Improving Profitability Through APC Benchmarking

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Advanced process control (APC) benchmarking can help identify and quantify GAPs in a site's advanced process control deployment and their performance. With this information, you can develop a plan to direct resources to close those GAPs and capture additional value. Participating in an APC Benchmark Survey will provide you with data to make better decisions that will improve your site's profitability.

"You can't manage what you can't measure."

– Peter Drucker

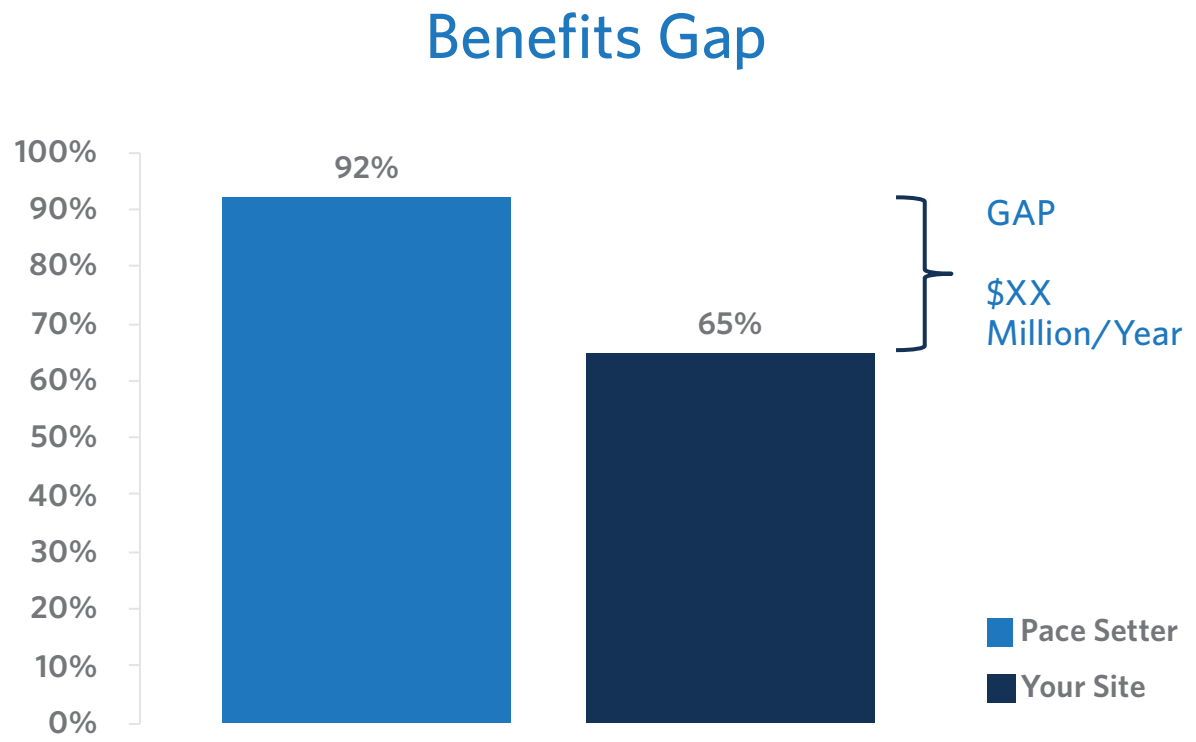

Figure 1: Once GAPS have been identified, the closing of those GAPS can be quantified.

Why Benchmark

The process industries comprise many diverse site configurations — no two chemical plants or refineries are alike. A method to benchmark these diverse sites needs to be industry- and technology-agnostic, independent of size and complexity, and allow a site to track their performance versus other similar sites anonymously. A good benchmarking study should show where you are doing well and where potential improvements can be made.

APC Benchmarking comprises multiple KPIs to help identify key APC GAPs such as % benefits achieved, APC Score, Coverage Score, Scope Score, On-Stream Time, Controller Effectiveness and Technology Score

% Benefits Achieved

Each process unit's benefits are derived by the percent the controller is on while allowing all the manipulated variables (MVs) degrees of freedom to push the unit to its economic optimum. There are a number of factors that impact a unit's controller effectiveness: operator training, controller technology, controller design, controller maintenance, instrumentation and regulatory loop performance. In addition, the controller's scope can impact the % benefits achieved. In order to reach a unit's true potential, the controller needs to be designed to be unit-wide.

APC Score

APC Score is industry- and technology-agnostic, independent of size and complexity, and an overall APC key performance indicator (KPI). As Figure 2 shows, it has a strong correlation to the amount of benefits being achieved; therefore, improving your APC Score will directly improve your site's profitability.

Drill Down for More Information

Breaking down the APC Score into its components helps identify where these benefits are being lost — **whether it is from incomplete deployment across units, inadequate controller scope, reactive maintenance practices or lack of enabling technologies to improve engineering productivity.**

Coverage Score

Incomplete deployments will show up in the Coverage Score. This KPI is the percentage of units that could have APC, and have APC deployed. For example, if a site has 10 units to which APC can be applied, but has only deployed APC on four units, then that site's Coverage Score would be 40.

To improve a site's coverage score, it must embark on an APC adoption program to accelerate benefits accrued through the implementation of APC.

Scope Score

Site Scope Score is the average of all individual unit Scope Scores. A unit's Scope Score is the percentage of MVs a unit should have, versus the controller's current design. This KPI checks to ensure the controllers are designed to be complete unit-wide controllers. For example, if a unit's full APC potential scope is 30 MVs, but the current controller design is only 15 MVS, then that unit's Scope Score is 50. If the unit does not have APC, it is not included in the average Scope Score.

A low Scope Score can be improved through controller redesigns and revamps.

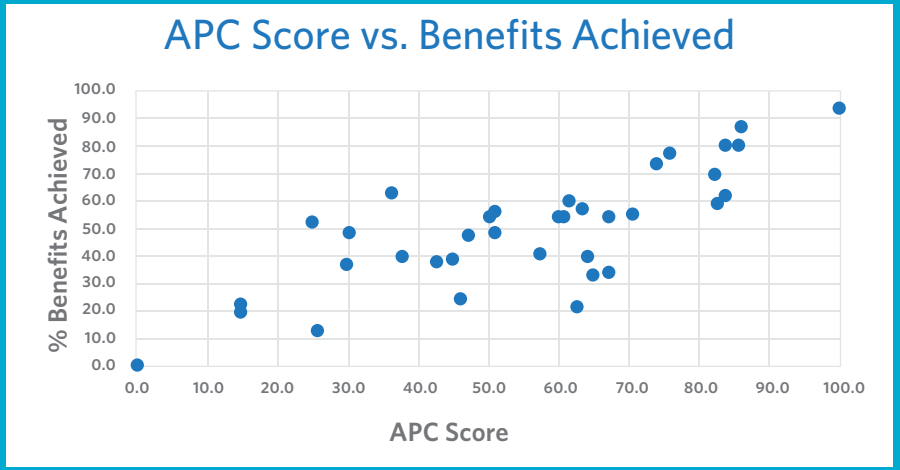

Figure 2: A better APC Score means more benefits, which lead directly to greater profits.

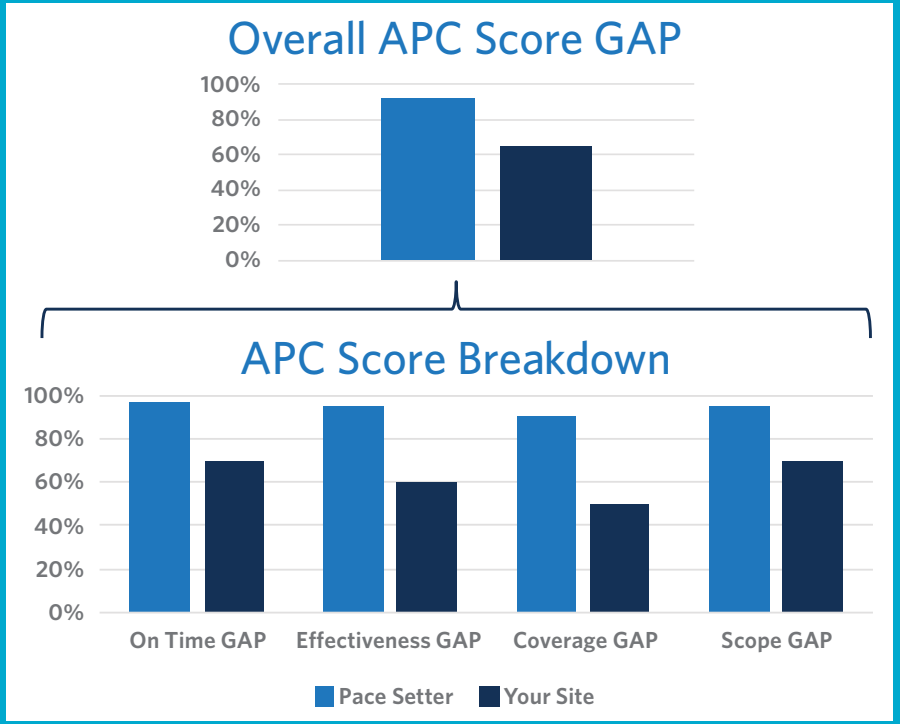

Figure 3: Breaking APC Score into its components helps locate where benefits are being lost.

On-Stream Time

On-Stream Time is the percent of the time the controller is on when the unit is available. The unit should be considered unavailable during these possible conditions:

- The unit or part of the unit is down or is in a startup or shutdown mode.
- Some of the process equipment is damaged and will be repaired in the short term. Plans to operate for a long duration with damaged equipment should be considered available, and a retest performed.

Controller Utilization

This KPI shows how unconstrained the controller is, allowing it to reach the economic optimum.

- Use data only when the controller is on (ONSTS)
- Count the number of controlled variables (CVs) at high/low limit, setpoint, ramp or external targets (CCS)
- Count the number of MVs at external target or engineering limits (MFU)
- Count the number of MVs at minimum movement, wound up, in bad status or taken out of service by the engineer (MOK)
- The actual number of MVs in the controller (IPMIND)
- Unit Utilization = (CCS + MFU + MOK) / IPMIND * 100
- The site's utilization = Average of the unit utilizations

Controller Quality

This KPI quantifies how well the controller is predicting the controlled variables (CVs). Choose an equal number of CVs as MVs that are the most typical constraints.

- Use data only when the controller is on (ONSTS).
- For each CV, calculate its baseline standard deviation (CVSD) with the controller off. CVSD could be calculated before the project has commenced, or when the controller is off.
- For each CV, calculate its dynamic performance factor (DPF). DPF = 2*[CVSD – average of the absolute value of the (variable – its steady state target)]/ CVSD
- The Controller Quality KPI is the average of all of its CVs' DPFs.
- The site's Controller Quality is the average Controller Quality of all the units that have APC.

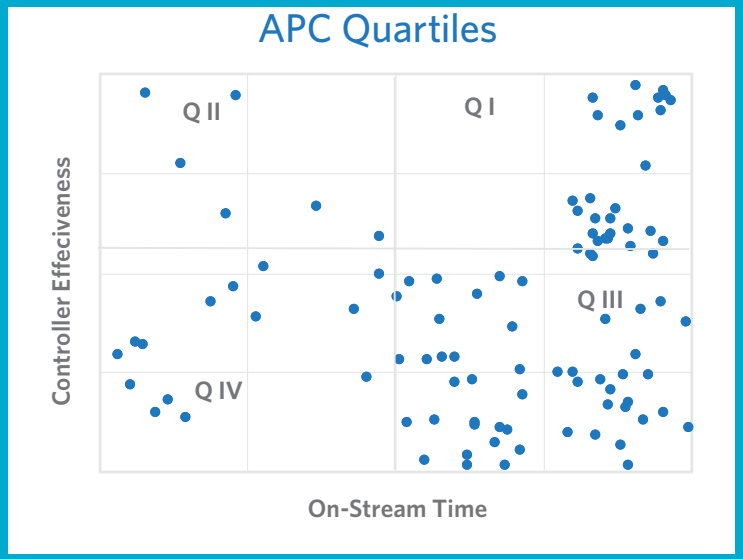

Figure 4: On-Stream Time tracking is not enough; you need to have effective controllers on.

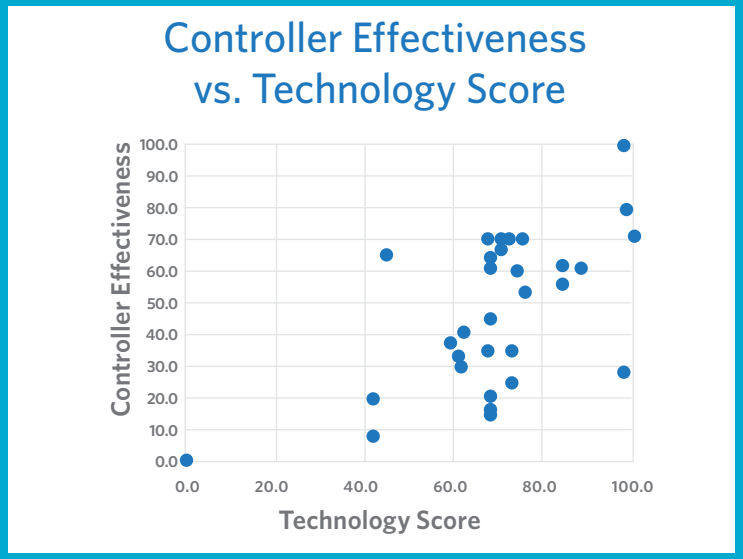

Figure 5: More advanced APC technology leads directly to greater Controller Effectiveness.

Controller Effectiveness

Controller Effectiveness is an important KPI, since it directly relates to the benefits being achieved. It should be an online KPI that will show how the controller is performing.

A unit's Controller Effectiveness is its Controller Utilization multiplied by its Controller Quality. The site's Controller Effectiveness is the average Controller Effectiveness of all units that have APC.

Either of these KPIs can be used for the Controller Effectiveness.

Causes of low Controller Effectiveness can be:

- **Bad controller design.** The original scope and/or tuning was not done adequately.
- **Operational mode has changed.** The controller was designed for one mode, and the unit is operating in another, and the controller has not been updated, causing the operator to clamp the MVs.
- **Poor APC technology.** The core APC technology cannot handle the problem, or lazily responds to disturbances, and operators clamp the MVs to keep the controller stable.
- **Lack of maintenance.** The process has changed, and the models don't match current operation, causing the operator to clamp the MVs to keep the controller stable.
- **Operator acceptance.** Operators do not trust the controller. Therefore, they clamp the MVs.
- **Equipment issues.** The plant is operating in an unusual operating envelope. Depending on the length of time the issue is expected to exist, a retest might be necessary.

Controller design and maintenance has a significant impact on Controller Effectiveness. Utilizing advanced adaptive technologies helps increase Controller Effectiveness by enabling proactive maintenance programs. As Figure 5 shows, technology score has a direct correlation with Controller Effectiveness.

Technology Score

This KPI is based on how much advanced technology has been deployed in the pursuit to capture APC benefits:

- Automatic testing
- Adaptive advanced process controller
- Inferential building tools
- Adaptive inferentials
- Performance-monitoring data historian
- Smart KPIs defined
- PID loop tuning tools

A Low technology score can be improved by adopting advanced technology to empower your engineering staff.

How to Estimate Benefits

While not the focus of this paper, a basic understanding on a simplistic way to estimate benefits is needed. The three main areas where APC improves a process unit's operation is through increased capacity, better yields/conversion and energy usage. Depending on the unit and operating goals, a combination of these three can be used to estimate the APC's value. For example:

- Capacity Benefit = Capacity Increase % * Unit Margin * % Time Pushing the Unit * Capacity
- Yield Benefit = Yield Increase % * Yield Improvement Margin * Capacity
- Energy Benefit = Energy Improvement % * Cost of Energy * Total Energy

These benefit calculations are used to help identify the value of the GAPs in performance.

GAP Analysis

Once the component scores have been determined and compared to the best-in-class performance of the top three similar-sized sites, GAPs are calculated along with the value of closing those GAPs.

Roadmap to GAP Closure

Now that the GAPs have been identified and the value assigned by closing those GAPs, what should you do? Looking at each unit's economics and their individual metrics, we can financially prioritize the list of new projects, revamps and migrations. Ideally, focus on the upper right-hand corner and work to the origin. Approaching your program in this matter will maximize its value for the site.

Another natural step to help close the GAPs is the creation of a smart APC KPI Dashboard. Besides the traditional % on-stream KPI, the controller effectiveness and estimated benefits should be readily displayed showing the value that APC is bringing to the site. This dashboard will keep the focus on proactive maintenance of the APC investment. This, in conjunction with quarterly status reports, will help maximize your site's profitability and convey the value APC is delivering.

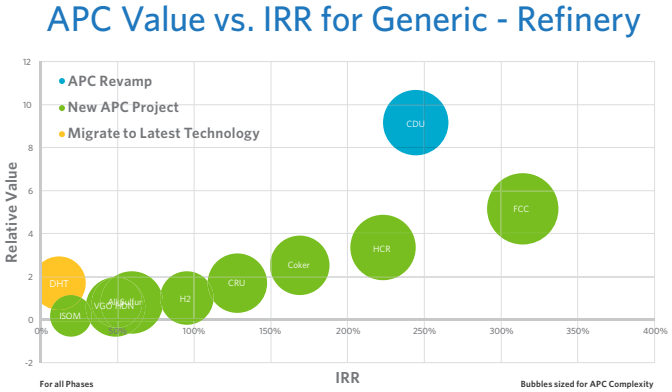

Figure 9: Evaluate each unit's economics and metrics to prioritize your APC projects.

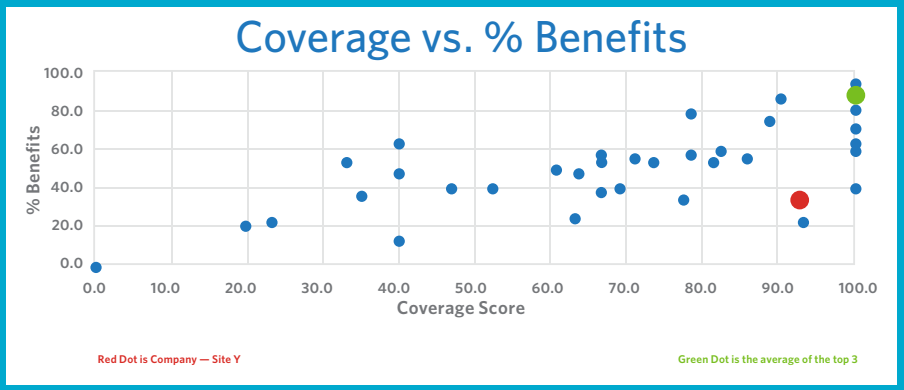

Figure 6: In this example, closing the Coverage Score GAP by implementing controllers on all process units can be worth $0.7 million to $1.4 million USD per year.

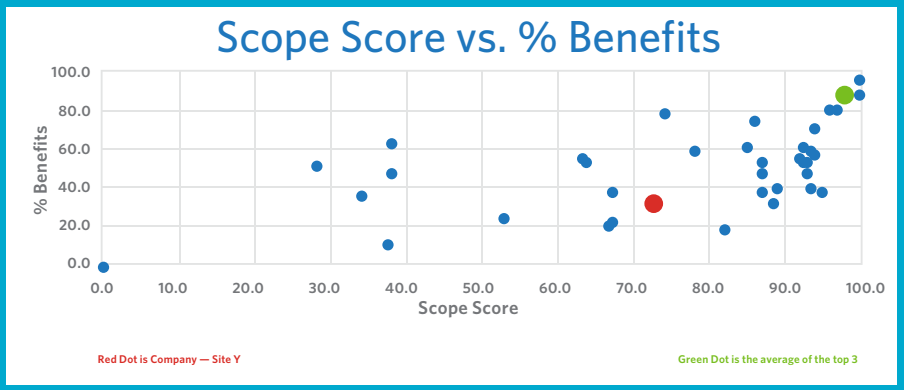

Figure 7: In this example, closing the Scope Score GAP through improved controller designs can be worth $2.9 million to $5.9 million USD per year.

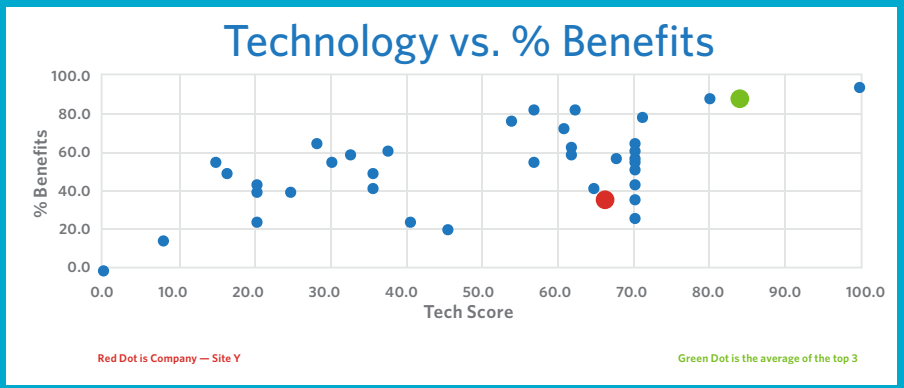

Figure 8: In this example, closing the Technology Score GAP by utilizing advanced technologies to improve APC maintenance work processes can be worth $3.6 million to $7.1 million USD per year.

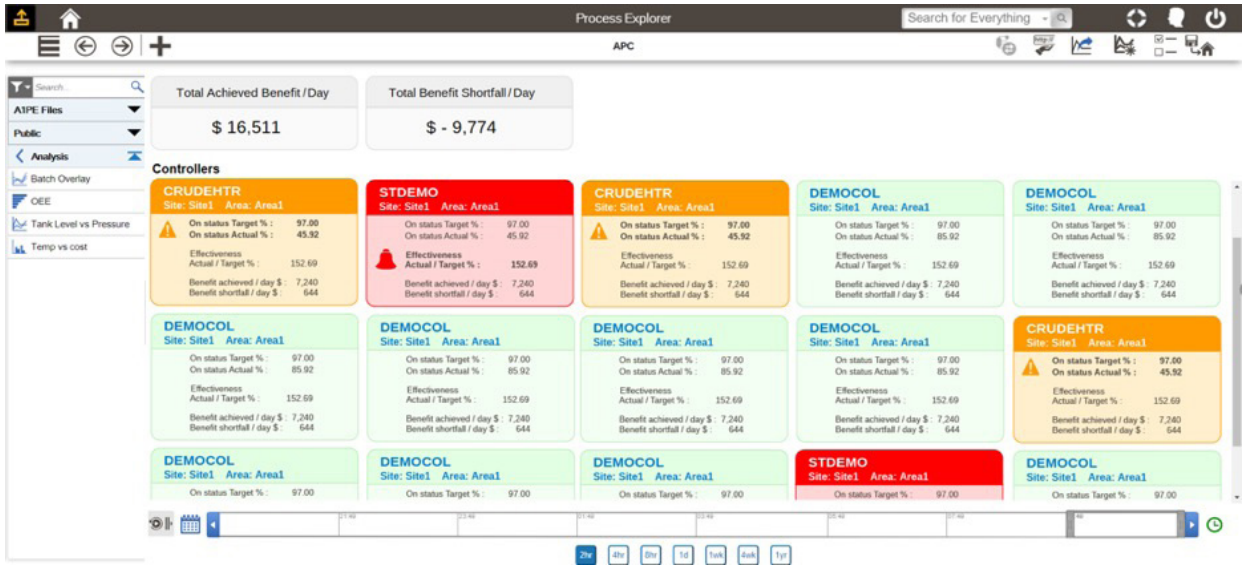

Figure 10: An APC KPI dashboard can help maximize your return on investment

Summary

Determining where you are versus your peers can help you develop a plan to close your APC GAPs and improve your site's profitability. A lot of benefits can be achieved; let's find out where you are on the spectrum. Simply contact AspenTech today to schedule a benchmark survey to start participating in this exciting study. Estimated effort to complete the survey is less than one person-day.

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