

Refinery-Wide Energy Optimization Model

Case Study

Summary

Valero Energy Corporation is one of the top refiners in the nation. The company owns 12 refineries throughout North America and is the largest independent refining and marketing company on the Gulf Coast. The Valero Houston refinery is mid-sized, with a throughput capacity of approximately 136,000 barrels per day.

In August 2002, the Valero Houston refinery began several energy performance assessments sponsored by the U.S. Department of Energy (DOE). The DOE Industrial Assessment Center at Texas A&M University performed an energy and productivity assessment, and DOE experts conducted a series of targeted energy system assessments. With cost-shared funding from the DOE, the Valero Houston refinery also began a plant-wide energy assessment, which included the development of a refinery Energy Optimization and Management System (EOMS) by Aspen Technology, Inc. (AspenTech). The EOMS will be used in assessing, implementing, and tracking results of the identified opportunities.

All of these assessments identified opportunities for energy performance improvements at the refinery. Plant engineers are reviewing and acting on these opportunities based on potential energy savings and capital availability.

Benefits

- Potential company-wide cost savings of \$7 to \$27 million per year.

Project Overview

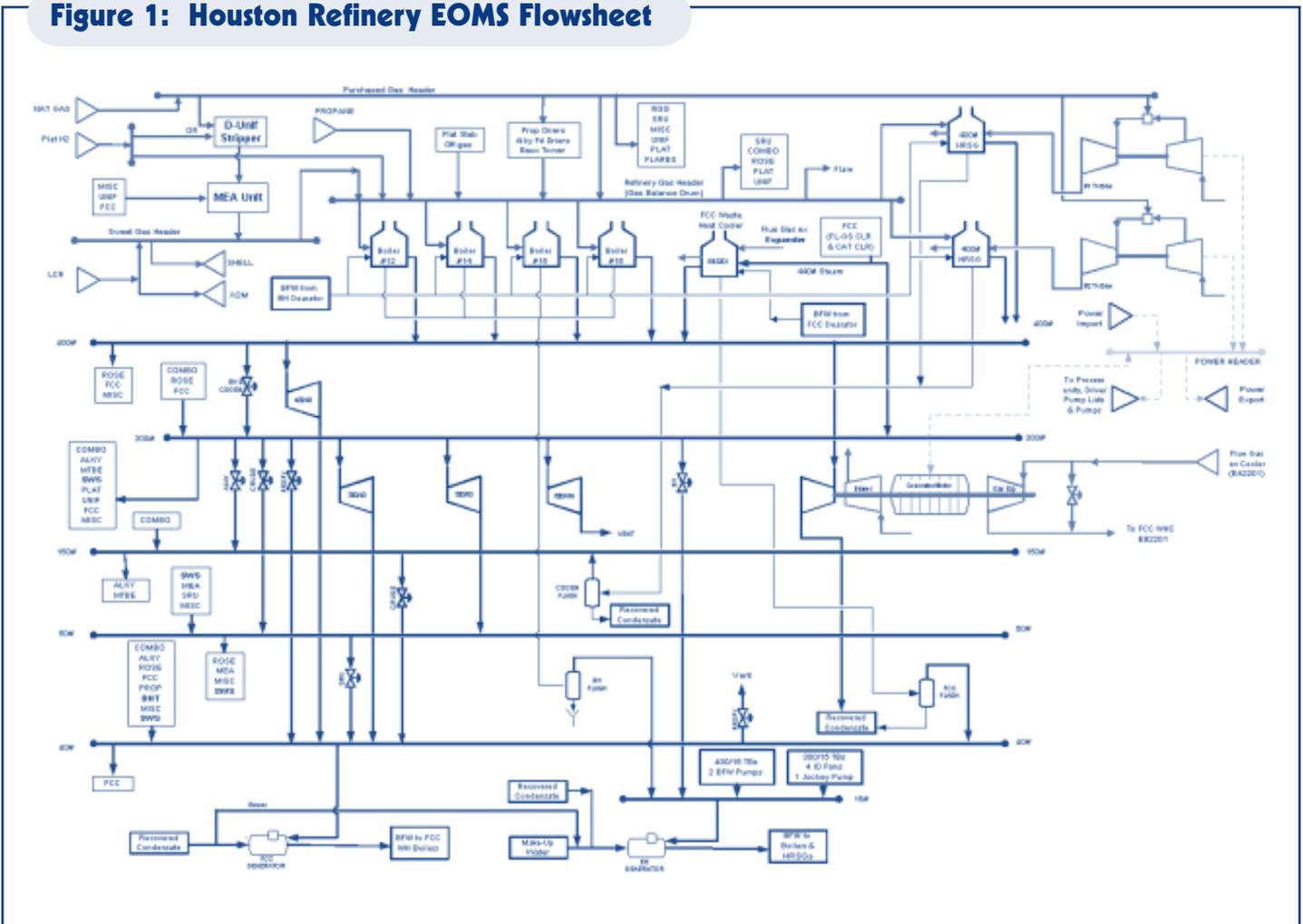
Valero's Houston refinery received cost-shared funding from the DOE to conduct a plant-wide energy assessment as part of the Texas Technology Showcase. To evaluate and track implementation of the identified opportunities, Valero hired AspenTech to design an EOMS, which is based on AspenTech's Aspen Utilities™ software.

Aspen Utilities™ is a model-based, equation-oriented simulation and optimization software tool. Within environmental constraints, it optimizes the purchase, supply, and usage of fuel, steam, and power at an industrial plant site. The software analyzes issues such as supply contract variability; alternative fuels; optimum loading of boilers and turbines; equipment choice; importing, self sufficiency, or export of electricity; and drive choice (motor or turbine).

Aspen Utilities™ uses a library of equipment models specifically developed for utility systems, which can be tuned with real-time data to reflect current performance at a specific site. The software integrates production planning, operation optimization, contract structures, and system constraints to construct a refinery-wide flowsheet as a single, rigorous model for use by refinery management. A Houston refinery example flowsheet is shown in Figure 1.



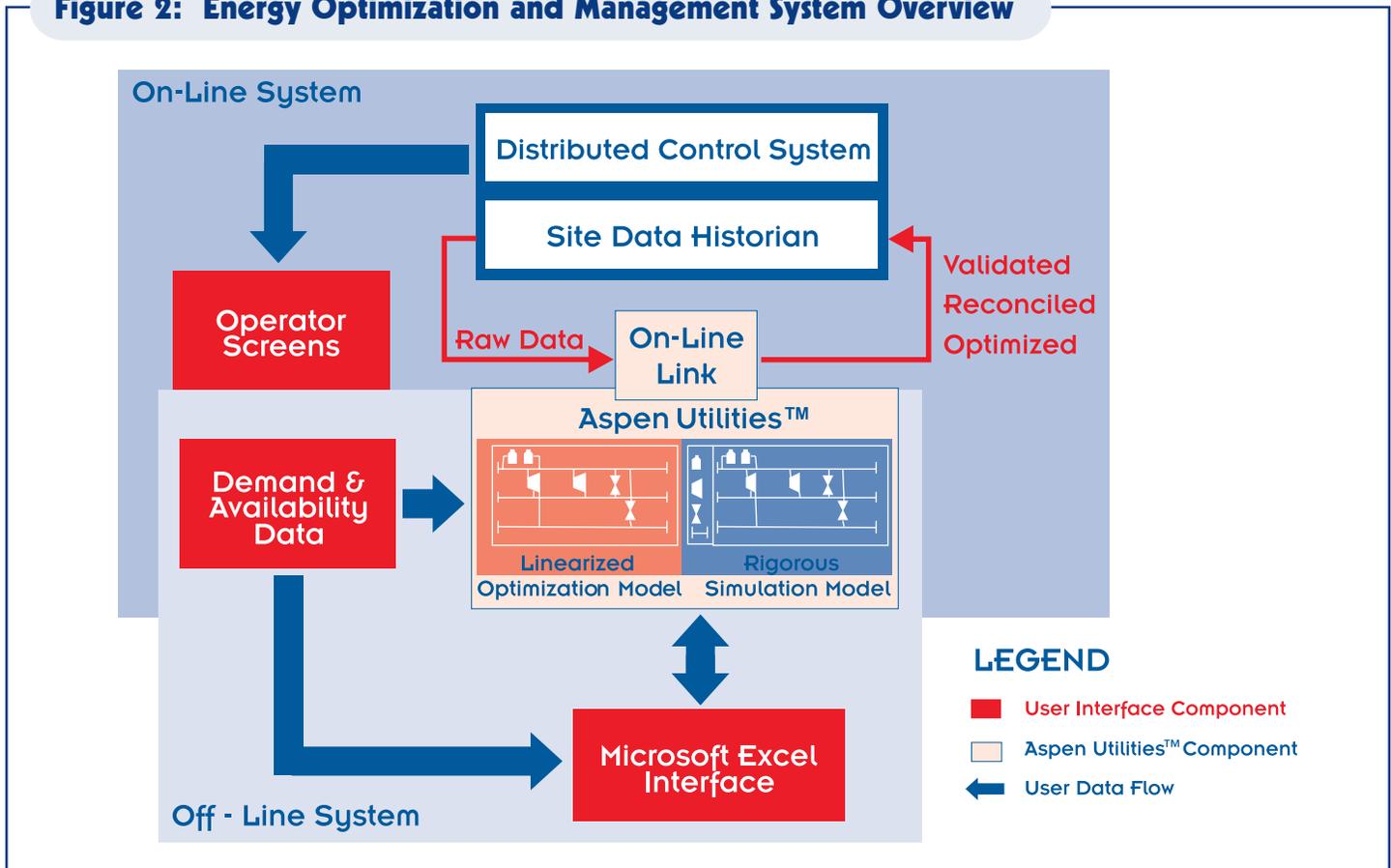
Figure 1: Houston Refinery EOMS Flowsheet



Aspen Utilities™ can be used both off-line and on-line. Off-line, the model is used for budgeting and planning, or for running “what-if” analyses to evaluate process changes or equipment modifications. On-line, the same model runs data validation and reconciliation routines prior to running an optimization sequence to guide operators. The optimizer determines the most economic method for meeting the refinery’s steam, fuel, and power demands by calculating

the optimum equipment line-up and load, subject to set constraints. Built-in equations provide information that can be used for performance monitoring (e.g., identifying metering problems and quantifying steam leaks). Additionally, the on-line system can provide information such as flow rates of unmetered streams. Figure 2 illustrates the flow of information through the facility and identifies on-line and off-line capabilities.

Figure 2: Energy Optimization and Management System Overview



Overall, the system is designed to perform the following functions:

- Facilitate optimal operations planning of utilities equipment.
- Assist in optimal operation of the utilities plant and associated equipment.
- Provide real-time information on site-wide energy performance, utility costs, and revenue.
- Provide real-time information for use in maintenance prioritization.

The Houston refinery EOMS is designed with the following plant-specific capabilities:

- On-line, open-loop/advisory utilities optimization that gives recommendations on the following:
 - Optimum electric power import/export balancing, including load allocation between the Cogeneration Unit gas turbines and the FCC Unit power train flue-gas expander and steam turbine.
 - Energy recovery from the FCC Unit regenerator flue gas, including optimum trade-off between electric power from the power train expander and steam generation in the waste-heat cooler.
 - Optimum configuration of the fuel-gas system, including selection of hydrogen or natural gas as the stripping gas in the Hydrotreater Unit, as well as recommendation on the use of propane to supplement the refinery gas.
 - Optimum load allocation between heat recovery steam generators and boilers.
 - Selection of steam turbine and electric motor drives.
- Off-line utilities optimization for planning and strategic development.
- Plant data validation and reconciliation with faulty-meter detection and reporting (limited to three steam headers and the fuel-gas distribution system).

Project Team

For the system to deliver sustained benefits to Valero, effective technology transfer from AspenTech to Valero is essential. The project is structured to involve Valero engineers as much as possible. Valero personnel's responsibilities include the following:

- Development of Excel graphics for the off-line model.
- Reviewing the model and testing the system for accuracy.
- Selecting appropriate tags (equipment variables) for reconciliation of data.
- Configuring the on-line version of the software, Aspen Online.

By staying heavily involved in the design of the EOMS, Valero personnel will become proficient in incorporating plant changes as they occur and expanding system capabilities in the future.

Project Implementation

The effort to develop and implement the proposed system will occur in three major stages as defined below.

Stage	Deliverable	Estimated Completion Date
Stage 1	Energy system review and user-requirements specifications	December 2002
Stage 2	Execution and delivery of off-line system	February 2003
Stage 3	Execution and delivery of on-line system	June 2003

To date, Stage 1 and 2 of the project are complete, with a refinery-wide assessment of all the energy-related systems at the refinery and delivery of the off-line system. The assessment provided the necessary information to define and begin development of the Aspen Utilities™ model. The primary use of the off-line system delivered at the end of Stage 2 is off-line planning and configuration of the utilities plant.

Future Plans

Valero's EOMS is designed for future expansion into other process and business areas. Valero plans to extend the EOMS by incorporating such functions as demand forecasting, performance monitoring, emissions monitoring, and cost accounting. Valero is using the Houston refinery to pilot test the energy model methodology and plans to replicate the refinery-wide energy model at its other facilities.

Savings

Valero Houston refinery expects significant economic benefits from refinery-wide implementation of the EOMS. Benefits will be realized through improved energy purchasing with lower contract prices, better adherence to contract terms to reduce penalties, maximized use of the most efficient equipment, accurate selection of fuel type, reduction of standby equipment and steam venting, and faster responses to problems.

Typical cost savings at comparable refineries are in the range of 2 to 8% of energy expenditures. If the EOMS performs as expected in all 12 refineries, it has the potential to save Valero \$7 to \$27 million per year company-wide.

The Office of Energy Efficiency and Renewable Energy of the U.S. Department of Energy conducts technology showcases to encourage industry adoption of energy efficiency technologies and practices. Replication throughout industry can boost productivity and help achieve National goals for energy, the economy, and the environment.

For more information, please visit our Web site: www.eere.energy.gov

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