TENASKA® TRAILBLAZER PARTNERS, LLC

Report to the
Global CCS Institute

Carbon Capture Plant Layout Optimization with a New Coal Fired Power Generating Facility

Final Report February 2011

DISCLAIMERS

This Report and the contents hereof (collectively, this "Report") are being provided pursuant to and in accordance with that certain Funding Agreement by and between the Global Carbon Capture and Storage Institute Ltd. and Tenaska, Inc. (the "Funding Agreement"). Except as otherwise explicitly stated in the Funding Agreement, the provisions of the Funding Agreement are for the sole protection and legal benefit of the parties thereto, and their permitted successors and assigns, and no other person or entity shall be a direct or indirect beneficiary of, or have any direct or indirect cause of action or claim against, any party arising from the Funding Agreement or the publication, disclosure or distribution of this Report.

This Report does not constitute the provision of engineering or design services or advice and should not be utilized or relied on by any person or entity as engineering or design services or advice. For the avoidance of doubt, neither Tenaska, Inc., Tenaska Trailblazer Partners LLC, nor their affiliates shall be liable to any third party for any harm or loss associated with utilization of or reliance on this Report.

Abstract

The Tenaska Trailblazer Energy Center (Trailblazer or Project), is a nominal 760 MW supercritical pulverized coal electric generating station under development in Nolan County, Texas, United States, approximately nine miles east of Sweetwater, Texas.

Trailblazer is expected to be the first new-build coal plant in the United States to incorporate a commercial-scale carbon dioxide (CO_2) capture plant into the initial design. The Project will be designed to capture 85 to 90 percent of the CO_2 that otherwise would be emitted into the atmosphere.

In June 2009, Tenaska signed a Memorandum of Understanding (MOU) with Fluor Enterprises, Inc. (Fluor) to work together to define the scope of the Project and to develop and negotiate an Engineering, Procurement and Construction (EPC) contract for the pulverized coal power plant and the carbon capture plant. The MOU allowed Tenaska to evaluate and bid the carbon capture portion of the Project separately, allowing for the possibility of a third party carbon capture supplier/constructor working at the Trailblazer site in parallel with Fluor.

This report describes how Fluor optimized the plant layouts for both the power plant and the carbon capture plant to provide a more economical layout between the two facilities. The optimized layout uses less material and therefore has a lower capital cost. The optimized layout will have little or no impact on plant operations. This optimization effort was completed in a short duration due to schedule constraints. No detailed designs or detailed cost estimates were carried out.

This is the fifth in a series of knowledge sharing reports on Carbon Capture and Storage (CCS), developed by Tenaska for the Global CCS Institute.

<u>Key Lessons</u>

The results of this “quick study” showed that the in-line arrangement provided for a significant reduction in the overall length of the ductwork needed to connect the capture plant to the power plant. The estimated savings were on the order of $10 million USD, which represents $17/kW for this nominal 600 MW plant with the carbon capture plant operating. The savings from the reduction in ductwork were somewhat magnified by the need to use corrosion resistant materials for the duct work when deploying an advanced amine system.

Carbon Capture Plant Layout Integration

Table of Contents

1.0 Introduction

1.1 Project Overview

The Project is a nominal 760 MW supercritical pulverized coal electric generating station under development in Nolan County, Texas, United States, approximately nine miles east of Sweetwater, Texas. Trailblazer is expected to be the first new-build coal-fueled power plant in the United States to incorporate a commercial-scale CO_2 capture plant into the initial design. The station is being designed to capture 85 to 90 percent of the CO_2 that otherwise would be emitted into the atmosphere. CO_2 from the Project will be sold into the Permian Basin CO_2 market, where it will be used for EOR and ultimately permanently stored underground. Geologic storage of CO_2 will be considered should it become economically attractive.

Sub-bituminous coal will be delivered to the Project from the Powder River Basin in Wyoming via the Union Pacific (UP) and/or Burlington Northern Santa Fe (BNSF) railroads. The Project site is bordered on the north by the UP and on the south by the BNSF. The Project will interconnect to the Electric Reliability Council of Texas (ERCOT) 345 kV electrical system, most likely at a substation about six miles from the Project site.

The Project is being developed by Tenaska, and is owned by Tenaska Trailblazer Partners, LLC. Tenaska Trailblazer Partners, LLC is owned 65 percent by affiliates of Tenaska and 35 percent by Arch Coal, Inc.

In February, 2008 the site was procured, an air permit application was filed with the Texas Commission on Environmental Quality (TCEQ), an electric interconnection request was filed with the ERCOT, and the project was announced to the public. Tenaska engaged Burns & McDonnell to serve as Owner's Engineer in November, 2008.

In June 2009, Tenaska signed an MOU with Fluor Enterprises, an affiliate of Fluor Corporation (collectively, Fluor) to work together to define the scope of the Project and related work and to develop and negotiate an EPC contract for the pulverized coal power plant and the carbon capture plant. The MOU allowed Tenaska to bid the carbon capture portion of the Project separately, allowing for a third party carbon capture supplier/constructor to work at the Trailblazer site in parallel with Fluor. After an evaluation process that was discussed in the *CO_2 Technology Evaluation, Methodology and Criteria* report to the Global CCS Institute, in June 2010, a MOU was developed with Fluor to conduct a FEED study for the carbon capture plant. Tenaska and Fluor executed a contract on July 15, 2010 for Fluor to perform the FEED study and to be the presumptive carbon capture technology provider for the Project.

See http://www.tenaskatrailblazer.com for more information about the Project. The report to the Global CCS Institute titled *Development of the Tenaska Trailblazer Energy Center*, dated August 2010, provides a history of the Project, the rationale behind the site selection and technology selection, and identifies key challenges the Project faces.

1.2 Developer Overview

Since its founding in 1987, Tenaska has successfully developed and constructed 15 power generation facilities, totaling more than 9,000 MW. Today, Tenaska operates eight power generation facilities totaling 6,700 MW that it owns in partnership with other companies. Tenaska also provides energy risk management services and is involved in asset acquisition and management, power marketing, fuel supply, natural gas exploration, production and transportation systems, biofuels marketing and electric transmission development.

Tenaska Capital Management, an affiliate, provides management services for standalone private equity funds, with almost $5 billion USD in assets, including nine power plants and multiple natural gas midstream assets, including gas storage, gathering and processing facilities. In 2009, Tenaska and its affiliates managed approximately 34,000 MW of assets on behalf of a variety of customers and private equity investors.

An affiliate, Tenaska Marketing Ventures (TMV), is regarded as one of the top 10 natural gas marketers in North America, and provides natural gas commodity, volume management, hedging and asset management products and services. In 2009, TMV was ranked No. 1 in the United States in natural gas pipeline capacity trading according to Boston-based CapacityCenter.com, which monitors and collects capacity and operational information on all interstate pipelines. Customers responding to Mastio & Company's "Value and Loyalty Benchmarking" survey in 2009 ranked TMV No. 1 in the nation among major marketers for value and loyalty.

Another affiliate, Tenaska Power Services Co. (TPS), specializes in electric power marketing and asset management for utilities and non-utility generators, and is one of the largest marketers of electric power in the United States. TPS has developed a significant presence in the wind industry, and currently schedules about 20 percent of the wind generation in ERCOT.

In 2009, Tenaska had gross operating revenues of $7.9 billion USD and assets of approximately $2.8 billion USD. In 2009, *Forbes* magazine ranked Tenaska as 16th among the largest privately-held United States companies, based on 2008 revenues.

See http://www.tenaska.com for more information about Tenaska.

1.3 Partner Overview

In March 2010, Arch Coal acquired a 35 percent share of Tenaska Trailblazer Partners, LLC from affiliates of Tenaska. St. Louis-based Arch Coal is the second largest U.S. coal producer, with revenues of $2.6 billion USD in 2009. Through its national network of mines, Arch Coal supplies cleaner-burning, low-sulfur coal to U.S. power producers to fuel roughly 8 percent of the nation's electricity. The company also ships coal to domestic and international steel manufacturers as well as international power producers.

In total, Arch Coal contributes about 16 percent of the United States' coal supply from 11 mining complexes in Wyoming, Utah, Colorado, West Virginia, Kentucky and Virginia.

Arch Coal controls a domestic reserve base totaling 4.7 billion tons. Of that total, 88 percent is low in sulfur and nearly 83 percent meets the most stringent requirements of the Clean Air Act without the application of expensive scrubbing technology.

In addition to becoming a valued partner, Arch Coal also will provide low-sulfur Powder River Basin coal to the Project under a 20-year coal supply agreement.

See http://www.archcoal.com for more information about Arch Coal.

1.4 Contractor Overview

Fluor is the presumptive EPC contractor for the Project. Fluor is one of the world's largest publicly owned engineering, procurement, construction, maintenance, and project management companies. Fluor has more than 36,000 global employees, and maintains offices in more than 30 countries across six continents. Fluor ranks No. 111 on the Fortune 500 list of America's largest corporations. *Engineering News-Record* magazine ranks Fluor No. 1 on its Top 100 Design-Build Firms list and No. 2 on its Top 400 Contractors list. See http://www.fluor.com for more information.

Burns & McDonnell is the owners' engineer for the Project. Burns & McDonnell is a full-service engineering, architecture, construction, environmental and consulting solutions firm. Its staff of more than 3,000 represents virtually all design disciplines. Burns & McDonnell plans, designs, permits, constructs and manages facilities all over the world. In 2010 *Engineering News-Record* ranked Burns & McDonnell number 22 in design firms and number eight in power plant design firms. See http://www.burnsmcd.com for more information.

2.0 Executive Summary

2.1 Reason for Optimization Study

The carbon capture industry for large coal applications is still in its infancy and the business and technology issues associated with scaling up carbon capture equipment to full commercial power plant scale create many challenges. Undertaking the carbon capture Front End Engineering Design (FEED) early in the design process, as has been done with Trailblazer, allows the owner to concentrate on the carbon capture portion of the project and allows the design to mature to a point where better construction cost estimates can be developed based on the carbon capture FEED results.

Tenaska and Fluor signed an MOU in June 2009 to develop and negotiate an EPC contract for the power plant and the carbon capture plant. The MOU allowed Tenaska to evaluate and bid the carbon capture portion of the Project separately from the power plant. In July 2010, Tenaska and Fluor signed an MOU to develop FEED and firm EPC pricing for the carbon capture portion of the Project. Incentives in the FEED phase encourage the EPC contractor to be innovative and reduce costs. Fluor investigated and proposed a layout revision to further optimize the capital and operating cost of the carbon capture facility.

The initial right angle layout of the Project, which was developed prior to the selection of Fluor's carbon capture technology, readily accommodated designs from any carbon capture technology bidder. The power plant and the carbon capture plant were clearly separated with minimum interface points, because numerous interface points between different EPC organizations can add complexity and lead to additional project cost and potential schedule impacts.

An optimized in-line layout, on the other hand, typically uses fewer materials and therefore can deliver a lower capital cost. Therefore, Fluor performed a layout optimization study to identify any net project savings that could be derived by adopting the in-line configuration into the power plant layout. This report describes the process undertaken to optimize the layout for the combined facility. This optimization effort was completed in a short duration due to schedule constraints. No detailed designs or detailed cost estimates were carried out.

Optimization of the layout for a conventional pulverized coal plant that includes a carbon capture plant into its original design can yield significant results in terms of project cost and schedule. By devoting the appropriate time and resources to the development of a comprehensive set of evaluation criteria, and by consistently applying those criteria to the various alternatives considered, significantly lower capital and operating costs can be achieved.

2.2 Optimization Process

Fluor designed an optimization process using a combination of 'group think' (brainstorming) and the Nominal Group Technique[1]. The optimization team developed 10 evaluation parameters which were used to evaluate potential enhancements. These parameters, which are discussed in more detail in Section 4.2, were:

- Reducing the total quantity of ductwork;
- Minimizing the number of duct bends and turns;
- Positioning of Air-Cooled Heat Exchangers (ACHE) with their long edge aligned with the direction of prevailing winds;
- Maintaining as much distance between the coal pile and the ACHE as possible;
- Maintaining as much separation between the ACHE and the Wet Flue Gas Desulfurization (WFGD) as possible;
- Avoiding the location of equipment in the power plant stack exclusion zone;
- Planning the layout to accommodate large crane access to critical systems;
- Maintaining layout flexibility given the early state of design;
- Maintaining constructability in general; and
- Holding the size of equipment constant in the study.

2.3 Key Lessons

As discussed in Section 4.3, the significant reduction in the quantity of ductwork, ductwork supported steel, support foundations and other ductwork-related items far outweighed small increases in other areas. **The change to an in-line configuration resulted in an estimated net capital cost reduction of $10 million USD.** This figure represents $17/kW for this nominal 600 MW plant with the carbon capture plant operating. Operating costs are also expected to be slightly lower, although no formal estimate of these cost savings was performed. The estimated reduction in the length of duct work was on the order of 1350 feet (411.5 meters). The savings from the reduction in ductwork were somewhat magnified by the need to use corrosion resistant materials for the duct work when deploying an advanced amine system.

---

[1] The **Nominal Group Technique** (NGT) is a decision making method for use among groups of many sizes, who want to make their decision quickly, as by a vote, but want everyone's opinions taken into account. Every member of the group gives their view of the solution, with a short explanation. Duplicate solutions are eliminated from the list of all solutions, and the members proceed to rank the solutions, 1st, 2nd, 3rd, 4th, and so on. The Facilitator encourages the sharing and discussion of reasons for the choices made by each group member, thereby identifying common ground, and a plurality of ideas and approaches. This diversity often allows the creation of a hybrid idea (combining parts of two or more ideas), often found to be even better than those ideas being initially considered.

3.0 Purpose and Goals

The purpose of this report is to outline the process which Fluor undertook in determining that an integrated in-line layout was more cost effective than the right-angle configuration for the Project.

The goal was to find significant material cost savings while providing a more functional and logical layout considering construction, major equipment placement, reduction of duct and flue lengths and complexity, and ease of operation and maintenance.

This report includes an explanation of the following: layout evaluation criteria; plant operating issues and costs; and construction and constructability issues.

4.0 Layout Integration and Optimization

4.1 Generic Layout

In the conventional pulverized coal fired facility, the post combustion gas (exhaust or flue gas) must be processed to remove air pollutants before emitting the gas to the atmosphere. The primary pollutants that are removed or significantly reduced are sulfur dioxide (SO_2), nitrogen oxides (NO_X), particulate matter (PM), volatile organic compounds (VOC), sulfuric acid (H_2SO_4), lead (Pb) and mercury (Hg). These traditional pollutants are addressed in the permit to construct a stationary emission source of such pollutants and each is evaluated for the potential to be reduced as much as is feasible through the use of the best available control technology (BACT).

The result of this BACT analysis, performed in conjunction with the air permit application is to utilize state-of-the-art equipment for the reductions of these pollutants. A WFGD unit or, wet scrubber is used to mix the flue gas with powdered limestone to form gypsum and extract the SO_2 from the flue gas as well as H_2SO_4 in a downstream flue gas polisher. The flue gas is directed through a fabric filtration system, or baghouse, to remove the particulate matter as well as Pb and Hg. Selective catalytic and non-catalytic reduction of NO_X is performed by injection treatment directly into the flue gas (ammonia (NH_3), or urea) at the proper reaction temperature and in the case of catalytic reduction allowing the treated flue gas to react with precious metal coated plates located at optimum collection temperature locations within the flue gas stream.

Other pollutants are reduced to their maximum feasible level through careful consideration in boiler design. This includes the use of low NO_X burners and the logical placement of overfire air ports to complete the combustion process.

Facilities for post-combustion CO_2 capture receive the flue gas after it has been processed by the conventional air quality control systems. The carbon capture plant must connect to the back of the plant, between the WFGD system and the plant stack.

As this plant will be the first, full-size, new coal-fired power plant to include a carbon capture plant in its initial design, it is anticipated that the carbon capture system will not exhibit the same level of high reliability as the more mature PC plant, particularly in the early years of operation. In order to allow operation when the carbon capture plant is undergoing maintenance, Trailblazer requires the ability to bypass the carbon capture system. As a result, the WFGD system needs to be reasonably close to the plant stack to avoid the cost of a long bypass duct.

The Project's initial right-angle layout concept could easily accommodate the designs from any of the potential carbon capture technology bidders, without complex interface issues. Historically, numerous complex interfaces between different design and construction organizations add cost, time to the schedule and risk to the project. In the right-angle configuration, the successful technology supplier would be assigned a clear space for its system, as typified by the large yellow shaded area on Figure 1.

4.2 Optimization Process

The overall goal of the optimization process was to reduce costs. Constructability, capital costs, schedule, operational costs and maintenance costs were all considered in this process. This optimization effort was completed in a short duration due to schedule constraints. It was accomplished by assembling a review team, which was comprised of engineering leads, construction management, operations and project management. No detailed designs or detailed cost estimates were carried out. More details on the process are described below.

The generic right-angle design for the carbon capture plant possessed long duct runs. It was hypothetically determined that a more optimal design could bring savings to the Project. Therefore, a layout optimization study was performed to determine the potential savings associated with this design change. A more optimal layout would use less material and therefore have a lower capital cost. Shorter duct runs with less bends and turns could lower the fan power requirement. Although not estimated for this effort, such auxiliary power reductions can increase net plant output and reduce specific emissions. Moreover, these same reductions would transfer to savings in installation and construction costs.

Fluor designed an optimization process using a combination of 'group think' (brainstorming) and the Nominal Group Technique, noted in section 2.2. All the technical and constructability requirements relevant to the layout design were collected from the parties involved in the design, engineering, construction and operation of the Project, and subject matter experts. In addition, certain principles and rules were established by the team to be used for the scope of the study. This data is summarized by the following list of evaluation parameters:

1. Historical power plant design experience indicates that the most economical layout minimizes ductwork quantity. This is followed by minimizing the piping quantity and then by minimizing electrical power distribution quantity. Layout priority is given to reducing the total quantity of ductwork, as indicated by the difference between Figures 1 and 2.

2. Bends and turns in the ductwork add pressure drop to the gas path, which has to be overcome with higher fan horsepower. To minimize these losses; the layout needs to minimize the number of duct bends and turns.

3. Due to the limited availability of water in West Texas, the Trailblazer carbon capture plant uses ACHEs for process cooling. This ACHE is in addition to the air cooled condenser required for the power plant. The most efficient orientation for ACHE modules is affected by the summer prevailing wind direction. The rectangular ACHE units are ideally positioned with their long edge aligned with the direction of the prevailing wind as is reasonably possible.

4. ACHE performance can be affected by dust fouling of the cooling fins. Therefore, the distance between the coal pile and the ACHE needs to be as large as is practically possible.

5. The power plant includes a WFGD system for flue gas sulfur dioxide control. The reagent for this system is limestone and the by-product is synthetic gypsum. Material handling of these materials can create dust, so the layout needs to separate the ACHE from theses systems, as far as possible.

6. The construction of the concrete shell of the power plant stack requires a 50-foot diameter exclusion zone around the base. No construction work can be performed in the exclusion zone for several months. Typically this creates an intolerable burden to the construction schedule, so no equipment is located in this zone. In addition, it was determined that it would be more cost effective to keep the large stack foundation separate from any of the adjacent equipment foundations.

7. Since these are very large field-erected systems, large cranes are needed to assemble the carbon capture absorber, the Direct Contact Cooler (DCC), the WFGD absorber, the ductwork support structures, the ductwork, ductwork dampers and other equipment. The layout needs to accommodate large crane access to these items. The primary purpose of the DCC is to cool the flue gas, allowing for more efficient operation of the carbon capture system. The DCC is located directly after the flue gas desulfurization tower.

8. At the time of the study, the power plant was still in the early design phase. The power plant layouts shown in Figures 1 and 2 were created using equipment drawings from similar prior projects. Since the final equipment sizes may change, judgment is needed to not "over-optimize" the layout this early in the design process. Otherwise there may be insufficient space to locate the equipment efficiently. Items whose layout still could change included limestone reagent preparation, aircooling equipment, gypsum dewatering and handling, coal pile location, and coal conveyor location. Layout for these items can be affected by final equipment selection, final fuel supply agreements, gypsum sale agreements and the final plant size or capacity. See the Preliminary Overall Plant Layout, Figure 3. Additional optimization of the plant final layout may be performed after final equipment selections are made.

9. Constructability in general is an important parameter, in addition to those mentioned above.

10. The sizes of the equipment, such as the DCC and the carbon capture absorber, were held constant in this study.

In three rounds of the process, the team was assembled in a conference room or open forum setting. Individual pieces of equipment were considered in variations of the two layout configurations (in-line and right angle). In each round, the candidate layouts were evaluated by the parameters listed above. The team discussed these layouts in real time and through open discussion format, and in this iterative and evolutionary process, the candidate concepts were either eliminated or improved using ideas from the discussions and from the previous round. The team reached consensus that the in-line arrangement depicted on Figure 2 offered the best overall integrated layout.

The following points typify the considerations of the proposed layouts that were debated by the group:

- Ductwork usually runs only in North-South or East-West directions to maintain a square and orderly configuration. The unusual 45 deg angles used in the final layout reduce the duct length and number of duct bends. The total reduction in duct length of 1350 feet accomplished with the in-line configuration, applying the uncommon 45 degree angles, represents approximately a 50 percent cost reduction.
- If major equipment is located too close together then constructability problems would be encountered, for example insufficient space for construction cranes.
- If the ACHE is located too far from the capture plant, long pipe runs would be required. This would add significant pipe material and pumping power costs.
- Should the carbon capture absorber be located too far from the stack, a self supporting span to the stack would be impractical.
- Duct runs that are too short for flow measurement devices need to be avoided and therefore duct runs require a minimum run length for flow measurement accuracy.
- Duct runs that are too short for adequate flow distribution at the carbon capture absorber inlet should also be avoided.
- Sufficient horizontal and overhead clearances must be provided for large cranes during future maintenance. They are not to be driven into the middle of the main duct, stack and WFGD Absorber area.
- ACHEs should not be located too close to sources of dust, for example the coal pile, the gypsum and limestone areas associated with the WFGD systems.

4.3 Costs

The material quantity changes, and therefore the construction installations costs, of the new in-line layout were compared to the right-angle case. The following is a summary of the differences:

- Large net reduction in quantity of ductwork, ductwork support steel, support foundations, expansions joints, access doors etc. The use of corrosion resistant materials for the duct work due to the use of advanced amine processes increased the impact of the reductions in the amount of ductwork.
- Small net increase due to deletion of one large bypass damper, but addition of two smaller isolation dampers.
- Small increase in stack cost due to the changes in the breeching configurations.
- Small length increase for the large bore alloy piping between the ACHEs and the other parts of the carbon capture plant.

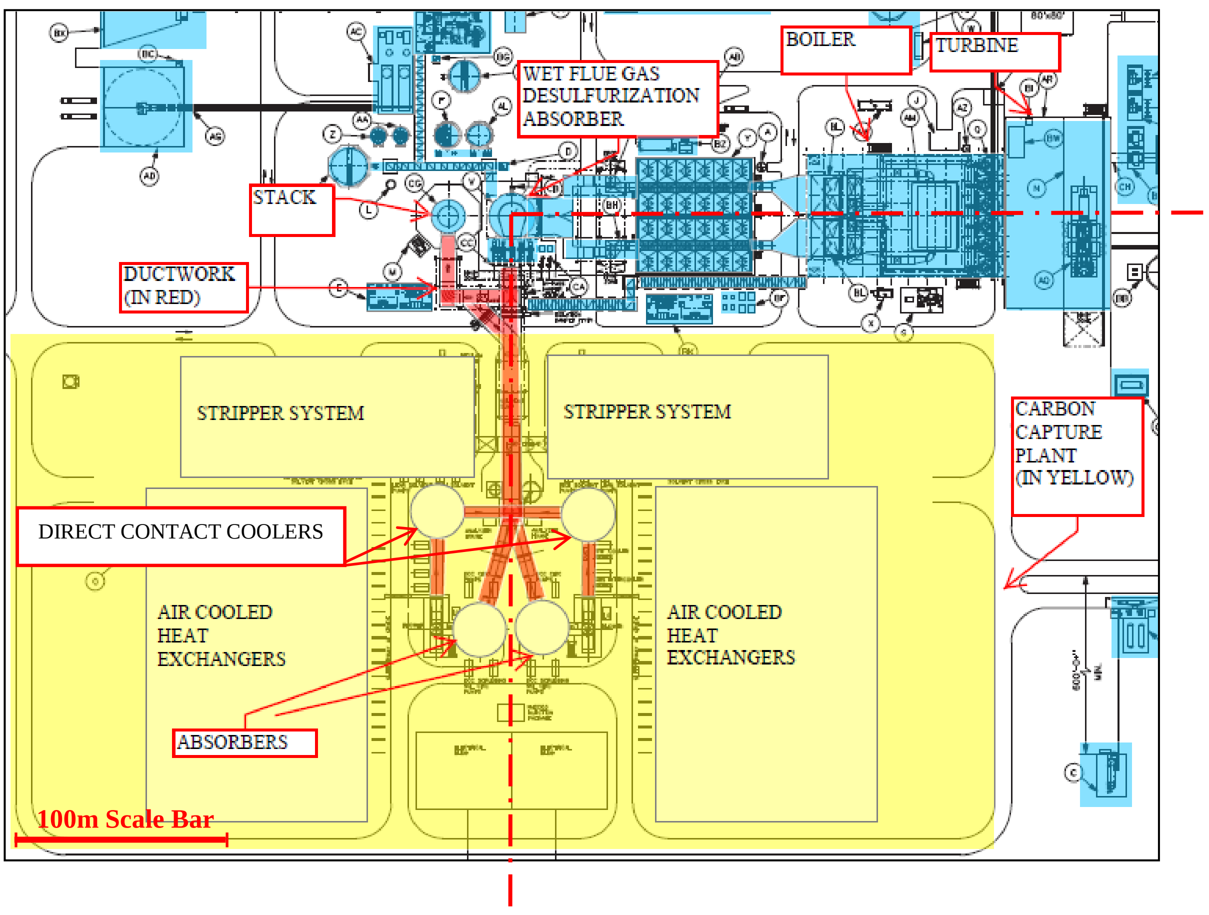
- Small length increase for the large low-pressure steam piping from the power plant to the carbon capture plant.

These changes resulted in an estimated net capital cost reduction of $10 million USD ROM[2] for the total indicative cost of the Project. As these savings are on a comparative basis, they are expected to be realized in the actual plant. For this nominal 600 MW plant with the carbon capture plant operating, the savings evaluates to $17/kW. This level is typical of a piece of auxiliary equipment.

Operating costs with the in-line configuration are expected to be slightly lower due to a lower flue gas pressure drop through the system. The result is less need for booster fan horsepower, which reduces the overall parasitic energy load for the carbon capture plant. Estimates for these cost savings were not performed.

Maintenance costs for the in-line configuration are expected to be similar to the right angle configuration. Estimates for maintenance cost differentials were not performed.

FIGURE 1 – The Right Angle Layout



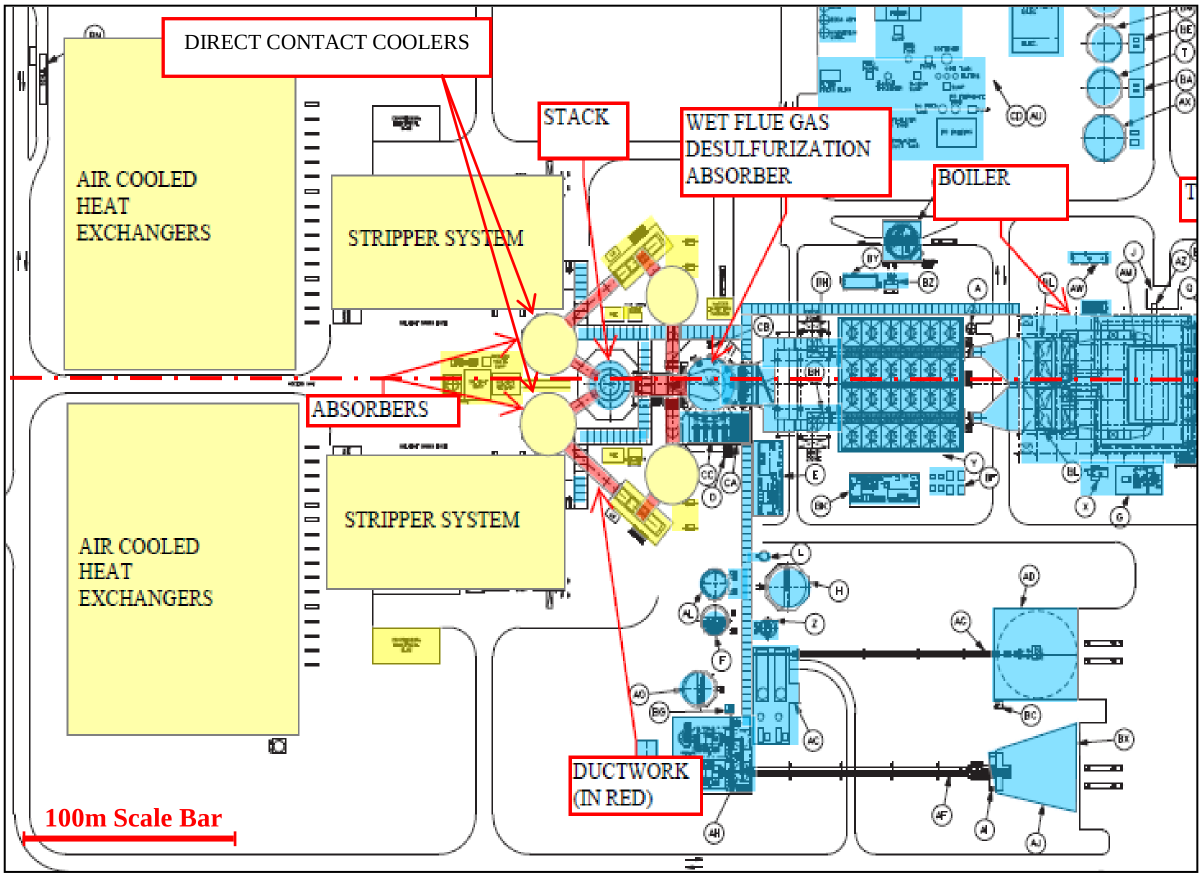
In Figure 1, the power plant is shaded in blue and the carbon capture plant is shaded in

2 Rough Order of Magnitude (ROM) Estimate

yellow. The large yellow area is the zone reserved for the carbon capture plant.

The centerlines of the two plants make a right angle. CO_2 is removed from the flue gas after sulfur dioxide control in the WFGD absorber and before reaching the stack. Ductwork, shaded in red, runs from the WFGD absorber, to the carbon capture plant, and then back to the stack.

FIGURE 2 – The Optimized In-Line Layout

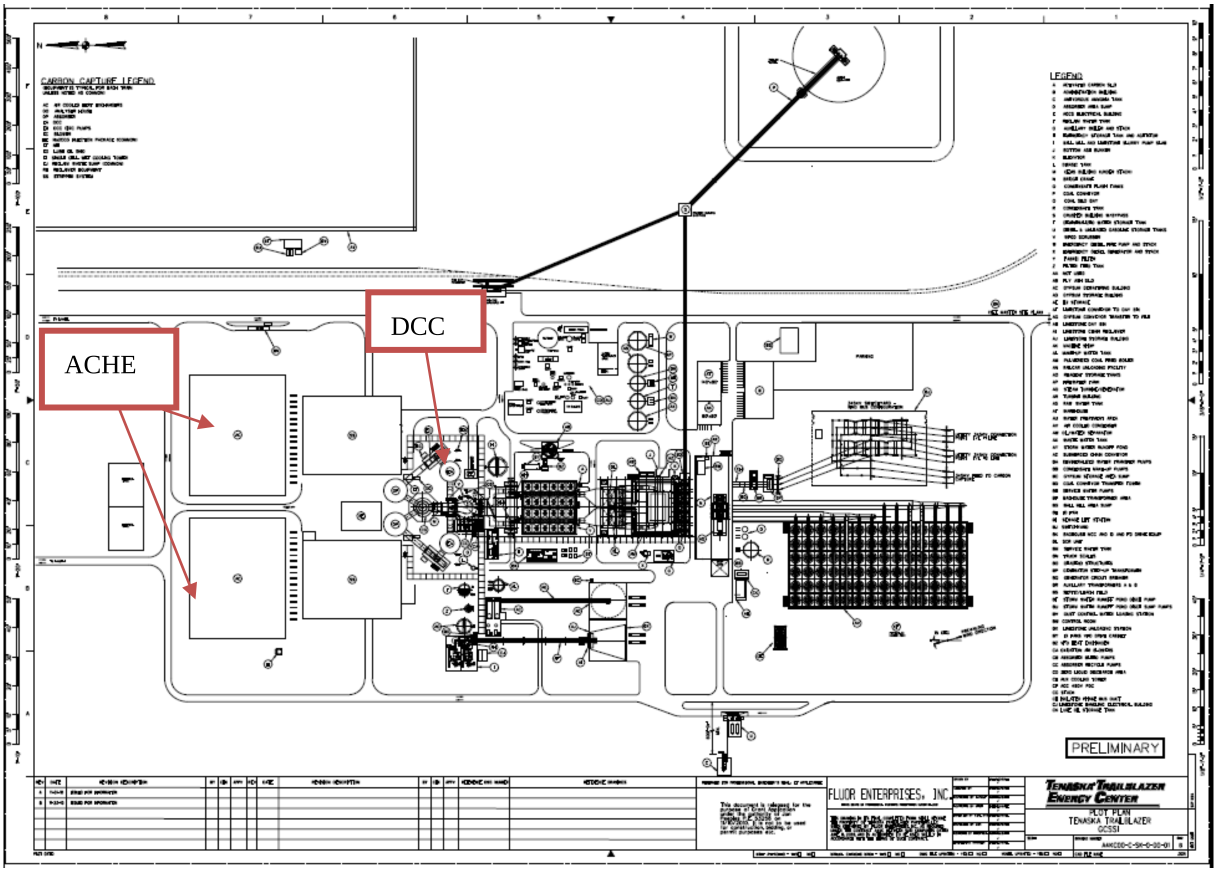


In Figure 2, the power plant is shaded blue and the carbon capture plant is shaded in yellow.

The power plant and the carbon capture plant have the same centerline. Note that the layout of the power plant has reduced the total quantity of ductwork (in red) when compared to Figure 1.

The early overall plant layout design proposed following this process is displayed at Figure 3 below.

FIGURE 3 – Preliminary Overall Plant Layout



5.0 Relevance to Carbon Capture and Storage

The carbon capture industry is still in its infancy. Standardized and accepted practices for the layout of carbon capture facilities are still evolving. In addition, the different carbon capture technologies use different equipment, which makes layout standardization unlikely.

Although each carbon capture plant likely will have a unique layout, the process used to determine the optimal layout for the Trailblazer carbon capture plant could be replicated at other locations.

6.0 Key Lessons

Optimization of the layout for a conventional pulverized coal plant that includes a carbon capture plant into its original design, if done correctly, can yield significant results in terms of project cost and schedule. By devoting the appropriate time and resources to the development of a comprehensive set of evaluation criteria, and by consistently applying those criteria to the various alternatives considered, lower capital and operating costs can be achieved.

As discussed in Section 4.3, the significant reduction in the quantity of ductwork, ductwork supported steel, support foundations and other ductwork-related items far outweighed small increases in other areas. **The change to an in-line configuration resulted in an estimated net capital cost reduction of $10 million USD. This represents $17/kW for this nominal 600 MW plant with the carbon capture plant operating.** Operating costs are also expected to be slightly lower, although no formal estimate of these cost savings was performed. The savings from the reduction in ductwork were somewhat magnified by the need to use corrosion resistant materials for the duct work when deploying an advanced amine system.

7.0 Acronyms and Citations

Acronym/Abbreviation/Frequently Used Term	**Definition**
ACHE	Air-Cooled Heat Exchangers
DCC	Direct Contact Cooler
CCS	Carbon Capture and Storage
CO_2	Carbon Dioxide
EOR	Enhanced Oil Recovery
EPC	Engineering, Procurement and Construction
FEED	Front-End Engineering Design
Fluor	Fluor Enterprises, presumptive EPC contractor
MOU	Memorandum of Understanding
NO_X	Forms of Nitrogen Oxide
Project	Tenaska Trailblazer Energy Center
ROM	Rough Order of Magnitude
SO_2	Sulfur Dioxide
Tenaska	Tenaska, Inc., developer of the Trailblazer Energy Center, and Tenaska Trailblazer Partners, LLC, owner of the Trailblazer Energy Center
TMV	Tenaska Marketing Ventures
TPS	Tenaska Power Services Co.
Trailblazer	Tenaska Trailblazer Energy Center
WFGD	Wet Flue Gas Desulfurization