



Small-Scale Flexible Advanced Ultra-Supercritical Coal-Fired Power Plant with Integrated Carbon Capture

Pre-FEED Contract: Coal-Based Power Plants of the Future Project Execution Plan

March 26, 2020

U. S. Department of Energy

Contract: 89243319CFE000023 (Mod. 004)
Proposal: RFP 89243319RFE000015

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Period of Performance: 4/15/2019 to
4/15/2020

Project Scope



Project Scope

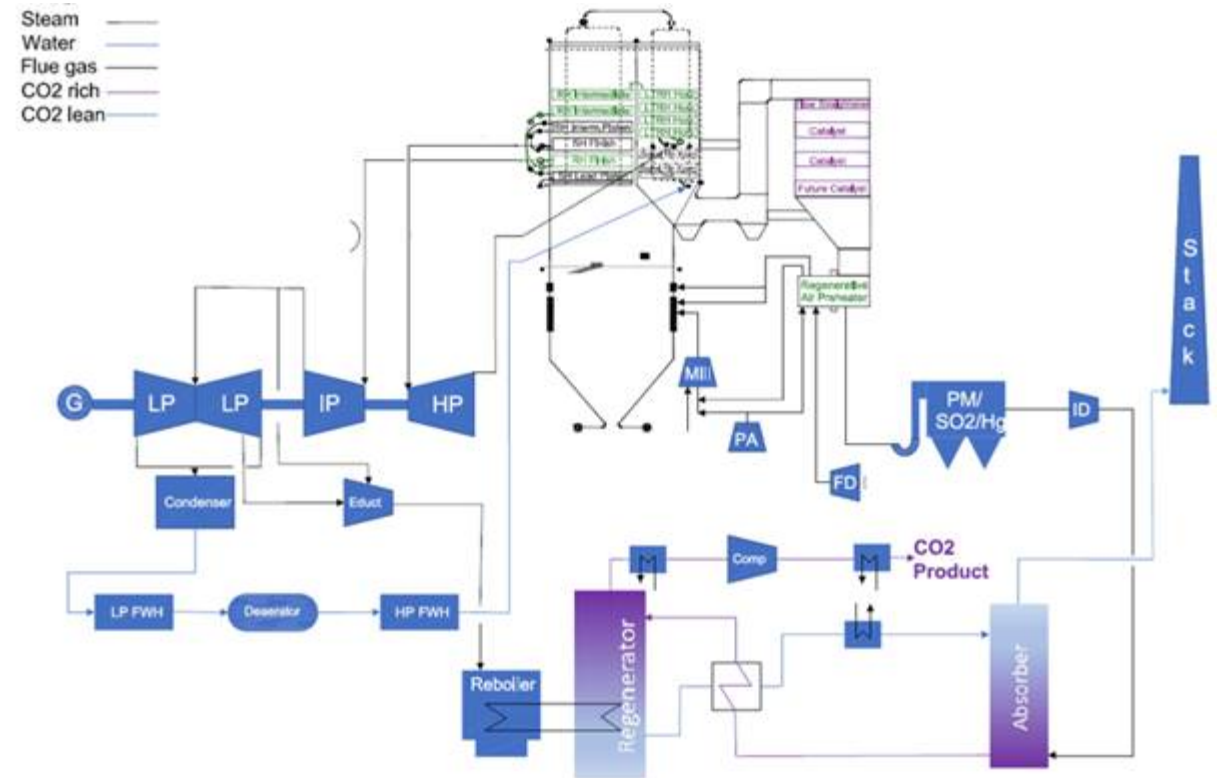
Introduction

The DOE has contracted AECOM and GE to develop the detailed design to provide an integrated plant concept & configuration for a Small-Scale Flexible Advanced Ultra-Supercritical Coal-Fired Power Plant with post-combustion carbon capture at nominal 300 MWe gross size.

- To be located in the Midwestern Region of the US.

Major components:

- Pulverized coal-fired boiler in a close-coupled configuration
- Air quality control system (AQCS) consisting of:
 - An ultra-low NO_x firing system
 - Selective catalytic reduction (SCR) system for NO_x control
 - Dry scrubber/fabric filter for particulate matter (PM), SO₂, Hg, and HCl control
- Amine-based post combustion carbon capture system
- Synchronous steam turbine/generator.



Concept 1 Plant Diagram

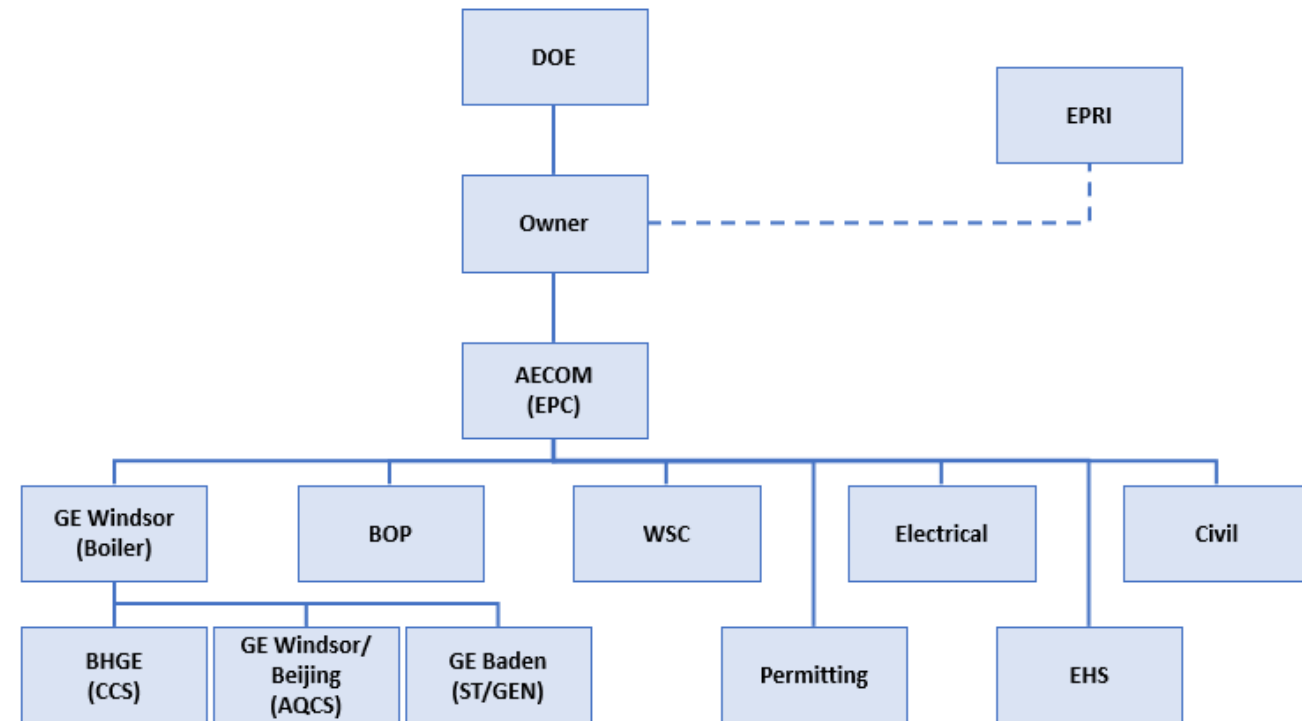
Note: The block diagram shows only the steam extractions for the carbon capture system for simplicity and clarity of the diagram.



Project Scope

Project Management

- AECOM, as EPC, will provide engineering services on the project including:
 - Project management
 - Site evaluation & selection
 - Site upgrades
 - Infrastructure and facilities
 - Utilities
 - Balance of plant design, including architectural, civil, structural, mechanical, piping, electrical, process and instrumentation & controls and interconnecting piping
- GE will assign a project manager to be single point of responsibility for
 - Communications between AECOM and GE
 - Development of project schedules
 - Coordination of engineering, test and start-up activities associated with the Steam Boiler, AQCS, Steam Turbine and Generator and the CCS



Project Scope

Engineering & Design

Engineering

- GE Engineering will be responsible for the design of the GE equipment supplied for the project. GE engineering leaders will interface directly with the GE Project Engineer Lead and that person will be the primary lead between GE engineering and the customer related to any engineering questions, designs and or drawing requirements from the customer.
- GE Engineering will perform all work, design reviews and freezes, drawing, etc. per GE's detailed processes and procedures.

Design

- GE will design all equipment per the contract meeting all applicable laws and codes.



Contract Execution

Following Contract award and hand over from Sales to the Project Team for execution, the Front End Engineering Design (FEED) goes through three phases until completion. These are Project Kickoff, FEED Design, and Detailed Design and these three phases are described below.

- **Project Kickoff** : Project Kickoff forms the first phase of the project execution process and the following activities are planned and initiated during this phase.
- **FEED Design**: During this next phase, many of the processes and activities planned and initiated during the Kickoff phase are developed and progressed.
- **Detailed Design**: During this final phase, the design is updated in order to include design data from Suppliers in order to prepare for fabrication and manufacturing.
- Each Design Phase is culminated in a design review with the DOE & Owner to gain approval before proceeding to the next phase.



Scope of Supply

FEED Design Deliverables

The project team will perform the basic design activities to define the process engineering design basis and the technical and engineering specifications for the equipment and process control systems that will be installed. The project team will conduct sufficient engineering design work to perform a FEED level cost estimate. The FEED design applies to the plant as a whole as well as the AUSC equipment.

AECOM

- Process Flow Diagrams
- Heat and Material Balance
- Equipment List(s)
- Utility Summary
- Emission Profile
- Influent/Effluent Summary
- Piping and Instrumentation Diagrams
- General Arrangement Layout(s)
- Process Narratives
- Control Logic Narratives
- Basis of Design
- Site Specification Documents
- Hazardous Operations Review (HAZOP)
- Preliminary Process Control and Safety Interlock Diagrams.
- FEED Cost Estimate (+/- 20%)
- Requests for Quotation for long lead items
- Issue POs for scope requiring sub-supplier Engineering (upon Owner release)

GE

- Preliminary GAs for GE equipment
- Preliminary foundation loads
- Preliminary Electrical Load List
- Preliminary I/O list
- Preliminary P&IDs
- Heat and Material Balances
- Plant Effluent Data Report
- Requests for Quotation for long lead items
- Issue POs for scope requiring sub-supplier Engineering (upon Owner release)



Scope of Supply

Detailed Design deliverables

Detailed Design of the AUSC plant – The project team will perform the following Detail Engineering design activities that are needed for the procurement, installation and operation of the AUSC plant.

AECOM

- Finalize **process engineering calculations** including the
 - Heat & mass balances
 - Process flow diagrams
 - Piping and instrumentation diagram
 - Equipment list(s)
 - Motor & utilities list
 - Final layout and general arrangement drawings
 - Final electrical single line diagrams
 - Facility process control strategy
- Design all **civil and structural works** including the:
 - Foundations
 - Structural Steel
 - Piping racks
 - Site modifications
 - Conveyors, buildings and facilities, and other structures.

AECOM

- Design and specify all of the **equipment** necessary for the project.
- Design all **pipng** required for the project. Generate the **pipng isometrics** required for the fabrication of all piping system components.
- Develop an **electrical power plan** to Electrical Code and National Fire Protection Association (NFPA) standards including the single line diagram, conduit and cable schedules, design of any necessary motor control equipment, heat tracing, and other ancillary electrical items.
- Develop the **instrumentation and control system** per Electrical Code and NFPA standards for the project including the instrument loop and wiring diagrams; the specification of the control system, data historian architecture and communication system; and all instrumentation and valves.
- Finalize process control and safety interlock diagrams.
- Conduct and document a plant operability meeting with all project participants to discuss safety, commissioning planning, and startup of all systems.
- Implement findings from **HAZOP** review conducted during FEED and conduct the final HAZOP reviews.
- Finalize the **construction strategy** and obtain all required construction approvals, permits and licenses.
- Generate and issue **Requests for Quotations (RFQ's)** for all remaining equipment items required to build the AUSC plant. Obtain and evaluate all bids, and select a preferred supplier for each equipment item.



Scope of Supply

Detailed Design deliverables

Detailed Design of the AUSC plant – The project team will perform the following Detail Engineering design activities that are needed for the procurement, installation and operation of the AUSC plant.

GE

- Design and specify all of the **equipment** necessary for the project.
- Design all **pipng** required for the project. Generate the piping isometrics required for the fabrication of all piping system components.
- Develop 90% **General Arrangement Drawings** and **Pressure Part Arrangements** for GE equipment
- Design and specify instrumentation and valve requirements, and issue **Instrument, Valve, Electrical Load, and I/O Lists**
- Develop and issue **Foundation loads**
- Generate **P&IDs** for all equipment
- Develop component **Modes of Operation** and **Control Narratives**
- Participate in a plant operability meeting with all project participants to discuss safety, commissioning planning, and startup of all systems.
- Implement findings from **HAZOP** review conducted during FEED and conduct the final HAZOP reviews.
- Generate and issue **Requests for Quotations (RFQ's)** for all remaining equipment items required to build the GE scope of equipment. Obtain and evaluate all bids, and select a preferred supplier for each equipment item.



Scope of Supply

Project Completion

Project Completion occurs upon release of construction documents (drawings, specifications, equipment details and specifications, erection document packages) to be used for bid and permitting:

30%, 60%, and 90% design reviews – complete and accepted.

Long lead items identified by project teams and POs placed (as approved by the DOE and/or Owner)



Project Management Plan

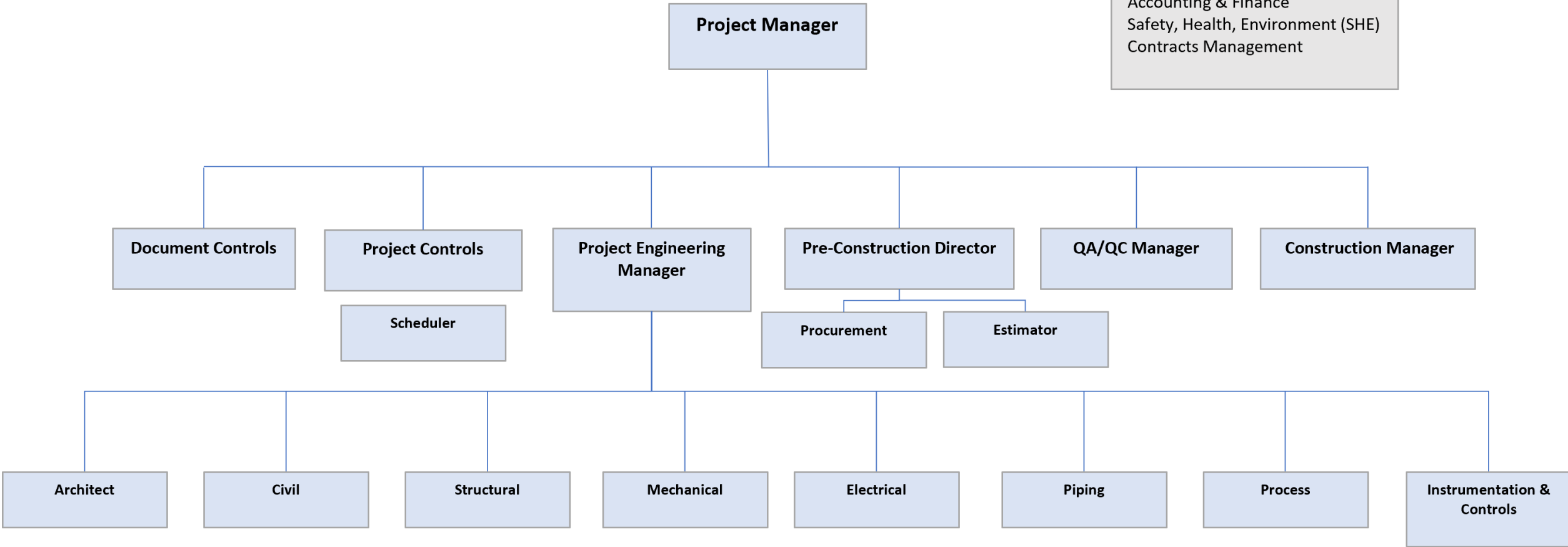


Project Structure

AECOM Organizational Chart

AECOM Corporate Support

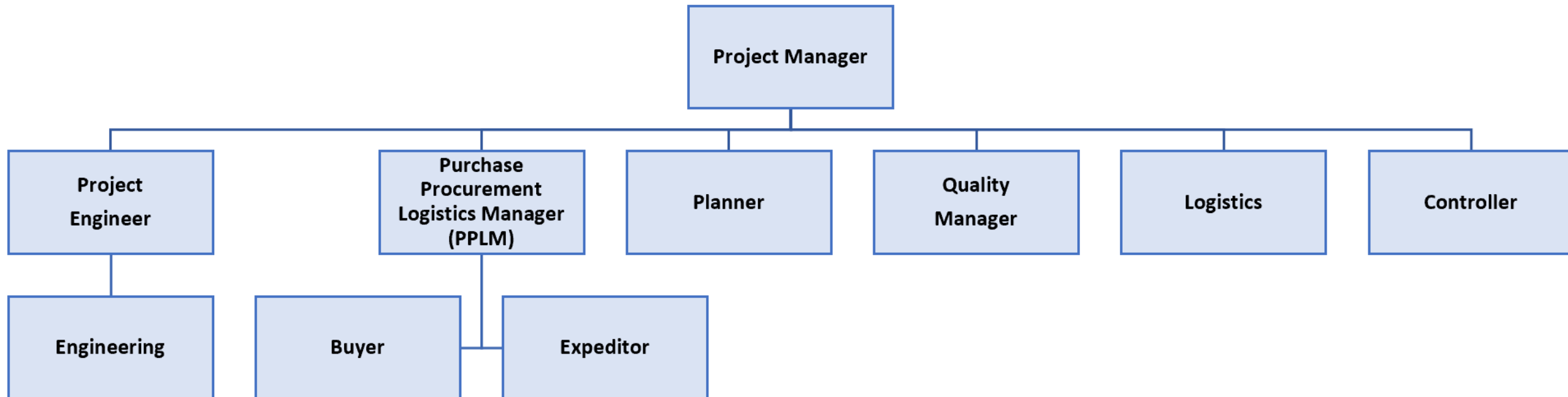
- Executive Sponsor
- Legal
- Accounting & Finance
- Safety, Health, Environment (SHE)
- Contracts Management



Project Structure

GE's Project Structure

GE Organizational Chart



Project Reviews

Project Team Reviews

A project team meeting shall be held on a regular basis to review the current status of the Project. All team members are required to attend in order to review:

- Project Overall – General Issues
- Customer correspondence, meetings, interfaces and requirements
- Progress and Planning
- Procurement
- Engineering status and progress
- Constructability
- Documentation
- Quality
- Participants status of Work
- Contract(s) Management
- Financial and commercial status
- Value Engineering

Such meetings provide a Project update for all team members. The meetings follow-up actions from previous meetings; again review the status in the above listed areas; and identify new issues and decide upon the required actions.

It allows interfaces between the Customer, disciplines, Participants and sub-suppliers to be identified, coordinated and progressed. In particular, Customer correspondence, meetings and requirements are reviewed and any necessary actions agreed



Project Reviews

Owner & DOE Review Meetings

A Owner & DOE review meeting shall be convened on a monthly basis to review the status of the Project. The topics discussed and reviewed shall cover:

- General and administrative topics – Organizations, Communications
- Financial topics – Insurances
- Project Progress and Scheduling
- Engineering including Layout and Documentation
- Procurement activities for the major items of equipment (selection/pre-qualification of vendors, soliciting of bids, clarifications with bidders, etc.)

The Owner & DOE review meetings provide essential feedback to the Project Team. From this feedback decisions and actions can be made to address any Owner & DOE concerns regarding the status of the Project. This feedback also provides information for the Project Team and allows to identify any issue and analyze the effectiveness of the Quality Management Systems.



Owner & DOE Related Processes

Requirements

Determine Customer Requirements: Project Kick-Off Meeting

- The Project 'Kick-Off' meeting with the Customer is one of the key activities at the start of the Project. In addition to establishing the Project administration procedures, it allows the Project Team to identify other Customer requirements.
- Such requirements may not be clearly specified under the Contract, but such clarification may assist and support in the timely and effective execution of the Project.
- The meeting also allows the Project Team to identify the Customer position and approach to the Project in terms of the Customer expectations, required support for local activities and in meeting local requirements.

Review Customer Requirements

- The Project Team reviews and assesses the Customer expectations and identified requirements to confirm how these will be met.
- Any Customer requirement for a Contract variation will not be accepted or implemented until similarly reviewed, documented, and then confirmed with a Contract Variation Order.
- Any change in scope will be processed in accordance to AECOM's Change Management procedures (Potential Deviation, Change Notice, Change Order). A Master Change Management Log will be used to identify, track, and report the status of all project deviations and changes.



Owner & DOE Related Processes

Communications

Customer Communication

- The establishment and implementation of an effective and efficient communication arrangement between the Customer and the Project Team is essential for the execution of the Project. At the Project 'Kick-off' meeting the agreement on, and establishment of, the Communication procedure is one of the main agenda items.
- The Project Team forms the communication center with the Customer and this, together with regular Customer Project Review meetings, ensures the establishment and implementation of an effective communication arrangement with the Customer.
- This arrangement keeps the Customer fully informed of all Project aspects, as well as providing Customer feedback. Customer feedback will also be addressed by GE management with periodic Customer meetings and surveys



Owner Development



Owner Development

Owner Identification & Integration

- The Owner will be identified and integrated into the project team by the Project Team

Project Financing

- Project financing will be arranged by the Owner. It will be a combination of:
 - DOE: Federal Funding
 - Owner: Host Site & Cost Share
 - Industry Partners: Cost Share

Site Selection

- The plant will be located on a 300 acre greenfield site with level topography and the necessary utilities including power, natural gas, potable water, sanitary sewers and be connected to rail. The specific site will be selected by the project team.



Permit & Regulatory

- AECOM will provide assistance and support to the Owner for permitting to the extent required in the Detailed Design phase. All the required permits necessary for constructing and operating the AUSC plant will be initiated. The project team will determine site environmental requirements and evaluate requirements for permit applications.
- The project team will determine what environmental emissions control equipment and systems are required and develop the engineering data and specifications for that equipment.
- The project team will develop the plan and schedule for an Environmental Assessment (EA) to satisfy the requirements of the National Environmental Policy Act (NEPA). The project team will work with the NEPA office at the National Energy Technology Laboratory (NETL) to prepare and submit to the DOE the documents needed to obtain a positive Record of Decision within a timeframe that is consistent with other key milestone dates of the project.
- The project team will work with the Owner to obtain all permits necessary for construction and operation of the facility.



Engineering Management



Engineering Management

AECOM, as lead organization, provides the overall Engineering and Design Management and Integration for the Project. GE Power Portfolio will lead and coordinate the overall Engineering and Design Management and Integration for the GE products in the Project. The other concerned GE Participants provide the engineering and design management for their respective business scope of work.

The Project Team will be responsible for:

- Engineering Planning
- Engineering Design Inputs
- Engineering Outputs
- Proposal Review
- Supplier Design Integration
- Control of Engineering Design Changes



Procurement Management



Procurement Management

The Project Participants manage the Procurement processes and activities for their respective Project scope of work.

For each GE Participant, the overall Procurement process covers the following sub-processes and as such each Participant is responsible for the following:

- **Procurement Process:** To ensure that the Suppliers of material and equipment comply with both the Customer and GE technical and commercial requirements, meet the required delivery time, the costs and the specified quality requirements defined in the Contract and also required by GE.
- **Transportation Management Process:** To plan, estimate the transport of material and equipment through the entire logistics supply chain. Special focus on Heavy Load Transport



Procurement Management

Procurement Team Kickoff

- Procurement concept:
 - Consists in a document defining the Project specific sourcing concept and for example:
 - Project description
 - General information
 - Negotiable terms between GE and Suppliers
 - Procurement procedure
- Engineering Procurement Plan (EPP) :
 - Defines the strategy to be applied on the different packages/equipment of the Project such as:
 - Complexity of the technical specifications
 - Long lead item
 - Turnkey approach
 - Engineer & Purchaser in charge of each equipment
 - Suppliers to be considered during the RFQ process
- Preliminary Vendors List:
 - Preparation of a Vendors List based on long time experience of GE in Power Plant business worldwide and more specially in Europe.
- Project RFQ Process:
 - Once the list of suppliers to be contacted has been defined through the EPP and the specifications have been received from the engineering department. The procurement department will send the RFQs to the relevant suppliers and will ensure to receive them on-time.
- Master Procurement Schedule (MPS):
 - Dashboard for the purchasing activities which consists in managing costs and timing as well as follow-up of RFQs. It is updated on a weekly basis and gives a good overview of the RFQ process:
 - Suppliers contacted
 - Date of RFQ issuance
 - Expected reception date
 - Cost level of offer received



Non-Commercial Component Technology Development



Non-Commercial Component Technology Development

- The AECOM and GE designs focus on **adapting existing technologies** to new operational requirements in order to generate the flexibility that is required of this AUSC Plant.
- While this is not a typical New Product Introduction (NPI) project, GE will still use the principles set out in its NPI product development gate process to ensure the integrity of the new portions of the design, such as:
 - Flexible Operations: Modes of Operations design and stress analysis to closely address required transient conditions
 - Integration of atypical boiler and turbine materials and fabrication methods into ASME code



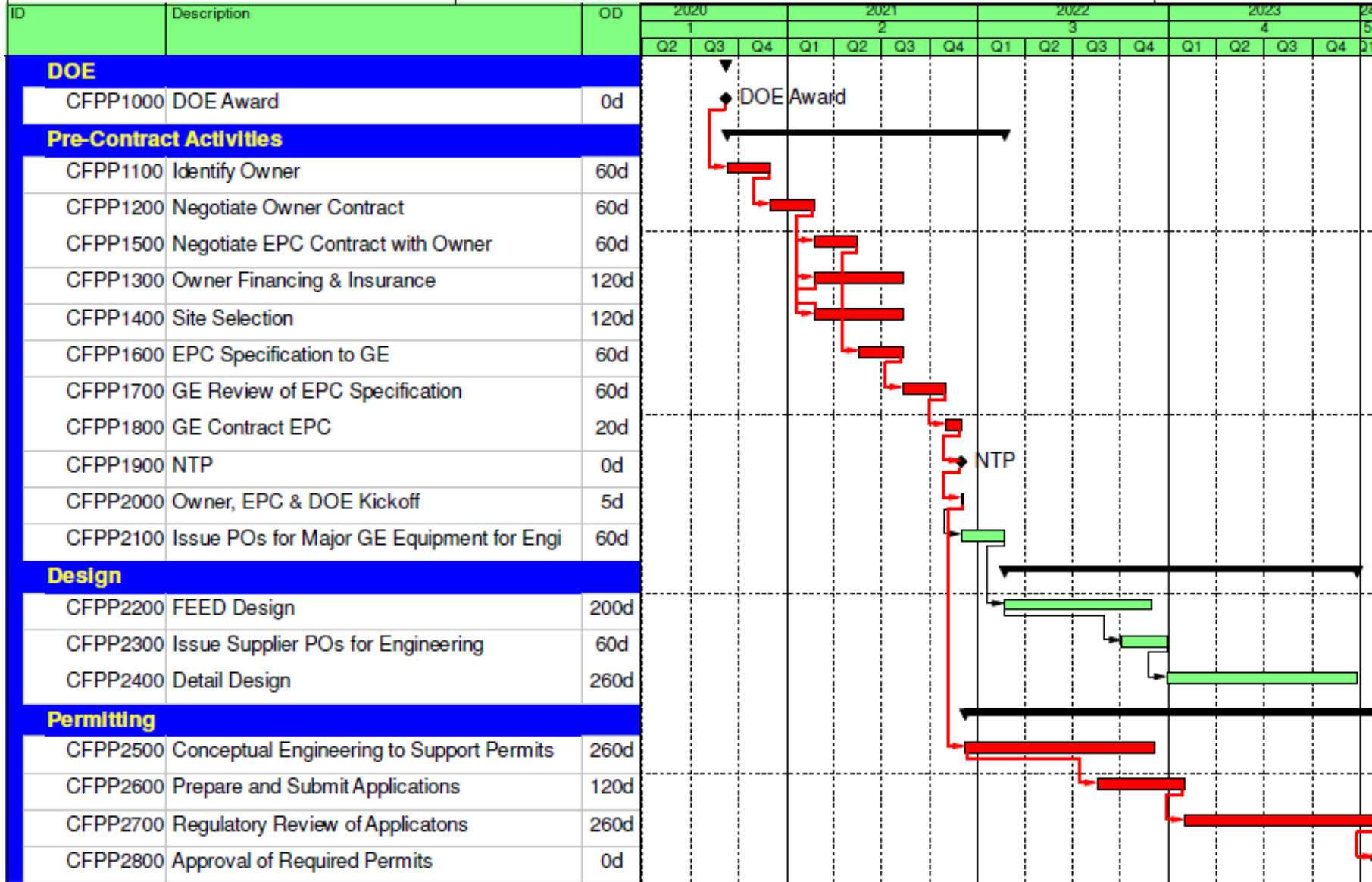
Project Timeline



Timeline Summary

- **Non-Commercial Component Development** - This project adapts existing technologies from GE's portfolio to develop this flexible 300MW AUSC Power Plant.
- **Partnering with Technology Providers** - GE, as a partner in this project, is the technology owner for special equipment, including the Carbon Capture System. There are no special agreements required to use this technology.
- **Project Financing** – will be a combination of:
 - DOE: Federal Funding
 - Owner: Host Site & Cost Share
 - Industry: Cost Share
- **Site Selection** – is a critical step in the development process and will be accomplished with the integration of the Owner and project team to select potential sites and make a final selection.
- **Permitting assumptions** – the permitting process takes approximately 18 months not including the engineering to support the application. The permitting phase and design/construction phase will partially overlap to decrease the overall implementation period.





Note: Schedule durations are in 5 day work weeks (20 day work months)



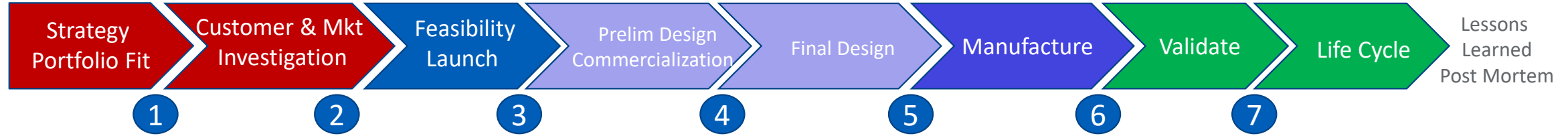


Engineering Management

- **Engineering Planning:** to review and verify the proposal engineering stages and to manage and co-ordinate the engineering interfaces at the respective levels
- **Engineering Design Inputs:** to clearly determine the Contract technical requirements and performance criteria, and applicable statutory and regulatory requirements and to review these inputs and ensure their adequacy for the design processes
- **Engineering Outputs:** to provide the required engineering work in terms of P&ID and system(s) design, equipment specifications and arrangement(s) of plant, equipment and buildings
- **Proposal Review:** at suitable stages to ensure proposal progress is in accordance with Time Schedule, to address Customer queries and concerns, and to identify, progress and resolve all interface issues
- **Supplier Design Integration:** to integrate detailed design data from Suppliers into the overall Plant design
- **Control of Engineering Design Changes:** to identify and record all design changes to the Contract requirements and obtain Customer approval to significant design changes before implementation.



Product Development Gate Process



GATE REQUIREMENTS	OBJECTIVE	ACCOUNTABILITY
Gate 4 - Preliminary Design Commercialization	<ul style="list-style-type: none"> •Preliminary Design •Develop Internal and external communication plans •Manufacturing, sourcing and logistics plan with IMS (Integrated Master Schedule) •Updated GE lifecycle business case (cost, schedule, performance) 	<ul style="list-style-type: none"> •Sales •Engineering •Global Supply Chain •Product Management •FieldCore
Gate 5 - Final Design	<ul style="list-style-type: none"> •Detailed design •Intellectual property has been protected •Integrated manufacturing and sourcing plan & schedule finalized with issued BOM •Updated GE lifecycle business case (cost, schedule, performance) 	<ul style="list-style-type: none"> •Engineering •Global Supply Chain •FieldCore •Product Management
Gate 6 - Manufacture	<ul style="list-style-type: none"> •Manufacturing and sourcing drawing non conformance review and lessons learned •Installation and repair procedures and processes •Updated handbook cost and cost out plan based on first unit manufacturing costs •Updated GE lifecycle business case (cost, schedule, performance) 	<ul style="list-style-type: none"> •Engineering •Global Supply Chain •FieldCore •Product Management
Gate 7 - Validate	<ul style="list-style-type: none"> •Validation lessons learned with identified corrective action plan •Installation, startup and testing lessons learned applied to fleet processes and procedures •Services outage execution and repair processes and procedures in place to support the fleet 	<ul style="list-style-type: none"> •Engineering •Global Supply Chain •FieldCore •Product Management

