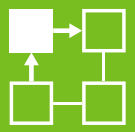

BPCL Mumbai Refinery Enhances Energy Management Using AspenTech Solutions

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The Challenge: Reduce Production Costs

India has set stringent targets for all refining companies in the region to reduce energy and water use. There are competing uses for these scarce resources, as well as global environmental concerns. This also coincides with business benefits applicable to all refineries worldwide.

Energy is often the single largest operating expense after raw materials for refining and petrochemicals, frequently starting out at over 50 percent of operating costs prior to energy reduction programs. Managing and optimizing these energy costs are critical capabilities for a refinery to meet profitability and sustainability targets. At the same time, companies need to improve the way they source, trade and use energy in an environment of increasing market complexity — brought about by events such as energy price volatility, increased refining complexity, the liberalization of world energy markets, emission taxes and carbon trading.

The challenge refiners face is to operate the utilities system with minimum cost and maximum reliability, while taking into consideration the constantly changing environmental, organizational and technical constraints.

Bharat Petroleum Mumbai Refinery (BPCL-MR) is in Mahul, India and has an installed capacity of 12 million metric tons per year. At present, the refinery is undergoing configuration changes to comply with the 2017 Auto Fuel Policy mandate for motor spirit (MS) and high-speed diesel. BPCL-MR has commissioned a continuous catalyst regeneration reformer to produce Bharat Stage (BS)-III and BS-IV MS, as well as a naphtha isomerization project to produce all BS-IV MS. The company has also recently commissioned a diesel hydrotreatment unit to produce BS-IV and BS-V fuel. Implementation has started for setting up a gasoline hydrotreating unit of 0.9 million metric tons per year to meet the 10 ppm sulfur specification for MS.

Changing the configuration of the refinery requires additional power and steam from the existing utilities system, which poses increasing challenges in day-to-day utilities planning. In addition, there are more stringent emission regulations, as well as a complex power supply and tariff arrangements, all of which influence utility choices. The change in configurations also places greater pressure on the overall utilities and refinery operating margins.

Typical challenges in the daily utilities planning include making decisions related to:

- How much steam to produce from each boiler
- How to react optimally to changing steam demand in real-time
- How to choose between turbine and motor drives for pumps and compressors
- How to optimize fuel mix to avoid exceeding sulfur oxide emission limits
- How to decide auxiliary firing for heat recovery steam generators (HRSGs)
- How to view steam balance and reconciliation in real time to address imbalances/surplus across process units
- How much should be own power generation and how much should be imported from the open grid
- How much power to generate in each gas turbine to achieve overall maximum performance efficiencies with steam balance and overall optimization

The Opportunity: Energy Management and Optimization

To address the challenges, BPCL-MR felt that it would be impossible to achieve optimal optimization without a tool that could model the complexity of the utility supply, pricing and constraints. Consequently, the company embarked on implementing a powerful model-based decision support system for utilities planning and optimization. The project, implemented by Aspen Technology, Inc, addressed the utility problem through an integrated combination of several of the company's innovative energy management and asset optimization software solutions:

- Aspen Utilities Planner™ (AUP) was used for supply-side utilities modeling, reconciliation and optimization, based on linear programming methods.
- Aspen OnLine® was used for the real-time online deployment of such models, automating the sequencing of data reconciliation and model runs.
- Aspen InfoPlus.21® (IP.21), a real-time "process historian" plant database, was used for big data storage and retrieval, and also to scale and support modeling and analytics.
- Aspen Process Explorer™ was used for web-based visualization of model and data key performance indicators (KPIs) useful for decision-makers, engineers and operators.

The project was started in March 2016. In January 2017, the system went live and was implemented as part of the refinery's daily business process. Designed to run both online and offline, the application facilitates the optimization of power plant operations and steam, heat and electric power utilization across the site and energy purchasing decisions.

Aspen Utilities Planner — Online System

The AUP Online Optimizer reconciles on an hourly basis the raw plant data coming from the refinery data historian (Aspen IP.21) and optimizes the utilities across the site. The optimized plan is published back into the Aspen InfoPlus.21 repository and can be accessed by users through Aspen Process Explorer KPI screens on the refinery local area network.

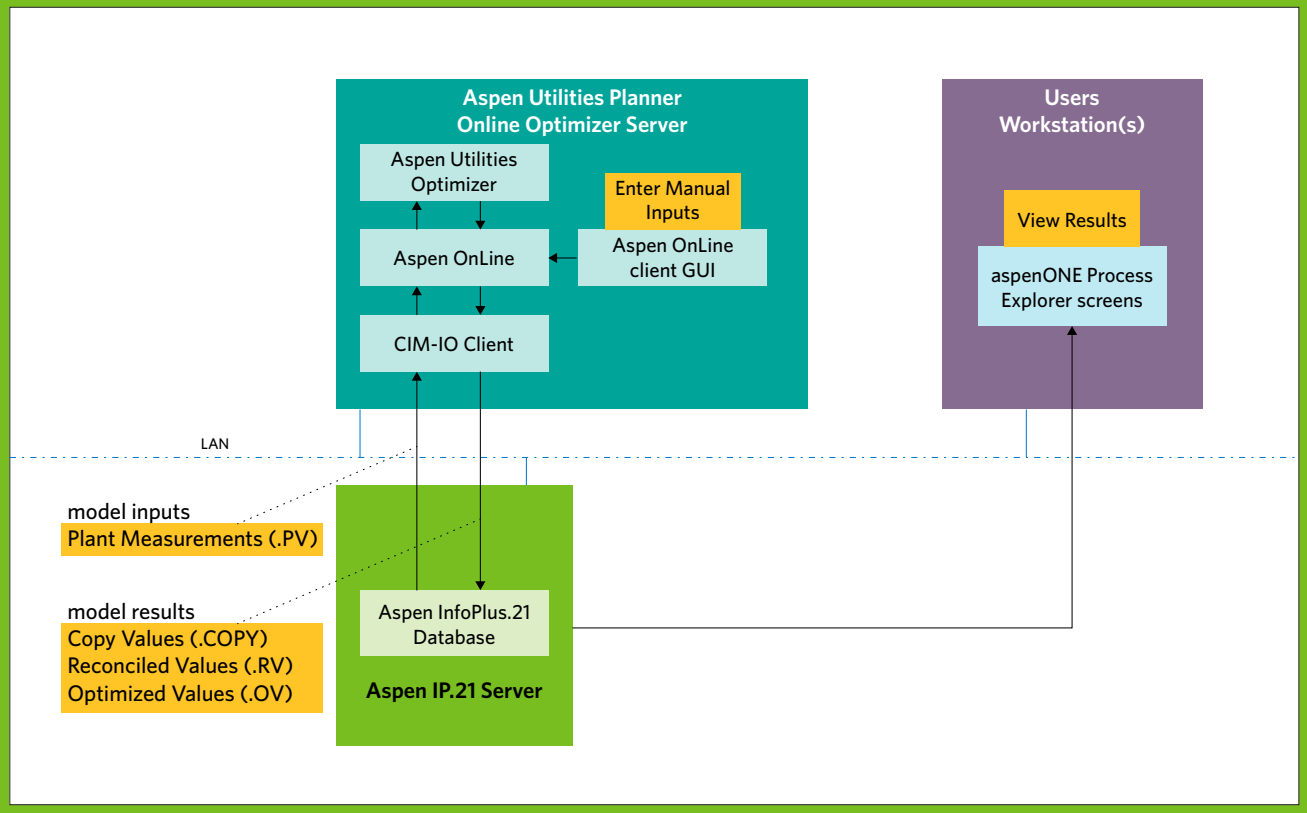


Figure 1:
Aspen Utilities Planner Online Optimizer system architecture

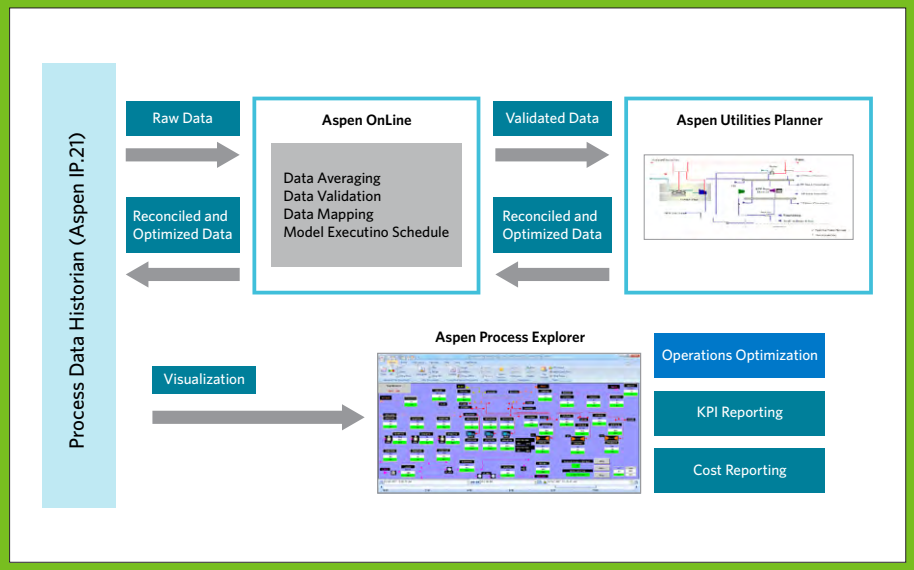


Figure 2: Aspen Utilities Planner online workflow

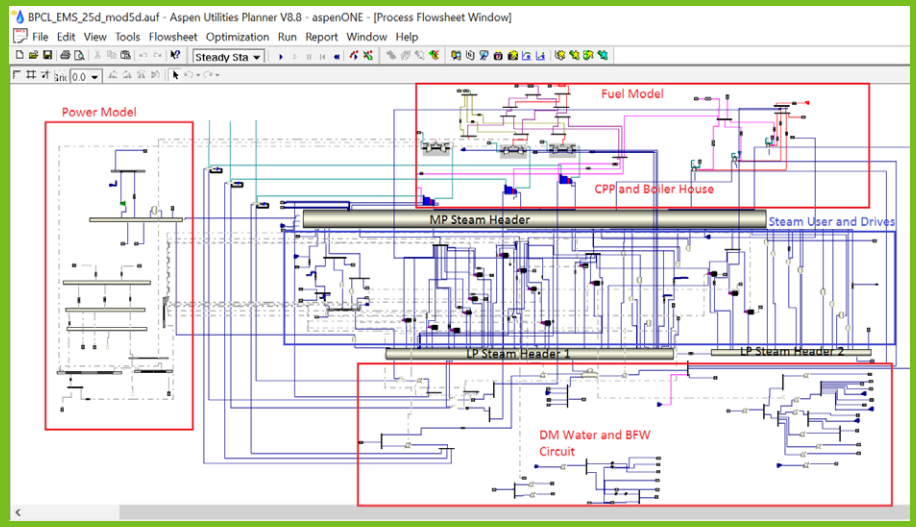


Figure3: Aspen utilities model

The scope of the AUP model includes all equipment at the refinery used for generation and distribution of utilities, including three utility boilers and three gas turbines with HRSGs. Also, all the pumps with the available energy supply options for drives (turbine, motor) are modeled in AUP. In addition, the overall steam, water, fuel network and power balance are configured in the model.

The application simulates and reconciles the model and provides optimized utilities plan based on the pricing data (and or models) and the equipment constraints. In other words, at a given time, depending on the energy pricing of each source and its availability and the demands of each equipment, the most efficient operating choice is made, based on the operating objectives. The objectives might be straight dollar efficiency, or they might incorporate regulatory and sustainability constraints or taxes.

Online System Screens — User Interface

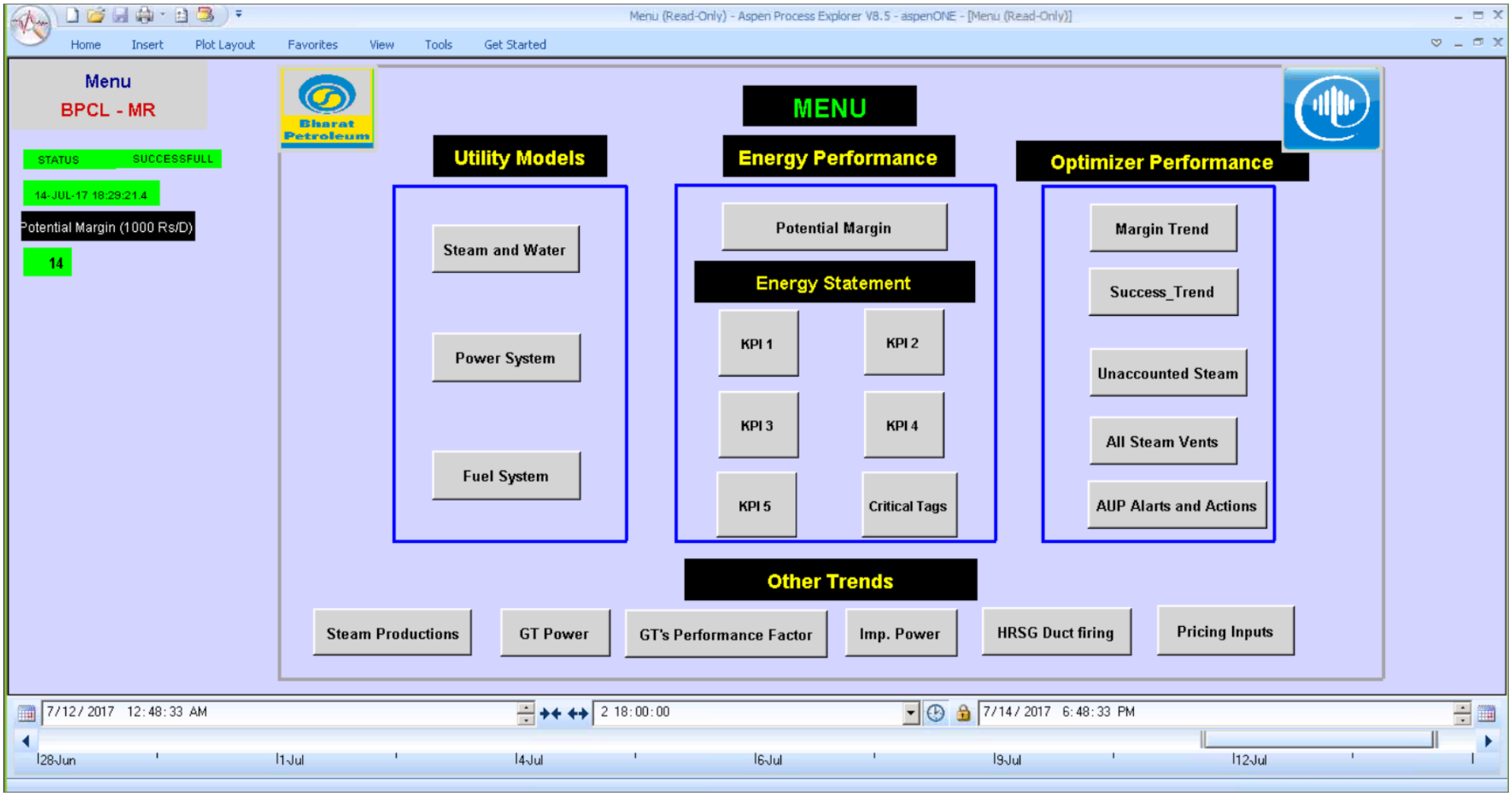


Figure 4: User interface — Menu

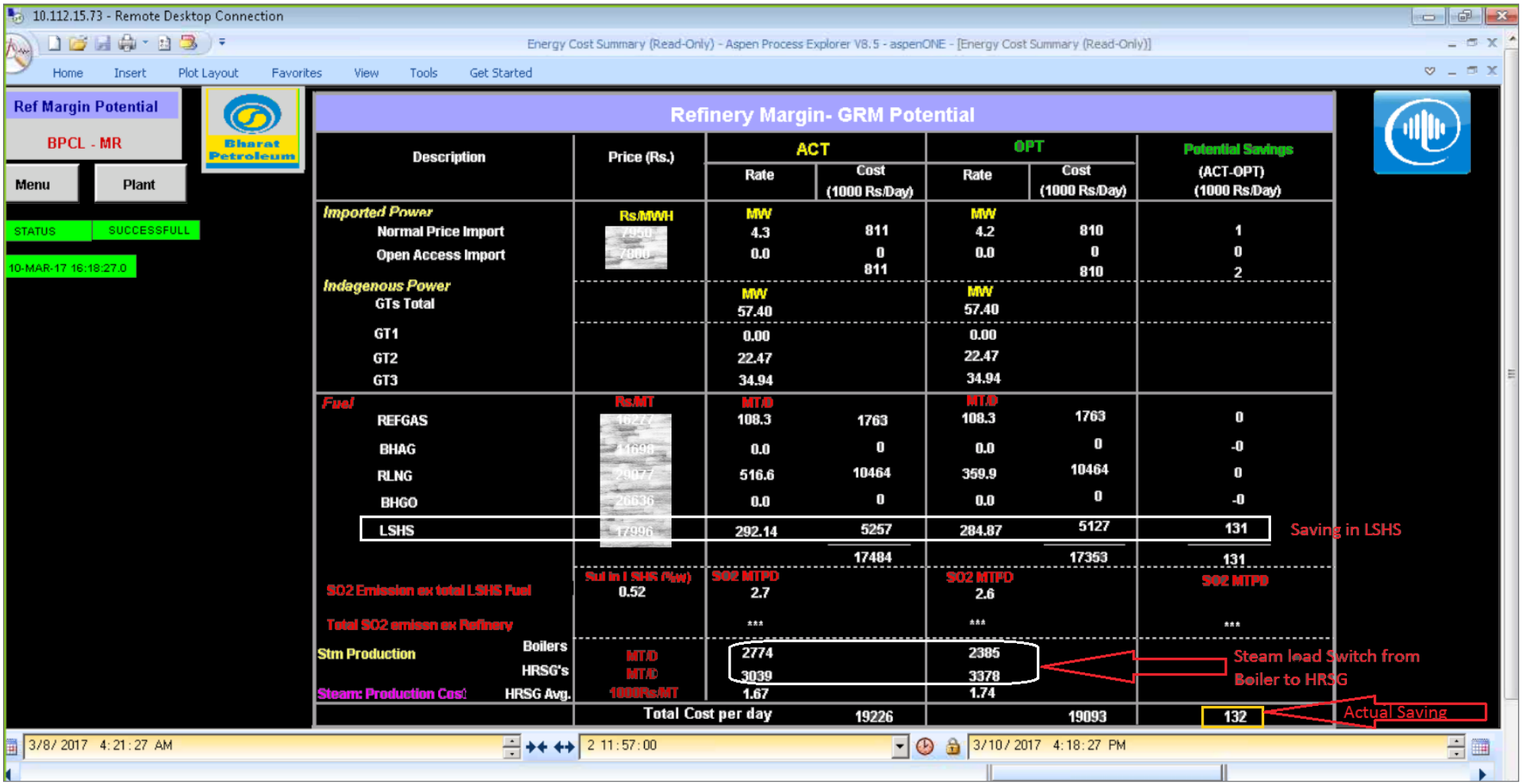


Figure 5: Energy cost report — Refinery Margin Potential Savings

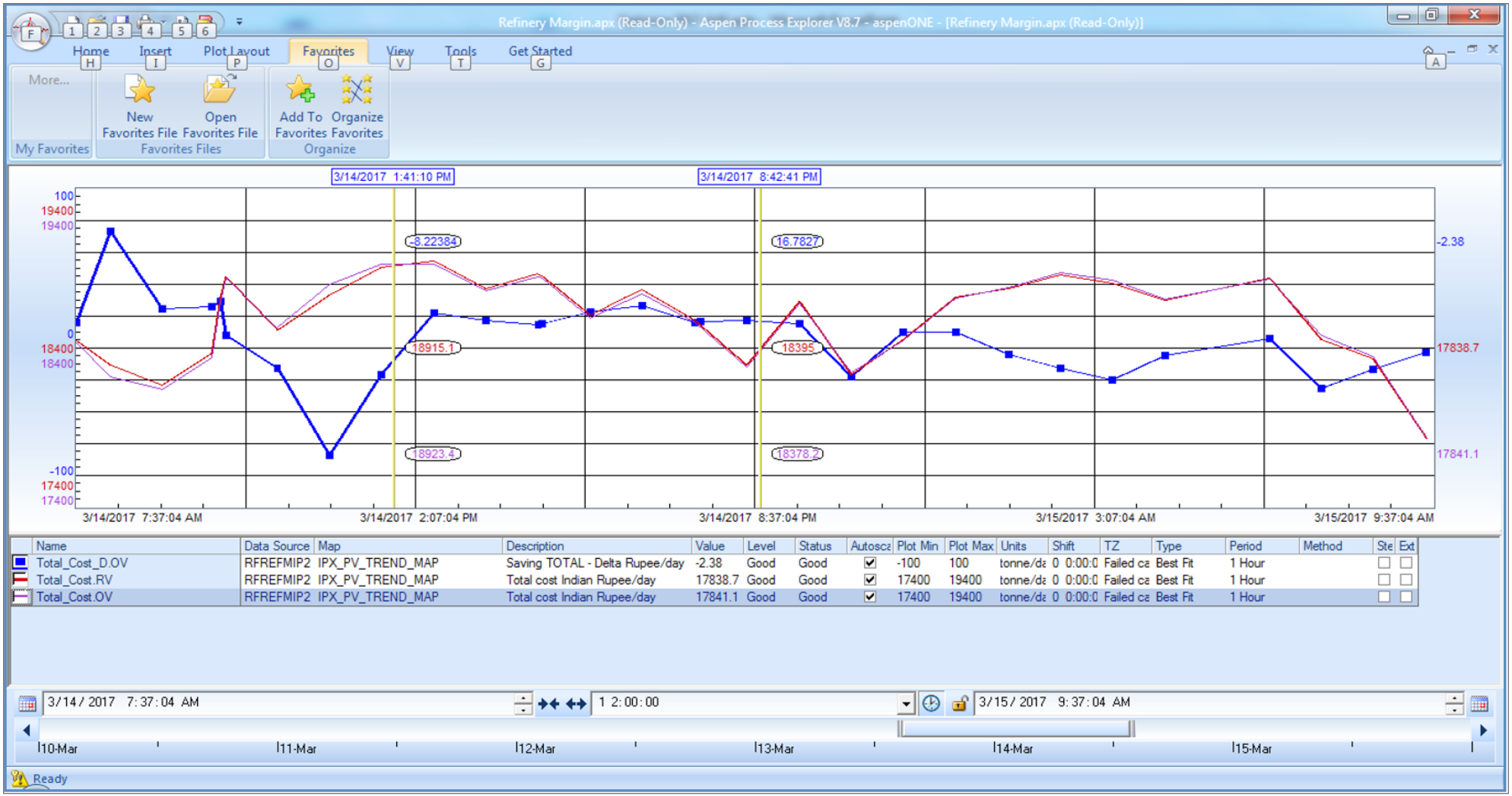


Figure 6: Reflecting actions — HRSG boiler load optimization, actual reconcile vs. optimized plan

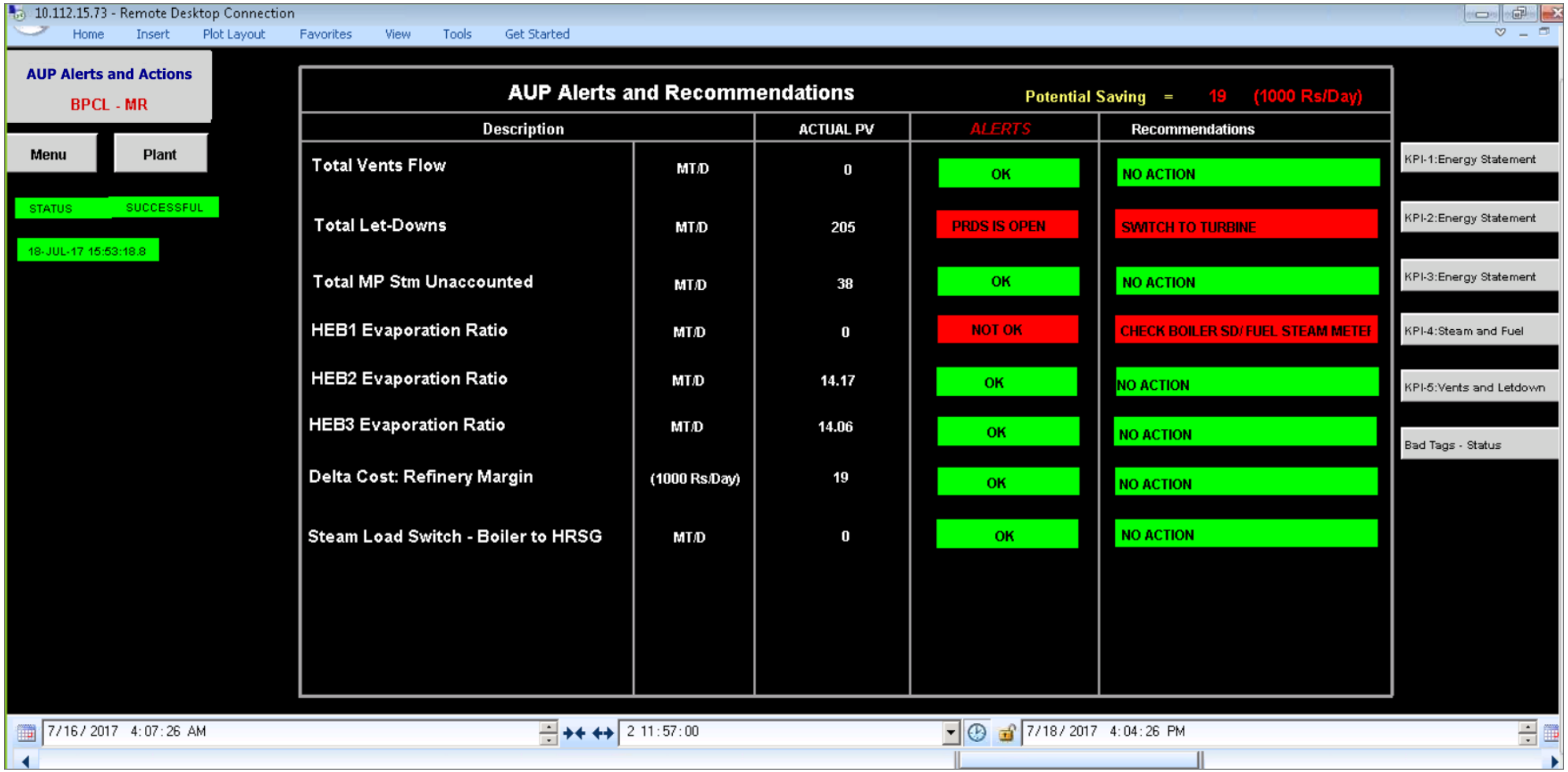


Figure 7: Aspen Utilities Planner — Alerts and Actionable Recommendations

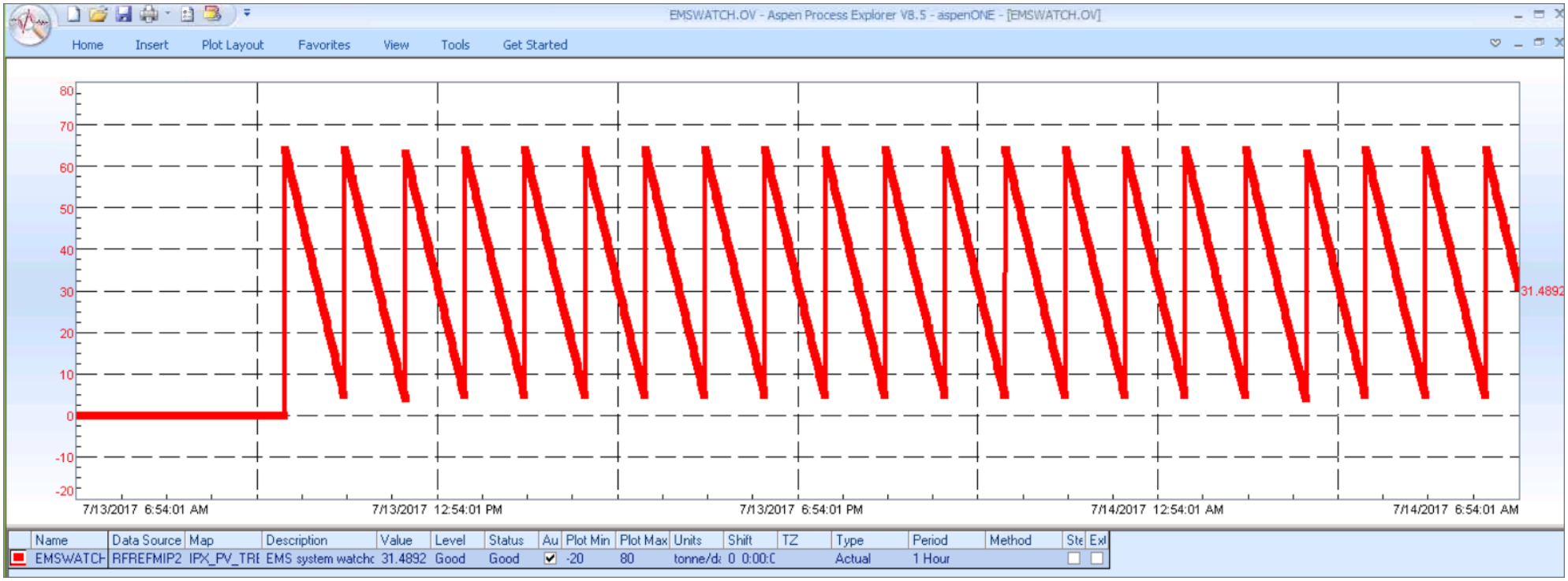


Figure 8: Model run status

Figure 9: Critical Tag/Meter Status

Online System Benefits

As shown in Figure 5, the Aspen Utilities Planner online system recommended, in the real PBCL situation being shown as an example, a shift of steam load from boilers to HRSGs by 300 metric tons per day, offering the potential savings of 132,000 rupees per day in low-sulfur heavy stock fuel. There are a number of significant qualitative benefits from the implementation of the AUP online system at BPCL-MR as well:

- Actionable recommendations to plant operators on how to reduce cost
- Reduced steam venting and minimized letdowns from high pressure to medium pressure to low pressure
- KPI reporting in terms of energy management statement or operational KPIs
- Reduced operating cost — optimization in fuel mix, boiler and gas turbine load distribution to achieve overall maximum possible efficiency for any given steam and electric demand from the process units

Aspen Utilities Planner — Offline System

A copy of the online model is used in offline mode to run "what if" scenarios for any shutdown and configuration related decision support. This is facilitated through custom-designed Excel templates that interface with the AUP model.

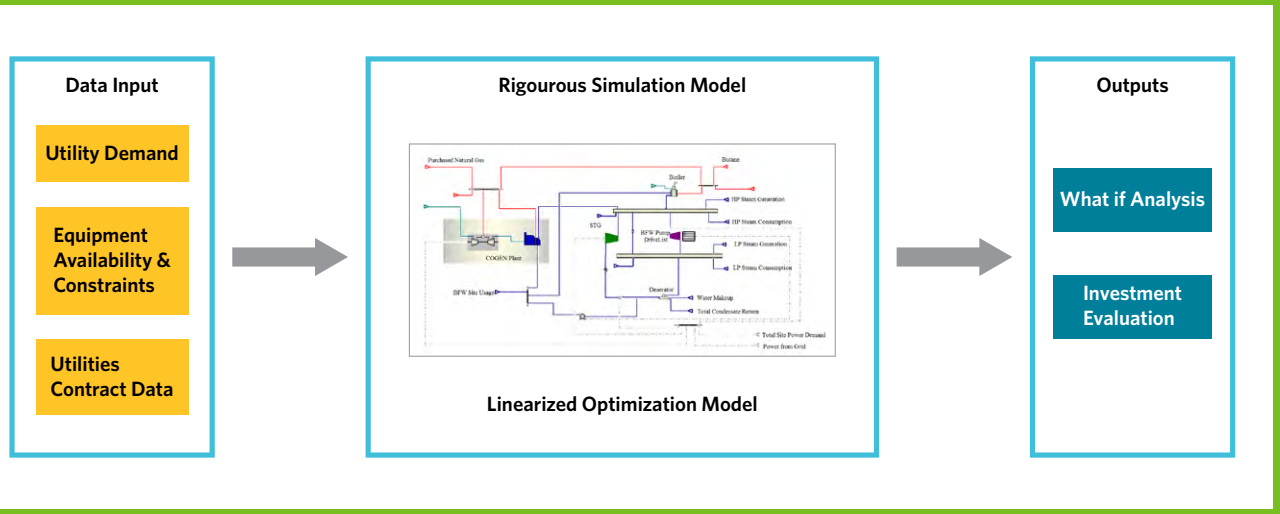


Figure 10: Aspen Utilities Planner – offline workflow

Using Aspen Utilities Planner in offline mode has brought the refinery some additional benefits:

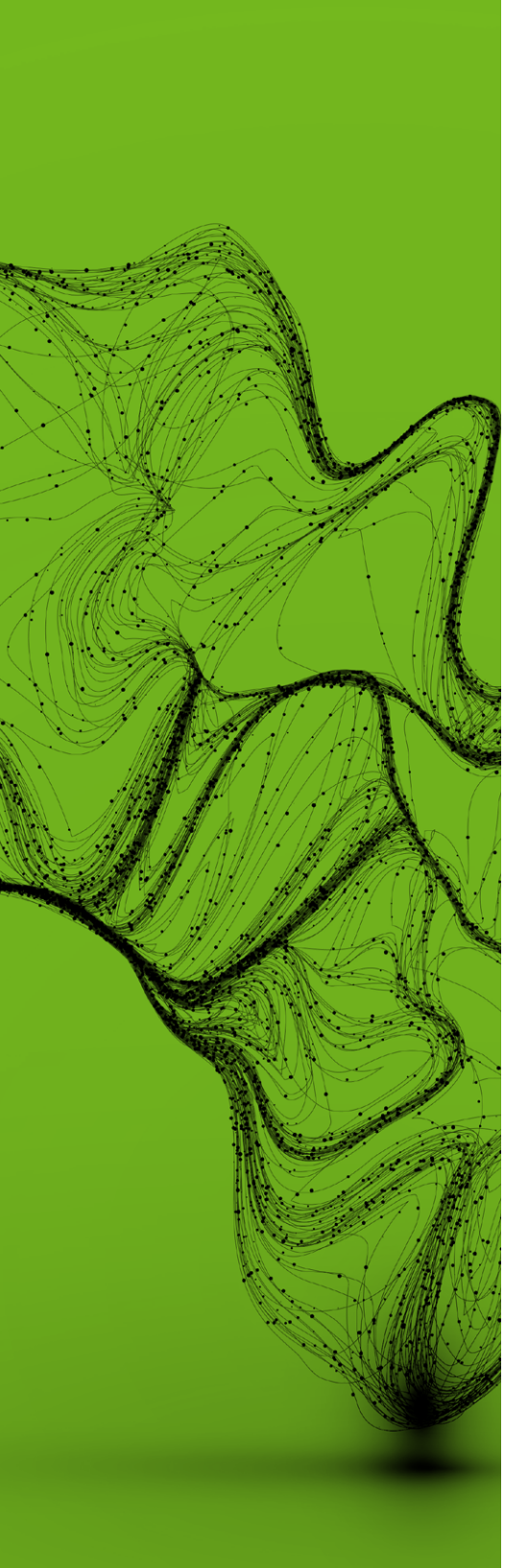
- Planning utility production based on forecasted process demands
- Producing nominations on a weekly or monthly basis for LNG suppliers
- Evaluating the impact on utility cost when production rates change
- Evaluating cost impact due to changes in utility prices
- Evaluating new contracts for utilities
- Evaluating optimum equipment usage during abnormal operation
- Carrying out "What if" analysis for:
  - Existing and new proposed configurations
  - Adequacy studies
  - Contract evaluation with LNG and power suppliers

Conclusion

The twin goals of minimum cost and maximum reliability in operating the utilities system can be achieved simultaneously with the implementation of an integrated energy management and asset optimization system, which links both business and operational objectives. Companies need to make more profitable decisions on how to use and source energy across the entire production site. Energy management needs to be carried out on a proactive basis, as part of the site operations.

The Aspen Utility Planner system, combined with a big data plant historian (Aspen IP.21), provided a rigorous and scalable solution to achieve these decision-making goals. The Aspen Utilities Planner and Online Optimizer as a system provides a user-friendly and state-of-the-art decision support system to help BPCL-MR achieve energy savings in real time, while also reducing operating costs and achieving higher refining margins.

BPCL is now looking at expanding the coverage of this program to other refineries. Other refiners in the region are looking at this success story as a recipe for addressing their similar needs.



About the Authors

Asawari Kelkar is a chief manager at BPCL-MR and a technical lead for various implementation projects. She holds a degree in chemical engineering from LIT Nagpur, India. Her professional experience includes implementing refinery planning models and advance process control, as well as utilities optimization.

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Sunil Patil is a director of business consulting at AspenTech in India. Sunil manages the overall Asia-Pacific Engineering Business Consulting team at AspenTech. He holds a degree in chemical engineering from Pune University, India. Sunil manages a team of technical sales support consultants who drive sales growth through deep technical skills and the ability to communicate business value at all levels of the client's organization.

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