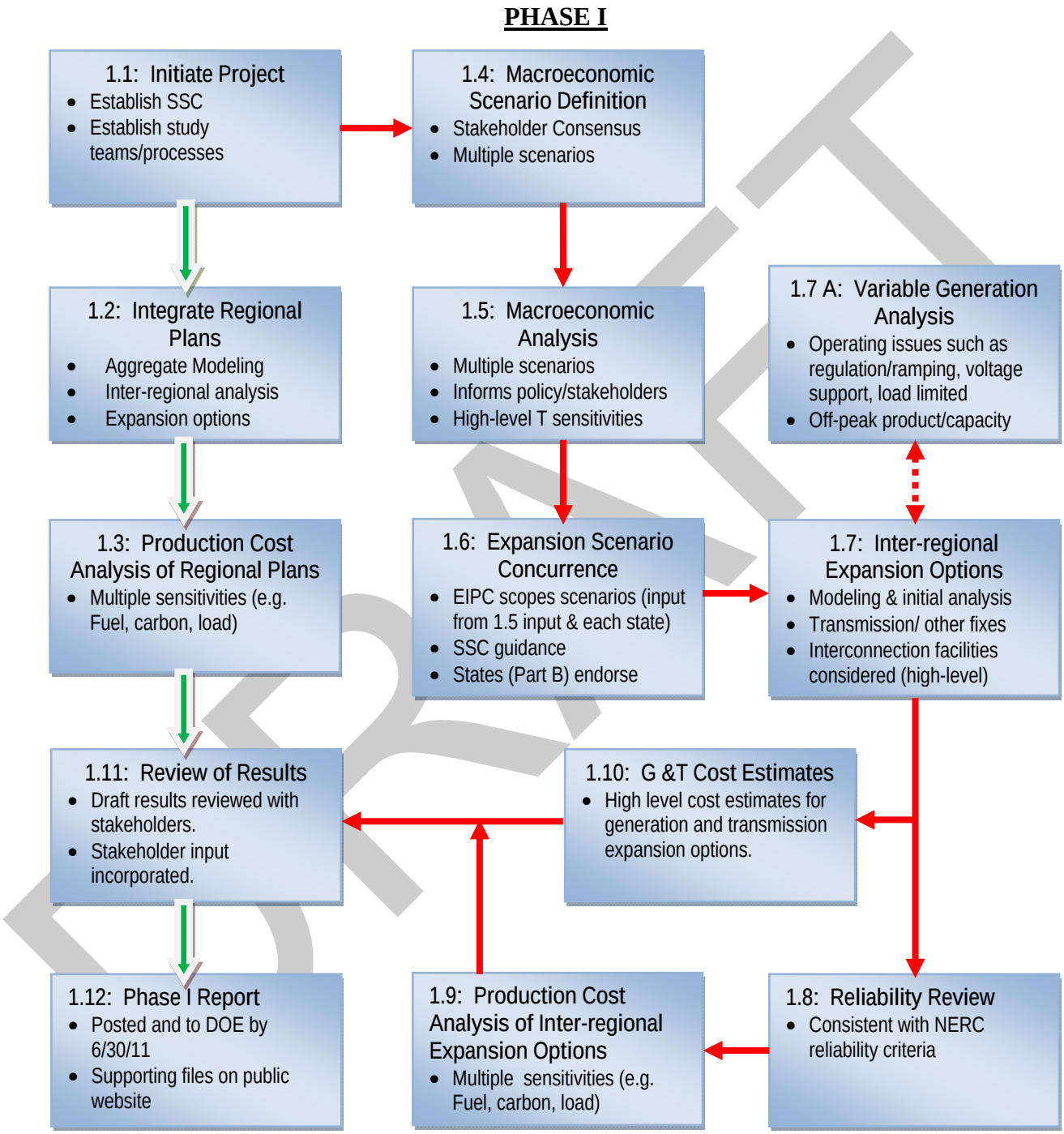
The Project will build upon the extensive annual planning activities associated with the local and regional planning processes, the FERC 890 processes, and the existing inter-regional planning processes. The Project will conduct a minimum of two sets of in person multi-constituency Stakeholder meetings for each phase, one to determine guidance for the analysis and one to convey the results of the analysis The Project will supplement these meetings with conference calls and web meetings as needed. The project will aggregate modeling and regional expansion plans developed in the annual regional processes for 2010, and will conduct base plan and scenario analysis for the 2020 planning year to identify potential impacts and inter-regional transmission expansion options. The Project will provide the initial results of the analysis at the second Stakeholder meeting(s), complete a formal commenting process with Stakeholders on the results and a draft report, and deliver a final report to the DOE prior to 6/30/2011.

The final report for Phase I will include the results of the reliability and economic analyses performed on the aggregated modeling of the regional expansion plans for the Eastern Interconnection for the subject years, including potential expansion options identified through the inter-regional analysis. The report will provide the results of the macroeconomic scenario analysis for each scenario initially proposed by the SSC including high level transmissions sensitivities. The report will provide the results of the reliability and economic analyses performed for the resource expansion scenario(s) selected for further study including the inter-regional expansion options identified and the associated cost estimates**.**

The Project will facilitate meetings with the associated regional planning entities to provide this input for use in their subsequent planning processes. The Project will provide a website to make public analysis results, modeling, work papers, and other materials, subject to applicable regulations associated with protection of CEII and Confidential Data.

In Phase II, the above scope of work will be performed again in conjunction with the annual Collaborative processes for 2012 and a final report will be provided to the DOE prior to 6/30/2013. In addition to the 2011 deliverables, the Project will provide a review of expansion options which were incorporated into 2013 regional expansion plans based upon the 2011 findings.

## C. TASKS TO BE PERFORMED



***Task 1.0 Project Management and Planning***
Key Inputs: Contract award details under the FOA
Key Deliverables: Revised Project Management Plan

As the first task to be completed, the Project Management Office (PMO) will revise the Project Management Plan (PMP) to include details from the final contract award. The PMP describes the general approach used to manage the Project and provides an overview of the project management tools and techniques to be utilized throughout the project. The approach, tools, and techniques will be revised as necessary along with the Project timeline and milestones.

The PMO will also revise the PMP periodically throughout the project as needed to reflect the results from work completed and the changes necessary to accomplish all project objectives in accordance with project delivery dates. Quarterly reporting on schedule progress, actual expenditures versus budget, and revised expenditure projections will be reflected in the PMP updates.

***Task 1.1 Initiate Project***
Key Inputs: Contract award details under the final FOA Agreement.
Key Deliverables: Stakeholder meetings and establishment of Stakeholder Steering Committee (SSC). Establishment of working groups.

The Principal Investigators will review their award under Part A and will meet with the Part B awardees to assess potential adjustments needed in the process for selecting the SSC or study team structures. The Principal Investigators and other Planning Authorities participating in the Collaborative processes[1] will update or establish study processes as required consistent with the award under Part A.

The Keystone Center will facilitate the formation of the SSC, a Stakeholder Working Group (SWG) and any necessary subgroups. The SWG will be responsible for facilitating the interchange of information between the broader stakeholder community and the SSC.

The Principal Investigators, with the Keystone Center providing process design and facilitation services, will conduct a series of regional stakeholder meetings to timely 1) communicate the Project's structure, processes, and deliverables, 2) work toward the establishment of the SSC and selection of representatives from multiple constituencies, and 3) initiate work toward consensus on scenarios for analysis. Throughout the Project, the Collaborative will supplement in-person stakeholder events with webinars and conference calls to facilitate timely input from the broader stakeholder community and the SSC regarding Project tasks.

[1] Principal Investigators, as used in the following task descriptions, also includes the work contributions of the other Planning Authorities in the Collaborative.

***Task 1.2 Integrate Regional Plans***

Key Inputs: Regional Plans and modeling, NERC MMWG modeling

Key Deliverables: Inter-regional modeling (reference cases), Inter-regional analysis, and Transmission Expansion options

The Principal Investigators, building upon the Regional Plans of the NERC Planning Authorities, will aggregate and update the modeling[2] required to perform inter-regional analysis for the entire Eastern Interconnection. This modeling will serve as the basis (reference cases) both for the inter-regional analysis of the Regional Plans and for the expansion scenario analysis selected by Stakeholders through the SSC. Inter-regional analyses will include contingency analysis, transfer analysis, and other reliability assessments performed on an inter-regional basis to identify potential conflicts among regional plans and opportunities for efficiencies in transmission expansion.

This integration and inter-regional analysis will assess compatibility among the Regional Plans, which are developed to meet all current state, provincial, and federal regulatory and reliability requirements, and will identify potential opportunities to enhance the Regional Plans across regions**.**

***Task 1.3 Production Cost Analysis of Regional Plans***

Key Inputs: Inter-regional modeling from Task 1.2

Key Deliverables: Production cost analysis

Economic analysis of the integrated Regional Plans will be performed using production cost modeling. Production cost analysis will assess all 8760 hours of the future year (2020) and will forecast energy production costs, constraints limiting dispatch and inter-regional transactions, anticipated emissions, renewable energy production, and other pertinent factors. The production cost analysis will be performed for multiple future sensitivities such as high/low loads, high/low fuel costs, high/low carbon taxes, or similar parameters.

The economic analysis will be performed by Charles River Associates (CRA) using GE MAPS, a security-constrained production cost analysis model that simulates the hour-by-hour operation of the transmission and generation system in the Eastern Interconnection, incorporating transmission, reliability, and environmental constraints. The analysis will quantify economic and environmental impacts under multiple sensitivities including changes in costs, prices, emissions, and reliability. The CRA model uses a highly-detailed database of generation and transmission facilities in the Eastern Interconnection, which will be refined using input from Collaborative members and stakeholders.

***Task 1.4 Macroeconomic Scenario Definition***

Key Inputs: SSC established in Task 1.1, Stakeholder input from Task 1.1

Key Deliverables: Consensus from SSC on Macroeconomic scenarios

The Principal Investigators, with the Keystone Center providing process design and facilitation services, will conduct meetings to generate strategic guidance from the multi-constituency SSC

[2] The Collaborative will build from the most recent NERC MMWG modeling.

toward developing a set of macroeconomic scenarios which will be analyzed and compared. While principal responsibility for reaching consensus on these scenarios will rest with the SSC, the Principal Investigators will assist and inform the SSC and the stakeholder SWG in their task. The SSC and SWG are responsible for gathering and synthesizing input from the broader stakeholder community on inputs and implications of the Macroeconomic Analysis and other phases of the analysis. The project proposal provides resources to facilitate the on-going interchange between the SSC, SWG and the broader stakeholder community.

The Macroeconomic Scenarios are intended to provide stakeholders and policy makers a forecast of how the interconnected electrical system might evolve for a range of potential policy and economic futures. For example, a set of Macroeconomic scenarios selected by the SSC might be a 20% Renewable Energy Standard (RES) under high, medium, and low fuel costs. Another set might be a 20% RES with $30 carbon allowances under high, medium, and low fuel costs. Such analysis will show potential renewable resource development, impacts on loads, emissions reductions, energy exchanges between regions, and other metrics of interest.. Given the fixed timeframe and resources of the project, the intent is to define a representative set of potential paths for further analysis to provide useful information to policymakers and stakeholders.

***Task 1.5 Macroeconomic Analysis***

Key Inputs: SSC consensus from Task 1.4.
Key Deliverables: Macroeconomic results, High-level Transmission analysis
The Collaborative will provide macroeconomic analyses to provide a high-level assessment of the outcomes of numerous proposed scenarios developed by the multi-constituency SSC. To help inform their decisions, stakeholders and policy makers will receive high level results such as economies of resources in various regions, impacts on renewable development, impacts on emissions, impacts on economic development and demand, and other factors.

The macroeconomic analysis will be performed by CRA using "NEEM", a model which considers impacts both to the electric power supply and to the other sectors of the US economy. Because the macroeconomic approach accounts for all sectors of the economy and not just electric power, it also conveys potential impacts on electric demand and prices that may result related to energy policy impacts in other areas of the economy.

The Principal Investigators will also provide high-level transmission analysis for the scenarios of interest as indicated by the SSC. This analysis would not be detailed power flow analysis, but rather conceptual assessments made by Planning Authority engineers of potential inter-regional transmission expansion to support the magnitude of inter-regional energy exchanges identified in the macroeconomic analysis scenarios.

***Task 1.6 Expansion Scenario Concurrence***

Key Inputs: Macroeconomic analysis and high-level transmission analysis results from Task 1.5, Individual State and LSE resource guidance, SSC input from Tasks 1.4 and 1.5.
Key Deliverables: Expansion Scenario(s), Transmission Analysis Study Scopes for Expansion Scenario(s)

The macroeconomic analysis of Task 1.5 provides stakeholders information regarding potential resources in other regions and associated inter-regional energy exchanges that may be desirable under certain policy or economic futures. The focus of Task 1.6 is to develop Expansion Scenarios of interest which provide a platform for states and other stakeholders to consider higher levels of energy exchange between regions than may be included in Regional Plans. The Principal Investigators will develop proposed scope documents for the Expansion Scenario(s) based upon the input received from the SSC during development and review of the microeconomic analyses in Tasks 1.4 and 1.5. The Principal Investigators will incorporate state inputs[3] in developing the level of external resources (imports) to be assessed for each area and/or the level of resources sited within each area to be assessed for exports to other areas. The Principal Investigators will review the proposed scope documents with the SSC to receive strategic guidance and adjust the scopes as appropriate. The Principal Investigators will provide finalized scope documents for each scenario to the Part B State body for endorsement. The endorsed scope documents will provide the basis for the inter-regional expansion options to be considered in Task 1.7.

***Task 1.7 Inter-regional Expansion Options Development***

Key Inputs: Transmission Analysis Study Scopes for Expansion Scenario(s) from Task 1.6, Reference Cases from Task 1.2.

Key Deliverables: Inter-regional Expansion Options and associated modeling, Preliminary Results Webinars

In Task 1.7, the Principal Investigators will modify the reference power flow cases developed in Task 1.2 to build inter-regional expansion models. Task 1.7 will then focus on transmission reinforcements to support the inter-regional energy exchanges for each of the expansion scenario(s) The Principal Investigators will develop transmission expansion options focused on the extra high voltage transmission network (230 kV and above), but will also consider operating options and other potential solutions. The Principal Investigators will consider the transmission facilities required to integrate new resources within a region using a similar, high voltage focus, but will not attempt to resolve potential local transmission issues. The Principal Investigators will leverage the expertise of the Collaborative's membership and Oak Ridge National Laboratory (ORNL) in considering HVDC and advanced technologies in developing expansion options.

The output of Task 1.7 will include transmission expansion options identified for each scenario and the associated solved power flow cases necessary to perform reliability and economic analyses. The transmission expansion options will also receive high level cost estimates in Task 1.10. The Project is intended to provide high-level interconnection-wide analysis and not substitute for regional planning processes or state, local or provincial siting processes. The Project will not identify specific routing, siting, environmental or other issues associated with any potential enhancements to the grid coming out of this task.

[3] State input is anticipated to be provided by state authorities consistent with state processes for making resource selections. One state or region cannot impose resource assumptions in another state or region in developing the scope outside of a consensus among the states.

The Collaborative, with the Keystone Center providing coordination and facilitation services, will conduct webinars to review preliminary results and solicit input from the SSC and Stakeholders.

***Task 1.7 A Variable Generation Analysis***

Key Inputs: Transmission Analysis Study Scopes for Expansion Scenario(s) from Task 1.6, Reference Cases from Task 1.2

Key Deliverables: Reliability constraints associated with operating variable generation. The Principal Investigators will work with Oak Ridge National Laboratory (ORNL) to develop and perform appropriate analysis to assess reliability constraints associated with operating significant amounts of variable generation. Such analysis would consider reliability issues related to ramp rates and regulation, off-peak power production limitations, operating reserves, reactive support, and other operating concerns. To the extent constraints are identified, they will be reflected in the expansion options developed in Task 1.7.

***Task 1.8 Reliability Review***

Key Inputs: Inter-regional Expansion modeling from Task 1.7

Key Deliverables: Reliability assessments of Inter-regional Expansion Options

The Principal Investigators will perform reliability analyses consistent with NERC reliability criteria for transmission planning to assess in aggregate for the Eastern Interconnection the inter-regional transmission options developed in Task 1.7. The Collaborative intends to engage the computational and technical capabilities of the ORNL to expedite this analysis. To the extent reliability issues are identified, these scenarios may be referred back to Task 1.7 for further review.

***Task 1.9 Production Cost Analysis of each Scenario***

Key Inputs: Inter-regional Expansion modeling from Task 1.7, Flowgates identified during Task 1.8 analysis

Key Deliverables: Production cost analysis

Economic analysis will be performed using production cost modeling for each scenario based upon the power flow modeling and transmission expansion options developed in Task 1.7. Consistent with Task 1.3, production cost analysis will assess all 8760 hours of the future year (2020) and will forecast energy production costs, constraints limiting dispatch and inter-regional transactions, anticipated emissions, renewable energy production, and other pertinent factors. The production cost analysis will be performed for multiple future sensitivities such as high/low fuel costs, high/low carbon taxes, and similar parameters.

As in Task 1.3, the economic analysis will be performed by Charles River Associates (CRA) using GE MAPS.

***Task 1.10 Generation and Transmission Costs***

Key Inputs: Inter-regional expansion options (G&T) from Tasks 1.6 & 1.7, High level, generic cost information

Key Deliverables: High Level cost estimates for expansion option facilities

Task 1.10 will provide high-level estimates of the capital costs of the inter-regional generation resource and transmission expansion options considered. Transmission costs will be developed by the Principal Investigators using generic planning-type estimates[4] referenced to the study year (2020) and will represent "overnight" costs[5].

Costs associated with resource additions and retirements will be developed by CRA (which will be informed by stakeholder assumptions regarding technology characteristics and costs).

***Task 1.11 Review of Results***

Key Inputs: Results from tasks 1.1 through 1.10.

Key Deliverables: Report review workshops with stakeholders, Draft report, SSC input on draft report.

A draft Phase I report will be developed by the Principal Investigators and posted for SSC and stakeholder review prior to the regional stakeholder workshop(s). The report will include the following[6]:

| | Regional Plans | Inter-regional Options |
|---|---|---|
| Aggregated modeling of the existing Regional Plans | X | |
| Inter-regional Reliability Assessments for the Eastern Interconnection | X | X |
| Economic (production cost) analysis for multiple future sensitivities | X | X |
| Macroeconomic Analysis for multiple future expansion scenarios | | X |
| Transmission expansion options and other potential solutions | X | X |
| Cost estimates for expansion options | X | X |

The Collaborative, with the Keystone Center providing design and facilitation services, will conduct regional stakeholder workshop(s) to present the results of the analysis, respond to questions, and solicit input from stakeholders. The SSC, taking into consideration the input from the Workshops and other stakeholder venues, will provide consensus-based comments on the draft report.



[4] For example, generic $ per mile for transmission lines rather than detailed ROW routing and engineering cost estimates.

[5] "Overnight" assumes the facilities could be built and placed in service in a given year. "Overnight" costs do not include significant financing costs for construction work in progress.

[6] Subject to legal and regulatory requirements for Critical Energy Infrastructure Information (CEII) and treatment of Confidential Information

***Task 1.12 Phase I Report***

Key Inputs: Draft report and Stakeholder input from Task 1.11.
Key Deliverables: Final report and work papers
The Principal Investigators, with CRA and ORNL providing technical support, will review the input received from the SSC and address it in the final Phase I report. The Phase I Report will be submitted to the DOE on or before June 30, 2011.

In addition to the final report, associated modeling, databases, and other work products will be made available electronically during the Project through a Project Website[7].



[7] Ibid.

**PHASE II (7/1/11 to 6/30/13)**

Phases I and II are broadly similar. Phase I will focus on the 2020 planning year and establishing group structures, methodology development, scenario development, inter-regional analysis of the Regional Plans, and scenario analysis.

Phase II will focus on the 2022 planning year utilizing the then current Regional Plans and models, which will have been updated to meet prevailing regulations and reliability requirements. Phase II will include enhancements incorporated into Regional Plans since Phase I including those options identified during Phase I that may have been adopted during regional planning activities. The SSC and stakeholders will determine which scenarios from Phase I should be refined in more detail and which new scenarios are of interest.

The Tasks for Phase II are largely the same as Phase I, except as noted below.

***Task 2.1 Review Phase I Results***
The Principal Investigators will conduct a formal "lessons learned" analysis to review the analysis performed in Phase I, how it could be improved, and where it could be modified.

***Task 2.2 Integrate Regional Plans***
The focus is on the latest modeling and Regional Plans for 2022.

***Task 2.3 Production Cost Analysis of Regional Plans***

***Task 2.4 Macro-Economic Scenario Definition***

***Task 2.5 Macro-Economic Analysis***

***Task 2.6 Expansion Scenario Concurrence***

***Task 2.7 Inter-regional Expansion Options Development***

***Task 2.7 A Optional analyses provided by ORNL per DOE approval***

***Task 2.8 Reliability Review***

***Task 2.9 Production Cost Analysis of Inter-regional Expansion Options***

***Task 2.10 Generation and Transmission Costs***

***Task 2.11 Review of Results***

***Task 2.12 Phase II Report***

The Phase II report would also include a review of those Phase I expansion options which have been incorporated into Regional Plans. The Phase II Report will be submitted to the DOE on or before June 30, 2013.