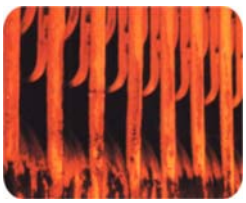
Cycling ⬍ Advisor™

Providing Guidance on Cycling Strategies as Input to Real-Time Dispatch Programs



Background

Growing interest in Smart Grid and renewables should cause utilities to reevaluate how they optimally dispatch their fleet of power plant units. In recent years, many utilities have been concerned that generation unit costs, and in particular, the wear-and-tear aspects of cycling costs, have not been well understood and estimated. Wind, solar, fuel prices, market conditions, and renewables have caused many fossil units to be cycled much more extensively than what they were originally designed. This has led to higher forced outage rates, increased maintenance costs, and larger capital replacement costs for these units.

In response to this issue, some utilities have spent significant resources determining the cost of cycling each of their units. Once this investment is made, it is important that utilities use the valuable results to reduce future system costs. We believe there are two important first steps in doing this:

1. Tuning the plant cycling operations via improved cycling procedures
2. Improving system dispatch and operations planning

Cycling ⬍ Advisor addresses the second of these two steps.

Current Status of System Dispatch Models

There are a number of system dispatch models in use by electric utility dispatchers. These models were developed with the objective of determining optimum hourly dispatch schedules with unit fuel costs, heat rates, and operational constraints, the primary factors in determining the optimum schedules. More recently, with the increases in market interchanges and complex purchase and sales contracts, significant effort has been put into better modeling of energy and capacity transactions. One area that has not been seriously looked at by most utility dispatchers and unit commitment vendors is the damage or wear-and-tear rates caused by varying generation unit operation practices, including on-off cycling, load following cycling, load changes with varying MW ramp rates, load following at varying load depths, higher than rated capacity operation, and minimum load operation. The design of the current system dispatch models does not include capabilities of modeling these damage rate factors other than allowing for "startup costs."

Inclusion of damage costs for all the various operational options listed above in the current system dispatch models would be a major task and would undoubtedly require hundreds of thousands of dollars and more than 1 year of time. This type of resource commitment would be needed for each unit system dispatch model being used, thus, the costs are not easily shared among utilities. For this reason, Intertek

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developed a new type of dispatch program which includes all the damage-as-a-function-of-operations factors listed above, while also accounting for the other major fuel, heat rate, operational constraints, and transactions factors. We call this program "Cycling◆Advisor."

Cycling◆Advisor is unique in its ability to include equipment damage rates for all types and characteristics of cycling and MW operation levels in developing optimal system dispatch schedules. This tends to lower plant damage and total combined fuel and damage costs while meeting system loads.

What Does the Cycling◆Advisor Do?

Intertek's Cycling◆Advisor seeks to find the lowest system cost hourly or minute dispatch schedule taking into account all major cost factors, including generation equipment wear-and-tear. It is currently set up to run over different study horizons - 10 day period to 1 year runs. Such periods allow Cycling◆Advisor to capture various scenarios, such as high/low loads, seasonal variability, cycling costs, and production costs. Its output includes hourly load levels of each unit, the number and characteristics of each cycle type (e.g., starts, load follows, equivalent hot starts), total system costs including "wear-and-tear," fuel, and net purchase/sale proceeds -- all for the lowest cost dispatch schedule found by the program.

Cycling◆Advisor uses an advanced numerical technique called "simulated annealing" to seek the optimum dispatch schedule over a 10-day or 1 year period. This technique allows for very complex, nonlinear cost functions, and makes use of the ability of high speed computers to scan many possible solutions and efficiently hone in on the optimal, low cost solution. Intertek uses its proprietary damage model, the LOADS model, to provide wear-and-tear rates of each operation scenario tested as a function of load change magnitudes and ramp rates of each generation unit.

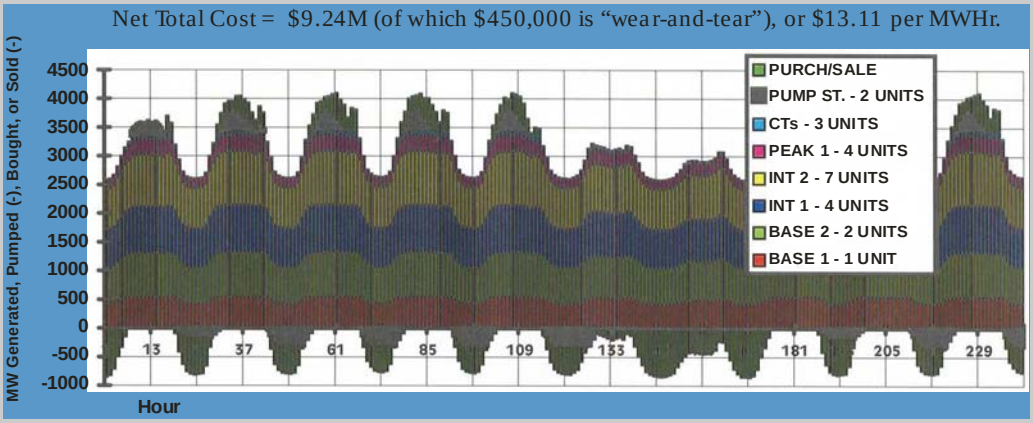
Also included in Cycling◆Advisor's cost algorithm is the heat rate impact model developed for each unit in the utility's system, which includes the standard heat rate impact of changed load levels, as well as the complex dynamic heat rate effects caused by inefficiencies due to changing load levels. This model is calibrated for each unit using monthly fuel burn and operations data over several years of past operation.

Cycling◆Advisor has the capability of modeling energy transactions of varying types. However, we must fully understand the various transaction contracts and market price structures currently in effect at utilities in order for them to be properly modeled in the dispatch and cost algorithm. Thus, detailed modeling of its energy and capacity transaction opportunities is typically part of Intertek's proposal to develop and apply a system-specific model.

Figure 1 shows an example system dispatch output for a hypothetical utility. Other Cycling◆Advisor outputs include tables of hourly dispatch for each unit and period summaries of all major cost factors (e.g., wear-and-tear, fuel).

What Are Cycling◆Advisor's Applications?

Currently, Cycling◆Advisor is being used to provide guidance on cycling strategies as input to real-time dispatch programs. In other words, the Cycling◆Advisor is used on a daily or weekly basis to provide guidance on optimal dispatch schedules, including wear-and-tear costs. The actual interface between Cycling◆Advisor and the real-time dispatch program may be detailed ramp and load level constraints that would minimize total system costs over the dispatch period. This application of the program can save millions of dollars per year in overall costs.



Other applications of the model include:

- Testing of alternative ramp rate constraints in terms of damage costs (i.e., what are the damage cost implications of a specified ramp rate for specific units?)
- Testing of alternative load levels for power plant load follow cycling
- Determining the overall system cost impact of putting a tight operational constraint on one unit or a small set of units
- Determining optimal pricing of energy purchases and sales with consideration of all system cost impacts
- Determining the optimal minimum load for a power plant
- Evaluating the value of a new resource, including the negative wear-and-tear impacts of a new must-run baseload resource or run-of-river hydro-type unit and the positive wear-and-tear impacts of a storage resource like pumped hydro
- Developing units missions and budgets (e.g., projected number of hot, warm, and cold starts, base load rating, load cycles per year)
- Smart Grid and renewable (wind and solar) integration effects on the fleet of power plants