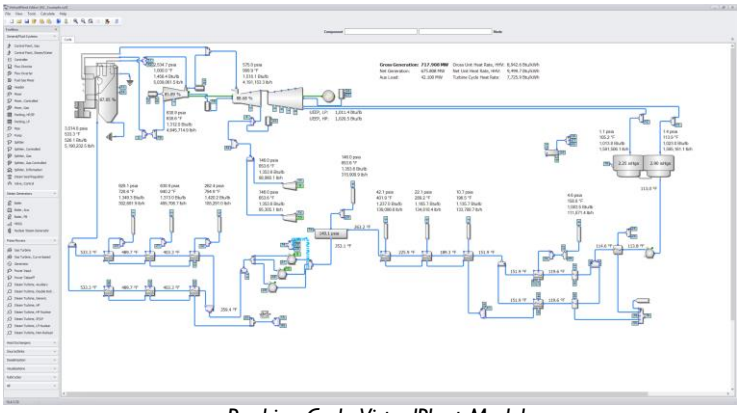
EtaPRO®

EtaPRO® VirtualPlant™

VirtualPlant™ is a modern software tool for building first principles thermodynamic models of power plant cycles. Using the latest Microsoft® software technologies, VirtualPlant conforms with today's secure data networks to provide real-time performance benchmarks from design and acceptance test data. With VirtualPlant, users can quickly and easily build first principles models of their specific power plant (conventional *fossil, combined cycle,* and *nuclear)* or desalination plant that work directly with EtaPRO. Multiple cycles can then be included within one model as SubCycles to provide more comprehensive results.

Customers use VirtualPlant on their computers to analyze plant performance problems, quantify the cost of equipment degradation, justify maintenance activities and capital improvements, and validate test data. EtaPRO's performance engineers use VirtualPlant for advanced applications such as on-line model-based performance targets, thermal audits, acceptance testing, and capacity and heat rate forecasting.



Rankine Cycle VirtualPlant Model

EtaPRO developed VirtualPlant to allow users to create detailed mass and energy balances for conventional fossil and combined cycle power plants. VirtualPlant models are an extension of the hardcopy heat balances provided by plant designers, and are better suited to the everyday needs of plant owners and operators since they can be adjusted to reflect actual operating conditions. VirtualPlant is in *off-line* mode for "what-if" analyses and in *on-line* mode for real-time prediction of plant performance. VirtualPlant models are used for:

- Real-time performance targets
- Real-time forecasting of plant capacity and heat rate
- Validating process data
- End-user interactive "what-if" analyses
- Evaluating steam path upgrades
- Evaluating boiler surface modifications
- Conducting thermal audits
- Supporting acceptance testing
- Correcting test results to reference condition basis

How VirtualPlant Can Help You

VirtualPlant models allow the impact of operating and maintenance activities on heat rate and capacity to be quickly and accurately quantified. Examples of "what-if" analyses include:

Fossil Plants

- Changes in feedwater heater performance (TTD, DCA, bypassing)
- Rerouting of drains and leakages
- Changes in throttle steam conditions
- Changes in fuel constituents
- Changes in condenser pressure, cleanliness, cooling water flow, or temperature
- Changes in excess O2 & burner level loading
- Evaluation of boiler surface changes
- Evaluation of steam path upgrades
- Increases in turbine seal clearances/leakages
- Miscellaneous leakages to the condenser

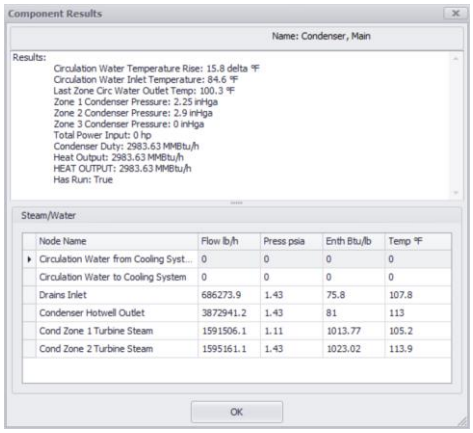
Combined Cycle Plants

- Varying ambient conditions
- Changes in fuel constituents
- Changes in evaporator effectiveness and operation
- Changes in condenser pressure, cleanliness, cooling water flow, or temperature
- Changes in duct burner flow
- Changes in HRSG section effectiveness
- Bypassing individual HRSG sections
- Changes in turbine section efficiencies
- Increases in turbine seal clearances/leakages
- Miscellaneous leakages to the condenser
- Changes in condenser tube materials
- Inlet fogger operation

VirtualPlant models are readily built from "scratch" or you can start with one of our sample cycles. Each component is characterized with its design information and then interconnected by "drag-and-drop" techniques.

EtaPRO™ VIRTUALPLANT™
THERMODYNAMIC MODELING FRAMEWORK

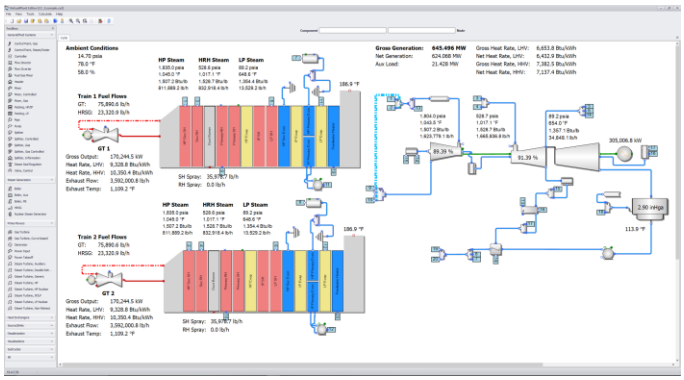
Boundary and operational conditions are set, and when executed, the model converges to a solution where energy and mass are conserved for all components and the overall plant. Results may be viewed by clicking on a component and selecting "Results" (as shown below), or by printing a report.



Detailed Component Results

Combined Cycles

Combined cycles can be modeled in any number of configurations, including 1x1x1, 2x2x1, etc. Gas turbines can be modeled using manufacturer's curves or with individual compressor, combustor, and turbine components. The heat recovery steam generator, often the most challenging component to model, is easily configured using the VirtualPlant HRSG wizard.



Combined Cycle VirtualPlant Model

Real-time Operation

VirtualPlant models can be installed on a computer running the Windows™ operating system. Models can be initialized with current process data from your EtaPRO System to speed analysis of real-world problems. Models can also be executed in real-time in combination with your EtaPRO System. VirtualPlant's built-in OPC client/ server allows data to be retrieved and sent directly to the EtaPRO Server.

Parametric Studies

Parametric studies allow VirtualPlant models, stored either local or on the EtaPRO server, to be run against multiple sets of model inputs through a Microsoft Excel add-in. Results may then be referenced directly within Microsoft Excel for further analysis.

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