

# Thermodynamic Modeling & Optimization

## Industrial Data Analytics

### Introduction

In order to have a meaningful understanding of the performance of a power plant, it is important to have a detailed physical model of the individual components that contribute to the plant's performance in addition to an overall model of the entire plant.

For such analysis thermodynamic models based on first principles are built using GE Energy's GateCycle software or Simtech's IPSEpro.

Due to the flexibility of the software, such thermodynamic models can be built for any manufacturer's equipment (e.g. GE, Siemens, Alstom, Hitachi, Mitsubishi, etc.). Site-specific & component specific design data are used to build these models and they are further tuned to match the performance of equipment at site to ensure accuracy. Such models can be used for -

- Real time thermal performance analysis
- "What-if" performance simulation
- Accurate heat rate and generation forecast
- Estimation of component level degradation - quantify the monetary impact of degradation on power and heat rate
- Thermo economic analysis
- Feasibility studies
- Performance optimization

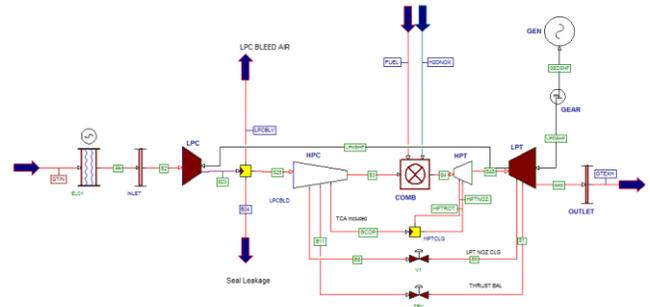
### Modeling Capability

Various major equipment of power plants can be modeled to the component level -

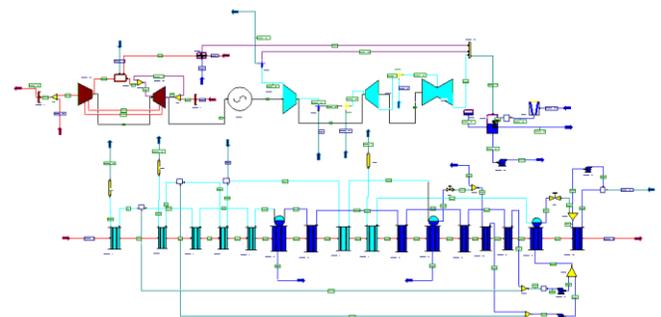
- Industrial Gas turbines, Aero-derivatives
- Single shaft / Multi shaft combined cycle
- HRSGs (fired & unfired, once through)
- Steam turbines
- Condensers, Cooling Towers
- Major Pumps & Fans
- Coal Boilers, Aux Boilers
- Heat Exchangers / Feed water heaters
- Gas Compressors

Sample thermodynamic models built using GE's GateCycle software-

### Simple Cycle



### Combined Cycle



# Optimization

## Operational Optimization

Optimization is maximizing or minimizing an objective function for a given set of constraints.

In power industry many plants with multiple generating machines often run at part load. Such part load operation could be due to fuel or load restriction or any other operational constraints.

In such operating modes, identifying the “optimal” load setpoints of respective generating machines helps save significant amount of money.

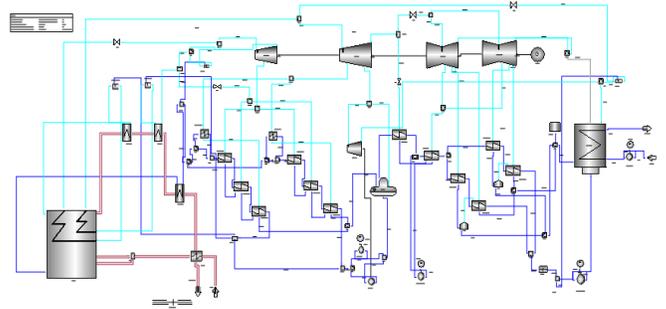
## Maintenance Optimization

Every outage involves various maintenance activities. Typically, in Power Industry, maintenance\planning engineers try to make the best out of scheduled outages and try to keep the down time to a minimum.

However, OEMs do not provide tools to plants that can advise them on the best time and duration of an outage based on the thermal performance of all major equipment and the best combination of maintenance activities they can perform within the given constraints

**We use powerful non-linear solvers to solve such problems and build custom optimization solutions based on customer requirements**

## Coal fired plans



## Nuclear Power Plant (secondary cycle) – modeled using IPSEpro

