Allegheny Science & Technology

Coal FIRST: Pre-FEED Study
Coal-Based Power Plants of the Future: Electricity and Ammonia Polygeneration
Execution Plan

April 14, 2020

WOMAN-OWNED SMALL BUSINESS

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Agenda

- Current Project Description
- Execution Phases and Categorization
- Pilot Plant Phase
- Execution Plan Timeline – Pilot Plant Phase
- Execution Plan Timeline – Commercial Plant Phase
- Execution Plan Description
- Site Selection Details

Current Project Description

Coal-based polygeneration system to meet the needs of the evolving bulk power system

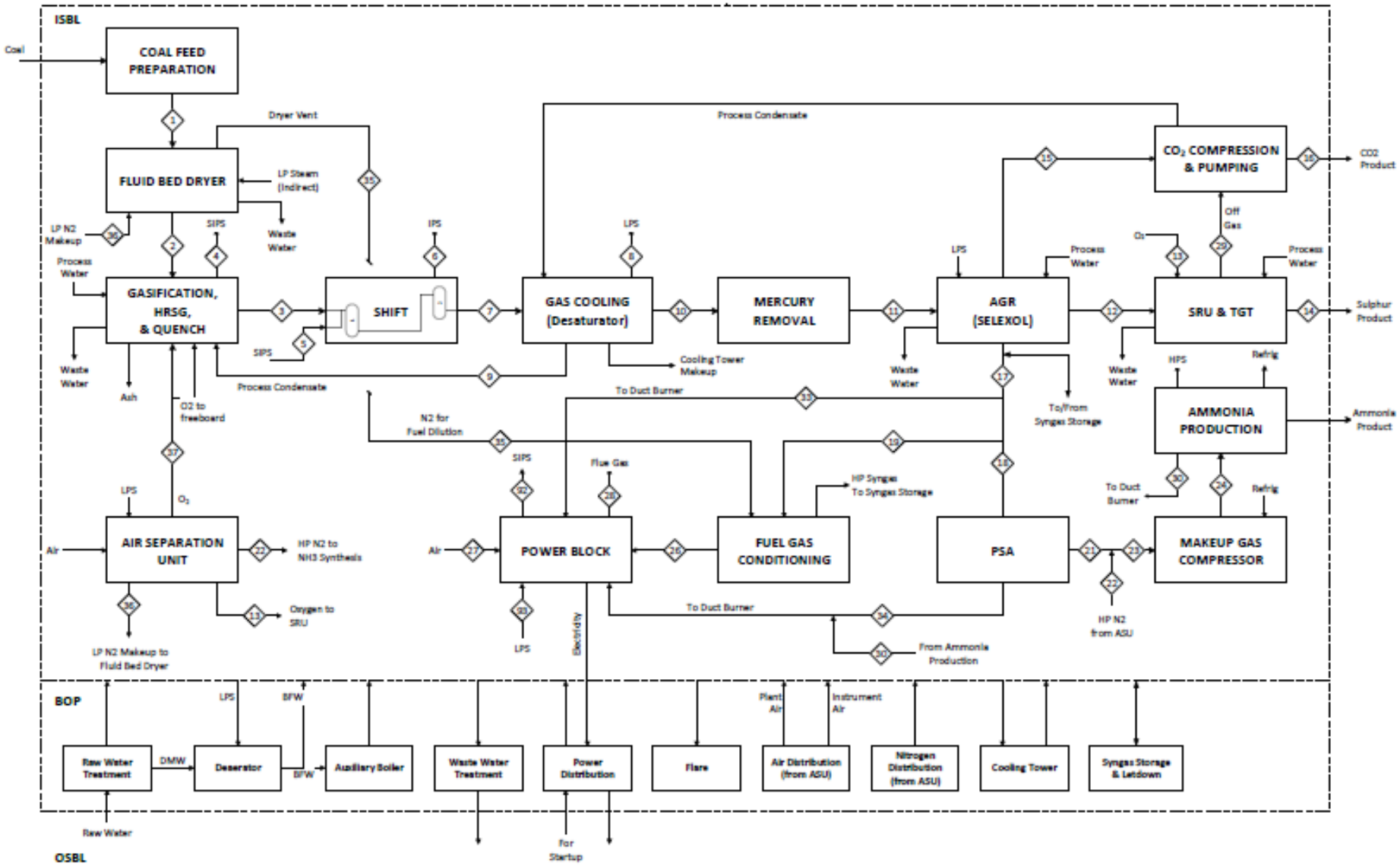
- High operational flexibility to respond rapidly to market conditions and signals, offer the ability to correctly match production to market demand
- Provide high operational efficiency while incorporating carbon capture rates of 90%

Business philosophy centers on offering multiple potential revenue streams

- Commercial electricity available for sale to the grid
- NH_3 for commercial delivery at or near retail (as opposed to wholesale) prices
- Saleable ancillary services

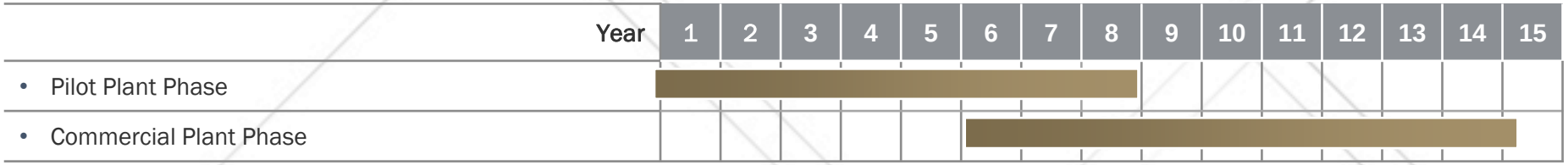
Operating Point	Net Export Power	Ammonia Production	Gasifier Operation	GT Operation	ST Operation	Ammonia Loop Operation
Balanced Generation, 3 GT's	48 MW	600 MTPD	100% of Capacity	Three Turbines @ 67% Capacity	Primary ST @ 86% load	Both Trains @ 100% Capacity
Balanced Generation, 2 GT's	51 MW	600 MTPD	100% of Capacity	Two Turbines @ 100% Capacity	Primary ST @ 91% Load	Both Trains @ 100% Capacity
Net Zero Power	0 MW	600 MTPD	66% of Capacity	One Turbine at 67% Capacity	Primary ST @ 40% Load	Both Trains @ 100% Capacity
High Electricity Production	82 MW	380 MTPD	100% of Capacity	Three Turbines @ 100% Capacity	Primary ST @ 88% Load	Both Trains @ 63% Capacity
Max Electricity Production	112 MW	59 MTPD	100% of Capacity	Three Turbines @ 100% Capacity	Primary ST @ 100% Load, Secondary ST @ 85% Load	Both Trains @ 10% Capacity

Current Project Description - Block Flow Diagram



Execution Plan Phases and Categorization

Execution Plan Timeframe



Execution Plan Step Categorization

Key	Element	Execution Plan Steps
	Non-Commercial Component Development	18-19
	Project Financing	2, 15, 20, 31, 43, 45, 49
	Site Selection	4, 26-30, 44
	Partner with Technology	8-12, 32-35
	Permitting	36-38, 50-51, 56
	Detailed Design	1, 3, 5-7, 14, 21-25, 39-42, 46-48
	Construction	13, 16-17, 52-55

Execution Plan Comments

- Given the mature nature of our core unit operations and the manageable level of technical risks associated with system integration, a higher risk approach of omitting the pilot phase could be considered to accelerate deployment
- In this instance, the first commercial application would be a pioneer plant with the understanding that evaluation of the pilot plant objectives would come during initial pioneer plant operations leading to an improvement based turnaround that implements the learning of the pilot stage investigations undertaken during the early operations of the pioneer plant
- We recommend separate piloting and commercial phases, particularly as successful pilot operations will prove out a reduced project risk level and lead to better financing terms

Pilot Plant Phase

Allow for rational development of controls, validate transitions and performance, and spur additional innovation

- As the plant is designed to be subject to frequent and rapid transitions, it is critical to validate transient characteristics agree with projected performance
- Implementation, observation and refinement of plant controls in the pilot plant will serve to mitigate risks of poor plant controls while verifying real-world operational performance, especially in regards to transient performance

Verify the ability to use partial oxidation in the freeboard oxygen-injection to limit methane content in the syngas to ~1%

Ensure the fluid bed dryer operates as intended, particularly with respect to the content of the overhead stream

- Verify that the conditions required to adequately dry the coal from ~11% moisture content to ~5% moisture content does not result in significant concentrations of hydrocarbons in the dryer overhead stream
- Verify mercury content of the overhead stream. If significant mercury exists, reassess overhead stream re-integration strategy

Key Pilot Plant Assumptions

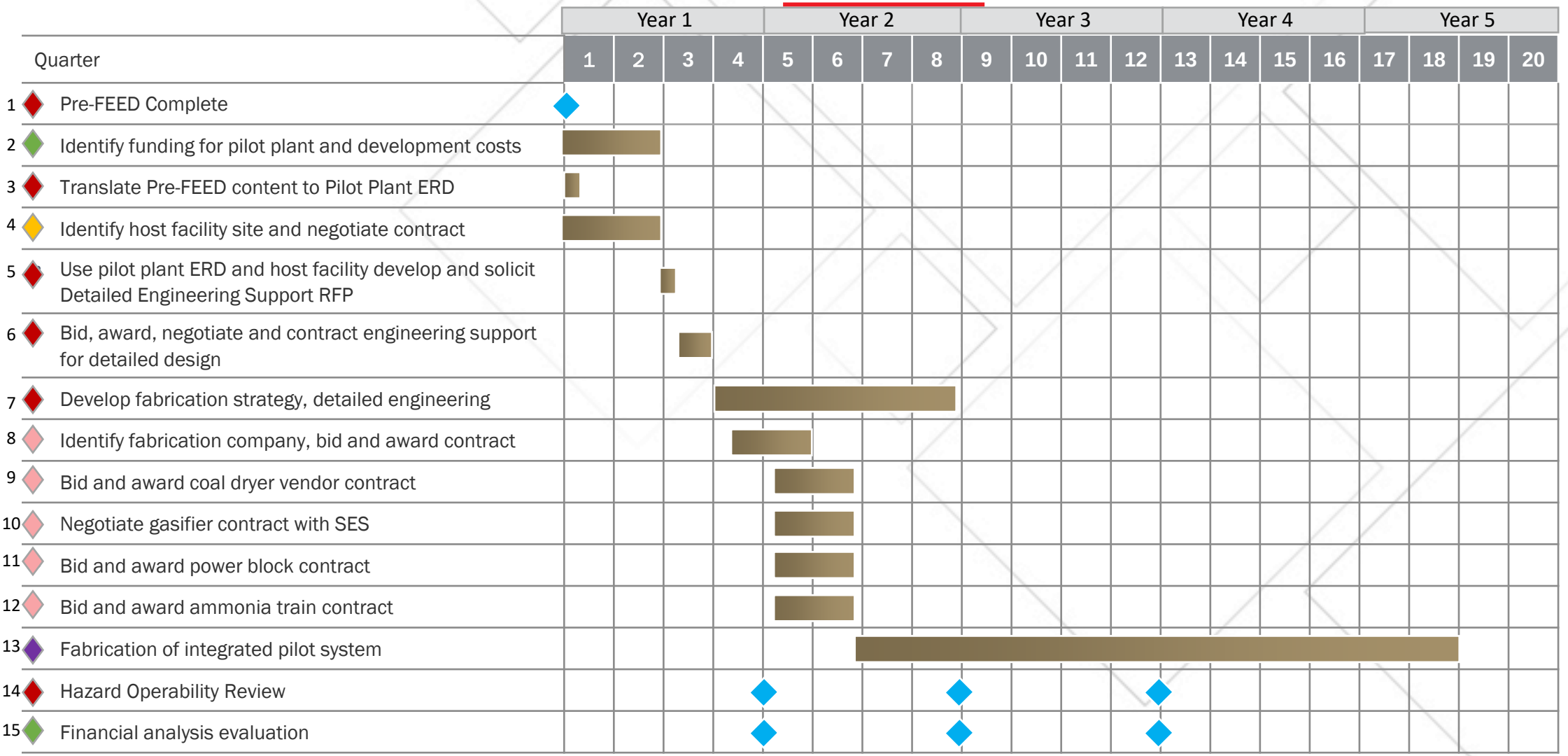
Available host site that can be used for pilot plant operations

All required infrastructure provided by/already in place at the host site

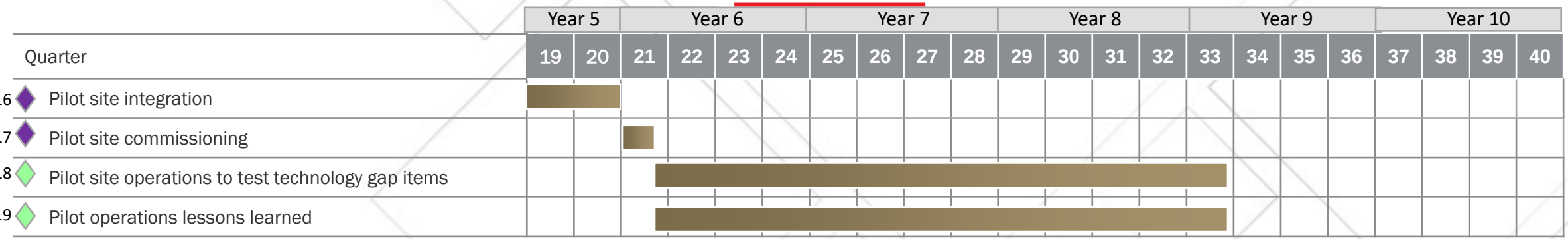
- Transportation infrastructure (roads, rail spurs, etc.)
- Complete complement of offsites, utilities, and electrical support systems (i.e. balance of plant and OSBL needs are met)

Permitting part of the general host facility permit (take advantage of permit by rule, facility level permitting constructs)

Execution Plan Timeline – Pilot Plant

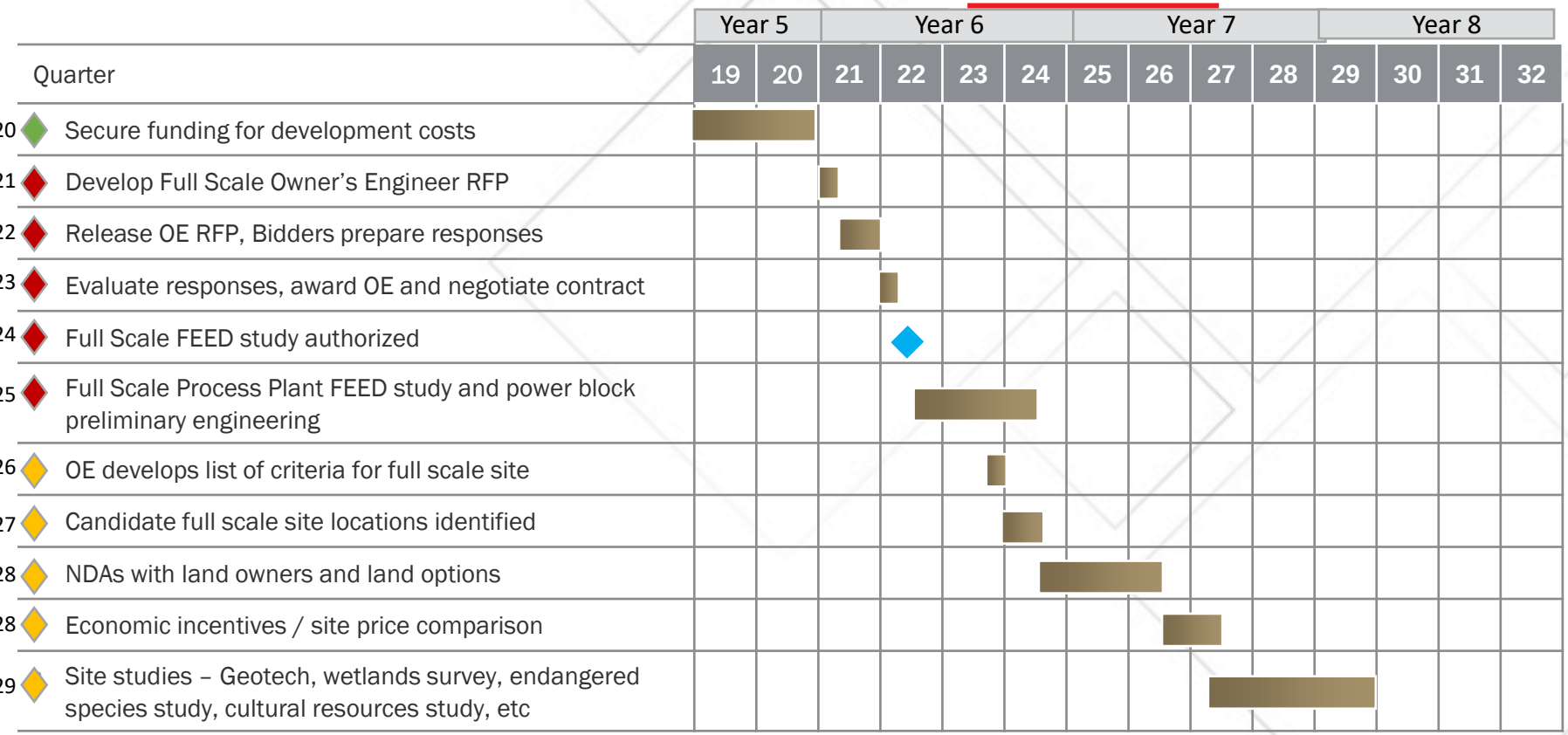


Execution Plan Timeline – Pilot Plant



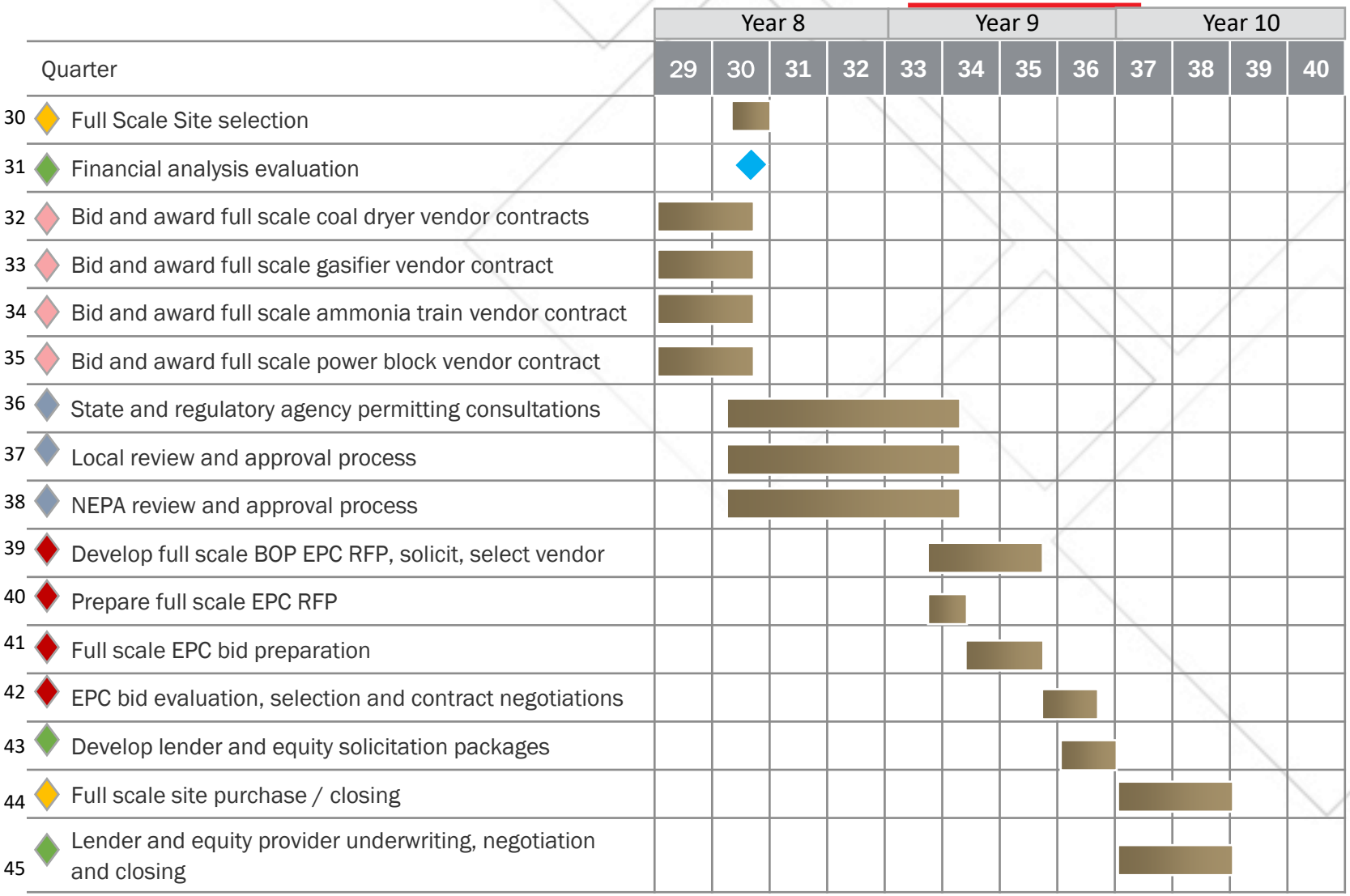
Non-Commercial Component Development | Project Financing | Site Selection | Partner with Tech | Permitting | Detailed Design | Construction | Milestone / Review

Execution Plan Timeline – Commercial Plant



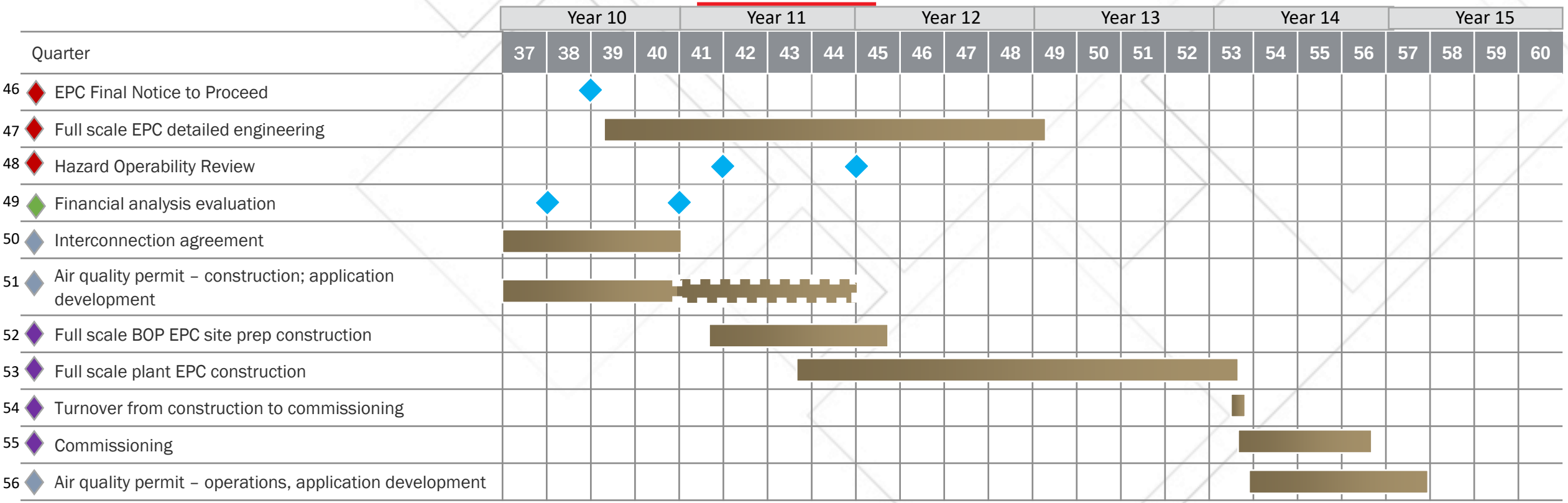
Non-Commercial Component Development | Project Financing | Site Selection | Partner with Tech | Permitting | Detailed Design | Construction | Milestone / Review

Execution Plan Timeline – Commercial Plant



Non-Commercial Component Development | Project Financing | Site Selection | Partner with Tech | Permitting | Detailed Design | Construction | Milestone / Review

Execution Plan Timeline – Commercial Plant



Non-Commercial Component Development | Project Financing | Site Selection | Partner with Tech | Permitting | Detailed Design | Construction | Milestone / Review

Execution Plan Description

#	Line Item	Description	Outcome
1	Pre-FEED Complete	Conclusion of CoalFIRST phase II	Completed Pre-FEED study
2	Identify funding for pilot plant and development costs	As the objectives of the pilot plant are not based on achieving economic profit, funding for the pilot plant and development costs will by necessity be equity funds from an investor, rather than debt financing which would be expected for later phases of the project. It is possible for funding activities to take up to 24 months, however in these cases development funding is typically provided by the developer to begin early activities such as RFP development, host site identification, etc	Pilot plant funding
3	Translate Pre-FEED content to Pilot Plant Engineering Requirements Document (ERD)	Pre-FEED study output will provide the detailed specifications for an engineering services firm to support project and work with pilot facility and fabricator, and work with fabricator on detailed engineering of the combined facility	Detailed specifications and requirements for engineering services support contract
4	Identify host site and negotiate contract	Piloting timeline assumes the ability to find an amenable functioning pilot plant hosting facility (cf. National Carbon Capture Center, GTI, U-ND EERC, UPARC, or a partner site), which can provide existing infrastructure including offsites, utilities, electrical, civil works, and safety can be leveraged. Additionally host site is assumed to have overall blanket permits and site work complete, such that site due diligence activities are not necessary at this stage and air permits are covered by the host site's existing permits ("permit by rule," inclusion in the facility permit, etc.). This enables the pilot plant phase to focus on capturing core technical aspects and facility integration experience to lower the risk of commercial development, rather than spending time during the piloting phase focused on the tactical issues of permits and optimizing development activities	Host site identified and contracted, understand what elements of pilot development are included in host site and what will need to be provided (blanket permits, civil infrastructure, etc.)
5	Use pilot plant ERD and host facility develop and solicit detailed engineering support RFP	Time allotted for pre-bid meeting, defined period for questions, answers prepared and presented by development team. During response time developer should begin to prepare for bid evaluation, including preparing evaluation materials, meetings, and ensuring development team is fully staffed	Proposals for vendors to perform engineering support tasks (mix of OE and EPC-like tasks) for the core development team

Execution Plan Description

#	Line Item	Description	Outcome
6	Bid, award, negotiate and contract engineering support for detailed design	Evaluation based on predetermined scoring criteria, as well as contract terms and conditions redlines and cost proposal; engineering support will likely come from an EPC firm, however at this stage neither the procurement nor construction is anticipated to be in the detailed engineering support scope of work, as those elements will be driven by the project developer, host site and fabrication company for the pilot plant	Executed engineering support contract
7	Develop fabrication strategy, detailed engineering	Engineering support contractor will develop detailed engineering for unit integration as well as strategy to have units fabricated and constructed on a skid to be delivered to host site; specifics of fabrication strategy are directly tied to host site selection regarding scheduling, what infrastructure exists, etc	Fabrication strategy and detailed engineering
8	Identify fabrication company, bid and award contract	Fabrication strategy work will inform the requirements for a fabrication company to assemble the unit operations on a skid and deliver to the host site; as seen on the timeline graphics identifying the fabrication company happens in parallel with the development of the fabrication strategy, this is to ensure the fabrication company is able to provide their input on strategy development and best practices	Fabrication company contract
9	Bid and award coal dryer vendor contract	In conjunction with fabrication strategy and fabrication vendor, engineering support company will develop duty specs based on the Pre-FEED work and detailed design to develop coal dryer RFP, solicit and evaluate bids, award and negotiate a purchase contract	Coal dryer vendor contract
10	Negotiate gasifier contract with SES	In conjunction with fabrication strategy and fabrication vendor, engineering support company will use duty specs from Pre-FEED work and detailed design and work with SES to negotiate a contract for the gasifier unit	Gasifier contract
11	Bid and award power block vendor contract	In conjunction with fabrication strategy and fabrication vendor, engineering support company will use duty specs from Pre-FEED work and detailed design to develop power block RFP, solicit and evaluate bids, award and negotiate a purchase contract	Power block vendor contract

Execution Plan Description

#	Line Item	Description	Outcome
12	Bid and award ammonia train vendor contract	In conjunction with fabrication strategy and fabrication company, engineering support company will use duty specs from Pre-FEED work and detailed design to develop ammonia train RFP, solicit and evaluate bids, award and negotiate a purchase contract	Ammonia train vendor contract
13	Fabrication of integrated pilot system	Fabrication company will assemble the unit operations into a single system and deliver to the site	Skid fabricated unit
14	Hazard Operability (HAZOP) Review	Safety and operability review of design to ensure intended operations do not pose a safety hazard and equipment will function as intended; especially relevant to assess additional hazards of rapid, repeated ramping and turndown; develops list of action items and required design modifications to assure safety and operability	Hazard Operability Review report and associated action items tracked to closure
15	Financial analysis evaluation	Periodic exercising and updates of the financial model as project specific parameters and costs continue to be informed and refined, market conditions for commodity inputs / outputs change, and overall economic landscape evolves. Informs detailed design choices, vendor/site selections, and negotiations. Helps obtain funding (debt and equity) and serves as “gate review” on continuing the technology deployment.	Updated financial model, improved guidance for commercial deployment and negotiation
16	Pilot site integration	After delivery of fabricated skid to host site, engineering support firm will work with host site to integrate the skid into the existing infrastructure of the host site, and construct / procure / install any integration components necessary	Integrated pilot plant
17	Pilot site commissioning	Preparation for commissioning can start when pilot site integration is ~60% complete, acceptance follows performance testing and punch list completion	Equipment capable of running safely and robustly
18	Pilot site operations to test technology gap items	Operating pilot plant to ensure smooth performance as expected, as well as testing operational procedures as outlined in technology gap report, ensuring controls perform appropriately, determine appropriate methods for transitioning between operating points, etc	Mitigation of technical risks, improved control strategy, more complete operating procedures/manuals
19	Pilot operations lessons learned	Document all lessons learned and results of pilot operations to ensure full scale plant design incorporates needed experience	Translate experience into operating manual and final detail design choices

Execution Plan Description

#	Line Item	Description	Outcome
20	Secure funding for development costs	Identify and allocate funding to fund development costs until financing for plant can be secured, including Owners Engineer contract, potentially some portion of EPC contract, and site options and/or purchase; not all funds may be delivered at this stage but firm commitments must be obtained	Funding for development costs
21	Develop Owner's Engineer RFP	OE scope includes FEED study completion, preliminary engineering for power block, turbine selection RFP, EPC bid RFP, BOP EPC RFP, permitting, site selection, review of EPC detailed design, construction surveillance, on site / off site QA/QC support, commissioning assistance. During this time developer will also prepare the evaluation criteria, both the public facing elements to be presented in the RFP but also the forms and format of bidder response evaluation. Additionally, RFP should include a draft contract Terms and Conditions for bidders to review	Specifications for Owners Engineer work, including RFP documents and evaluation forms
22	Release OE RFP, Bidders prepare responses	Time allotted for pre-bid meeting, defined period for questions, answers prepared and presented by development team. During response time developer should begin to prepare for bid evaluation, including preparing evaluation materials, meetings, and ensuring development team is fully staffed	Proposals from companies to perform Owners Engineering tasks
23	Evaluate responses, award OE and negotiate contract	Evaluation based on predetermined scoring criteria, as well as contract terms and conditions redlines and cost proposal	Finalized Owners Engineer contract
24	FEED study authorized	Coincides with final contract signed, budget for OE work must be secured	OE may begin FEED study

Execution Plan Description

#	Line Item	Description	Outcome
25	Full scale process plant FEED study, power block engineering, BOP engineering, system integration engineering	This plan anticipates the OE completing the FEED study for the process plant and integration, and engineering for coal dryer, gasifier, ammonia train and power block to get to an RFP for fixed price quotes from an EPC/Vendor. Work includes conceptual and detailed engineering for modularization, EPC bid RFP, refined cost estimate, air permit support, construction planning study, noise engineering, general arrangement drawings, construction planning study, civil works study, foundation designs, grading plans, underground piping & electrical engineering. Additional detailed engineering for bubbling bed coal drying at scale and with proposed coal feed will be required; demonstration of partial oxidation in the gasifier freeboard; process controls development; operations and transition detailed dynamic modeling; note these elements will also be addressed as part of pilot plant operations and lessons learned	FEED study outputs, such as functional specs for unit operations RFPs, process engineering, general arrangement drawings, cost estimate, construction planning, foundation designs, grading plans, civil works study, underground piping and electrical engineering, support for permits and site studies
26	OE develops list of criteria for site	Acreage, access to feedstocks, general topography, greenfield/brownfield requirements, distance to / access to rail (expected Class 1 service needed), electrical infrastructure, ammonia infrastructure if desired, CO2 pipeline, water, natural gas; zoning needs	Prioritized list of characteristics needed for project site
27	Candidate site locations identified	Pilot scale site location driven by most amenable and available host facility location. Many firms specialize in site identification, including EPC firms. Companies may have databases of potentially available land, and / or contacts with a variety of economic development agencies across jurisdictions to both help identify potential sites and begin to develop economic incentives provided by municipalities or states for the job creation and increased tax basis provided via the development	Pilot stage – this step provides final site location. Full scale stage produces short list (<~10) of potential sites identified

Execution Plan Description

#	Line Item	Description	Outcome
28	NDAs with land owners and land options	Multiple sites will be put under contract, typically via options to purchase the parcels which allow for the developer to decline to purchase the property as well as perform a variety of environmental surveys and site investigation studies. NDAs are particularly important, as large tracts of land are often owned by multiple different owners, such that the selection team will need to negotiate purchase options with several owners simultaneously, and need to avoid existing land owners communicating and potentially colluding to increase the land offer price.	Nondisclosure agreements with land owners and purchase options executed; ~3 – 5 sites
28	Economic incentives / site price comparison	Negotiations with municipalities and states can produce economic incentives to develop the project in a specific area; these incentives are viewed in conjunction with the land purchase option prices in order to fully understand the costs of specific parcels	Detailed price for each site, including purchase price and local economic incentives
29	Site studies – Geotech, wetlands survey, endangered species study, cultural resources study, background air quality measurements	Site purchase option should include ability to perform tests and surveys in order to determine financial suitability of site; all point source air emissions should be known at this point such that background air quality measurements and computational fluid dynamic modeling can be done to see how the new emissions sources will affect the ambient conditions. Unfavorable results likely rule out proposed parcels, while successful modeling enables preparation of the air permit application. Other studies typically must consider: feedstock supply and product delivery availability review, raw water sources and characteristics, water supply due diligence, waste water discharge provisions/agreements, air permit and other permit preliminary review to determine ability of site to receive permits, surveys/topography of site, initial threatened/endangered species consultation, wetland delineation and stream investigation, cultural resources investigation, development of preliminary environmental impacts, hydrographic surveys, phase I / II ESA	Site due diligence studies

Execution Plan Description

#	Line Item	Description	Outcome
30	Full scale site selection	Final site selection will be done in consideration of financial modeling of the specific impacts a site has on the project's financial return, including local economic incentives, costs of civil improvements, access (or cost to access) to feedstock and product delivery points, as well as the results of site studies. Firms exist to help with the site selection process (many EPC firms also provide this service), these companies can work through local economic development agencies, or may have their own databases, to identify available land, surrounding infrastructure, etc; some of these firms will also do wetlands surveying, endangered species studies, cultural resources studies, and other of the site due diligence studies	Final site selection
31	Financial analysis evaluation	Periodic exercising and updates of the financial model as project specific parameters and costs continue to be informed and refined, market conditions for commodity inputs / outputs change, and overall economic landscape evolves. Informs detailed design choices, vendor/site selections, and negotiations. Helps obtain funding (debt and equity) and serves as "gate review" on continuing the technology deployment.	Updated financial model, improved guidance for commercial deployment and negotiation
32	Bid and award coal dryer vendor contract	Work facilitated by OE in advance of EPC contract bids in order to reduce EPC firm's risk and thus improve EPC fixed price contract pricing; RFP will indicate intent to have unit shop fabricated versus assembled on site	Final price and contract for coal dryer
33	Bid and award gasifier vendor contract	Work facilitated by OE in advance of EPC contract bids in order to reduce EPC firm's risk and thus improve EPC fixed price contract pricing; RFP will indicate intent to have unit shop fabricated versus assembled on site	Final price and contract for gasifier
34	Bid and award ammonia train vendor contract	Work facilitated by OE in advance of EPC contract bids in order to reduce EPC firm's risk and thus improve EPC fixed price contract pricing; RFP will indicate intent to have unit shop fabricated versus assembled on site	Final price and contact for ammonia train
35	Bid and award power block vendor contracts	Work facilitated by OE in advance of EPC contract bids in order to reduce EPC firm's risk and thus improve EPC fixed price contract pricing; RFP will indicate intent to have unit shop fabricated versus assembled on site	Final price and contract for power block

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#	Line Item	Description	Outcome
36	State and Federal regulatory agency permitting consultations	Note that different states have different permit application processes; a multi-technology application will allow the project to provide details for multiple generators in the permit application, and then revise the permit when a specific vendor has been selected. Other states will revert the application to the beginning of the process once the specific vendor is selected, thus impacting the timing of permit issuance. Based on the state's application process, permitting may need to begin after technology vendor is selected. Proposed power block is fossil fuel-fired combustion devices used to generate electricity for sale and serve as a generator over 25 MWe. Therefore, plant will meet the definition of an affected Phase II "utility unit" under the Acid Rain Program pursuant to the Clean Air Act, and require a phase II acid rain permit.	Detailed list of necessary permits, application processes and application timelines
37	Local review and approval process	Specific city or county jurisdictional agencies may require planning and land use approvals that require independent review and approval processes from the State and Federal environmental entitlements. Land approvals may include zoning change, conditional use permits, or various planning approvals specific to setbacks, siting and other general plan exemptions. Additionally, local agencies will be involved in transportation and traffic permits; building and engineering reviews and permits; grading and drainage plan approvals; stormwater pollution protection plan approval; hazardous waste materials generation, collection, handling or transport; onsite waste water treatment facilities; infrastructure; and wastewater discharge activities	Local approvals
38	NEPA review and approval process	Environmental documentation for either Categorical Exclusion (CA), Environmental Assessment (EA) or Environmental Impact Statement (EIS), based on project's potential to have significant environmental impacts and the involvement of Federal funds or permitting. Many of the studies completed in the Site Studies step will be applicable to this process	NEPA categorization, application and approval
39	Develop full scale BOP EPC RFP, solicit, select vendor	RFP for site construction activities outside of main plant components and integration, such as site preparation, road / parking infrastructure, administrative buildings, rail infrastructure	BOP EPC firm contract finalized

Execution Plan Description

#	Line Item	Description	Outcome
40	Prepare full scale EPC RFP	Request for fixed price EPC bid in order to transfer construction risk to EPC firm, however to do this all detailed design work and site selection activities must be complete and permitting largely de-risked. During this time developer will also prepare the evaluation criteria, both the public facing elements to be presented in the RFP but also the forms and format of bidder response evaluation. Additionally, RFP should include a draft contract Terms and Conditions for bidders to review	Specifications for EPC work, including RFP documents and evaluation forms
41	Full scale EPC bid preparation	Time allotted for pre-bid meeting, site visit for bidders to walk the identified parcel, defined period for questions, answers prepared and presented by development team. During response time developer should begin to prepare for bid evaluation, including preparing evaluation materials and clear evaluation methodology	Final proposals from EPC firms
42	EPC bid evaluation, selection and contract negotiations	Evaluation based on predetermined scoring criteria, as well as contract terms and conditions redlines and cost proposal	Negotiated final contract for EPC vendor
43	Develop lender and equity solicitation packages	Economic and business model details, financial analysis of project, sensitivities to key risks and mitigation plans, expected returns for investors, required amount from equity and debt, preferred types of equity (i.e., preferred equity, non-voting, etc, depending on legal entity), detailed budget including fixed price EPC contract, progress towards permitting, studies from site selection activities. Financial projections are built from the periodic financial analysis evaluations (lines 15, 31 and 49). Packages will likely be delivered to several lenders and potential equity partners	Detailed business plan, financial model and project description
44	Full scale site purchase / closing	Land purchase price is likely to be a component of project developer's upfront equity contribution to the project, and thus option execution may occur prior to loan closing; purchase of land may also happen concurrent with loan closing but no later than loan closing as lender will place a lien on the property	Final site purchase
45	Lender and equity provider underwriting, negotiation and closing	Bank finance is likely to be a syndicate of lenders. While negotiation will occur with only the lead lender, the syndicate must come to consensus on loan terms and conditions, which adds time to the underwriting and negotiation phase.	Financing commitments

Execution Plan Description

#	Line Item	Description	Outcome
46	EPC Final Notice to Proceed	Final notice to the EPC firm to begin work and begin accumulating charges; note this notice will happen after a financial analysis evaluation and at or just after closing of the financing instrument	EPC start
47	EPC Engineering	Final detailed integration engineering by EPC firm	Detailed engineering
48	Hazard Operability Review	Safety and operability review of design to ensure intended operations do not pose a safety hazard; especially relevant to assess additional hazards of rapid, repeated ramping and turndown; Develops list of action items and required design modifications to assure safety and operability	Hazard Operability Review report and associated action items tracked to closure
49	Financial analysis evaluation	Periodic exercising and updates of the financial model as project specific parameters and costs continue to be informed and refined, market conditions for commodity inputs / outputs change, and overall economic landscape evolves. Informs detailed design choices, vendor/site selections, and negotiations. Helps obtain funding (debt and equity) and serves as “gate review” on continuing the technology deployment.	Updated financial model, improved guidance for commercial deployment and negotiation
50	Interconnection agreement	Prepare interconnection request with preliminary site documentation, expected in-service date and deposit; perform interconnection studies, negotiate schedule for constructing interconnecting facilities and network upgrades, finalize interconnection agreement	Interconnection agreement
51	Air quality permit – construction; application development	Depending on emissions expectations of FEED design, several requirements may be needed to be met for construction permit (from air quality perspective): best available control technology analysis, air quality analysis, and additional impact analysis. Application will include process description, process flow diagrams, plot identification, identification of applicable federal and state air regulations and emissions limitations, emissions quantification and application forms. Facility will also be required to apply for a phase II acid rain permit, install CEMS to demonstrate compliance with the ARP provisions meeting the requirements specified in 40 CFR 75, and hold allowance equivalent to annual NOx and SO2 emissions	Air permits
52	Full scale BOP EPC site prep construction	Mobilization, construction management trailers, site clearing, civil infrastructure, roads, grading, retaining walls, foundations, underground piping and electrical	Balance of plant construction

Execution Plan Description

#	Line Item	Description	Outcome
53	Full scale plant EPC construction	Integration of shop-fabricated coal drying, gasifier, power block, process plant, storage units, integration components, development of control room, underground utilities, electrical equipment installation, interconnection infrastructure, etc. A conservative timeframe based on standard construction timeframes for a plant of this scale is used to account for this being the first application, however for subsequent plants construction time would be reduced as shop fabricated unit construction and integration times will reduce	Mechanically complete plant
54	Turnover from construction to commissioning	Hand over of all relevant project documentation, completion of final punch list items and deconstruction of construction staging equipment	Start of commissioning work
55	Commissioning	Preparation for commissioning can start when plant is ~60% complete, acceptance follows performance testing and punch list completion	Equipment capable of running safely and robustly
56	Air quality permit – operations, application development	Anticipated that an operating permit under the Clean Air Act Permit Program (CAAPP) or Federally Enforceable State Operating Permit (PESOP) will be required. Title V Part 70 identifies the standard permit requirements that each permit shall include, including all monitoring and analysis procedures or test methods required; potential exclusions of testing or monitoring and compliance certification. CAAPP is generally required for “major source” emissions as defined by criteria pollutants (NOx, SOx, CO, Lead, Ozone, VOC, PM 2.5, PM10), limits based on Hazardous Air Pollutants (HAPs) in the Clean Air Act; FESOP is applicable when a facility can voluntarily limit emissions by accepting limits on operations.	Air permits for ongoing operations

Site Selection Details

Project Stage	*Comments*
Pilot Site Selection	• Pilot site selection includes an inherent assumption that the project sponsor can identify potential host sites, and as such site selection process does not start from scratch • Piloting timeline assumes the ability to find an amenable functioning pilot plant hosting facility (cf. National Carbon Capture Center, GTI, U-ND EERC, UPARC, or a partner site), which can provide existing infrastructure including offsites, utilities, electrical, civil works, and safety can be leveraged • Host site is assumed to have overall blanket permits and site work complete, such that site due diligence activities are not necessary at this stage and air permits are covered by the host site's existing permits ("permit by rule," inclusion in the facility permit, etc.)
Full Scale Site Selection	• Identifying a site for the full scale plant will be more complicated than the pilot plant site, as confidentiality during the search process is essential to ensure land prices are not inflated – One challenge in acquiring a large tract of land is the high likelihood that the project team will need to secure multiple smaller parcels of land to aggregate into a sufficient size. In this scenario, it is crucial to avoid landowners holding out on selling or signing purchase options with the hopes that they will be the last holdout – and thus inflate the cost of their land. For this reason nondisclosure agreements are key – Similarly, executing property purchase options (as opposed to immediately purchasing land) is typically done in order to have several sites moving down the due diligence and procurement path simultaneously, in the event there is a problem with a due diligence study or if a landowner reneges on the purchase option for any reason • There are firms that specialize in executing site selection, including some EPC firms. These companies may have databases of potentially available land, and additionally are typically informed as to the potential economic incentives that different municipalities/counties/states might be willing to provide • Typically the OE will provide the site selection firm with a list of criteria, such as access to feedstock / product offtake sources, distance to transmission lines, parcel size, preferred topology, etc • In most cases the project developer will purchase the land using equity funds, and as such the land closing would occur prior to the closing of a loan facility. By doing it in this order the lender is able to place a lien on the property as part of the loan collateral. It is possible to close the land purchase and loan closing simultaneously, but this does open the project developer to additional transactional risk should one of the two transactions need to be delayed