Economic Impact of Digital Technology on New Plant Construction

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Executive Summary

Study Scope

This study compares two potential implementations of a Distributed Control System (DCS) on a Greenfield 600 MW supercritical power plant installation. The "Traditional" installation utilizes dedicated cables to hardwire non-intelligent field devices to input/output (I/O) cards. The Digital Bussed Plant (Bussed) installation uses bussed I/O, high speed field communications networks, and intelligent or "smart" field device technology to simplify construction. Costs were estimated for both implementation approaches in five categories: system selection, engineering, construction, startup, and overheads. Potential operating and maintenance (O&M) cost savings were also estimated.

Implementation

Typical supercritical plant layouts and design criteria were researched to create a proposed study plant. The plant was physically defined by plan, elevation and several general arrangement (GA) drawings. Remote buildings containing auxiliary systems were also dimensioned. Engineering time was estimated for typical design tasks for both approaches. The plant was logically defined by an existing Emerson DCS specification with approximately 5200 hard and 4250 soft I/O partitioned into typical power plant system designations. Appropriate systems were placed on GA drawings to complete the physical plant definition.

Two selection methods were defined to purchase a system. The Traditional approach utilized an Engineer, Procure, Construct (EPC) model with a detailed specification, bid, and evaluation process. The Bussed approach used a model called PEpC with similar, re-ordered activities: Procure strategic suppliers, Engineer, procure balance of plant, and Construct. The PEpC selection process eliminates the expense of a complex specification and bid process. Costs associated with the EPC and PEpC selection process were identified and estimated. Use of the PEpC model was not considered beyond system selection in this study.

DCS implementation strategies were developed for both approaches, including system configuration and field I/O interface methodologies. The Traditional strategy used a system of tray and conduit to route individual I/O cables from a field device to a DCS cabinet. The Bussed approach used three types of field I/O networks and a combination of hardwired I/O to interface with smart field devices. The networks include Analog, Temperature, and Digital I/O segments. In the Bussed approach, Sequence of Events (SOE), non-smart analog, and high speed process loops were hardwired to I/O cards.

DCS cabinets and Motor Control Centers (MCC's) were placed on GA drawings. Design criteria were developed for both approaches, including construction labor costs, tray, conduit, and cable lengths and material costs. Individual design parameters were assigned to all I/O points in the study to complete the construction estimate. Device upgrade costs for smart transmitters, digital I/O, and intelligent motor interfaces were estimated for the Bussed approach.

Plant checkout and startup tasks were defined for each I/O type. Plant maintenance and operations costs were then estimated for all I/O. Potential critical path schedule savings were estimated based on the difference in checkout time for both approaches.

A plant construction schedule and budget was created to estimate a total spending curve, from which a construction financing methodology was developed to estimate interest during construction (IDC). Inflationary escalation was estimated based on typical utility accounting methods.

Fixed overhead costs were assigned to all construction and startup line items, and included administrative and general support, construction management, contingency, contractor indirect charges, freight, project management, spares, and sales tax. Variable overheads included inflation escalation and interest during construction at a rate of 3% and 6% respectively, both compounded calculations.

Analysis

The construction estimate is summarized in the following table. Approximately $19.7 million is potentially saved when utilizing the Bussed approach, a 39.4% total reduction in considered costs.

Item	Traditional Total	Bussed Total	Total Delta Traditional-Bussed	Percent Delta
System Selection	$ 459,000	$ 157,600	$ 301,400	-65.7%
Engineering	5,353,538	1,851,683	3,501,854	-65.4%
Construction	10,402,980	6,775,638	3,627,341	-34.9%
Startup	834,424	408,533	425,891	-51.0%
Subtotals	17,049,942	9,193,455	7,856,487	-46.1%
Overheads	33,068,487	21,184,242	11,884,245	-35.9%
Totals	$ 50,118,428	$ 30,377,697	$ 19,740,732	-39.4%

The following metrics were developed from costs estimated in the study. Regional construction costs and project specific requirements may have a significant impact on the financial results of this study.

Metric	Traditional	Bussed	Amount
Total Cost	$ 50.1 M*	$ 30.4 M	($19.7M)
% of Total Plant Cost	5.97%	3.62%	-2.35%
Construction Cost per Point	$ 5,301	$ 3,213	($ 2,088)

* (M) = Million

Use of the Bussed approach can reduce O&M staff due to high levels of automation and ease of troubleshooting. Use of Emerson's AMS Suite may help prevent forced outages and increase plant efficiency due to high performance of well-maintained field elements.

Observations

The Bussed approach is a new concept for the utility developers and may require revised marketing tactics. Use of the PEpC selection process will result in a much earlier entry for the project engineering team, requiring procedural changes to initial project cycle stages. A strong owner presence and a diligent supplier presence may be required to assist other development process stakeholders utilize the Bussed approach until accepted as an industry standard.

Implementation of the Bussed concept as specified in this study may be affected by other disciplines, suppliers, and entities within the development process. Specifically, development areas with larger investments in equipment scope, tighter schedule deadlines or different contract requirements could change the study outcome. Construction accounting methods and internal owner practices may also have a significant effect on potential application outcomes.

Conclusion

The Bussed implementation concept as specified in this study resulted in nearly $20 million in selection, engineering, construction, startup, and overheads savings for a typical utility development project. Additionally, plant staffing and forced outage rates may be reduced while plant efficiency is increased. Challenges will include convincing development stakeholders to risk using new technology, marketing a new concept to a wider audience, and supporting project implementation differently. Use of this study as a reference to support marketing efforts will help lead to a successful implementation of the Bussed approach as an industry leading standard.