Five Keys to a Successful APC Program

Douglas McCallum
Advisory Business Consultant, Aspen Technology, Inc.

aspentech | White Paper

APC has become a "must have" in order to effectively compete in the world marketplace …

Companies looking for ways to improve their operational excellence or execute an internet of things (IoT) strategy quite often turn to implementing advanced process control (APC). Modern refining and chemical plants utilize APC to reduce quality deviation, maximize production and minimize energy consumption.

APC has become a "must have" in order to effectively compete in the world marketplace, and there are five main aspects to successfully implement APC:

1. Ultimate captured starting benefits
2. Capturing benefits while safely testing
3. Minimizing controller performance degradation with preventive maintenance
4. Developing people and creating a supportive organization
5. Judicially deploying financial capital

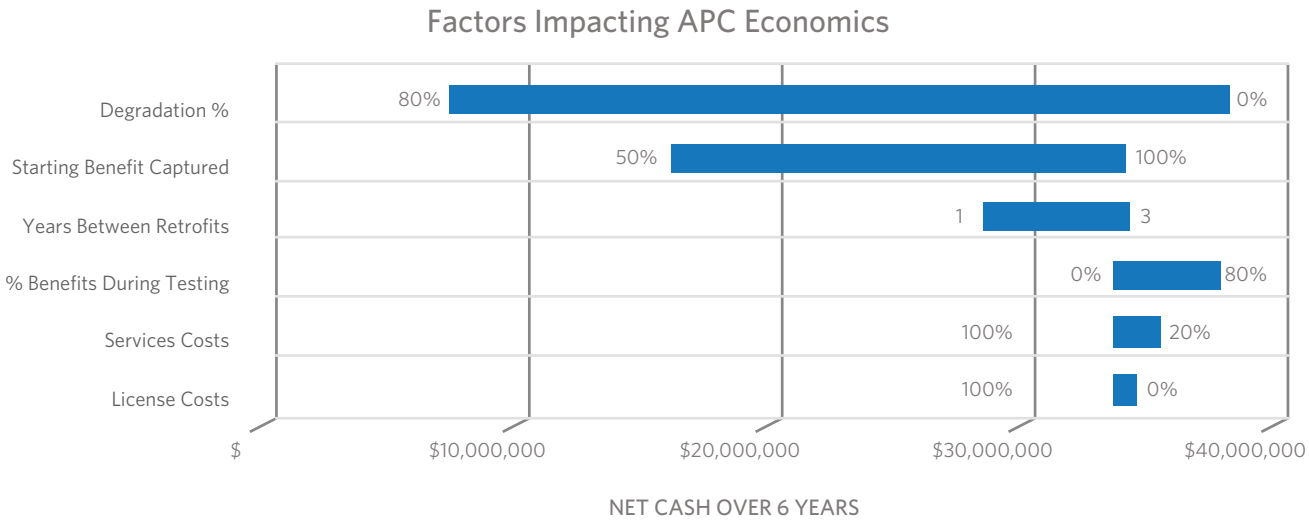
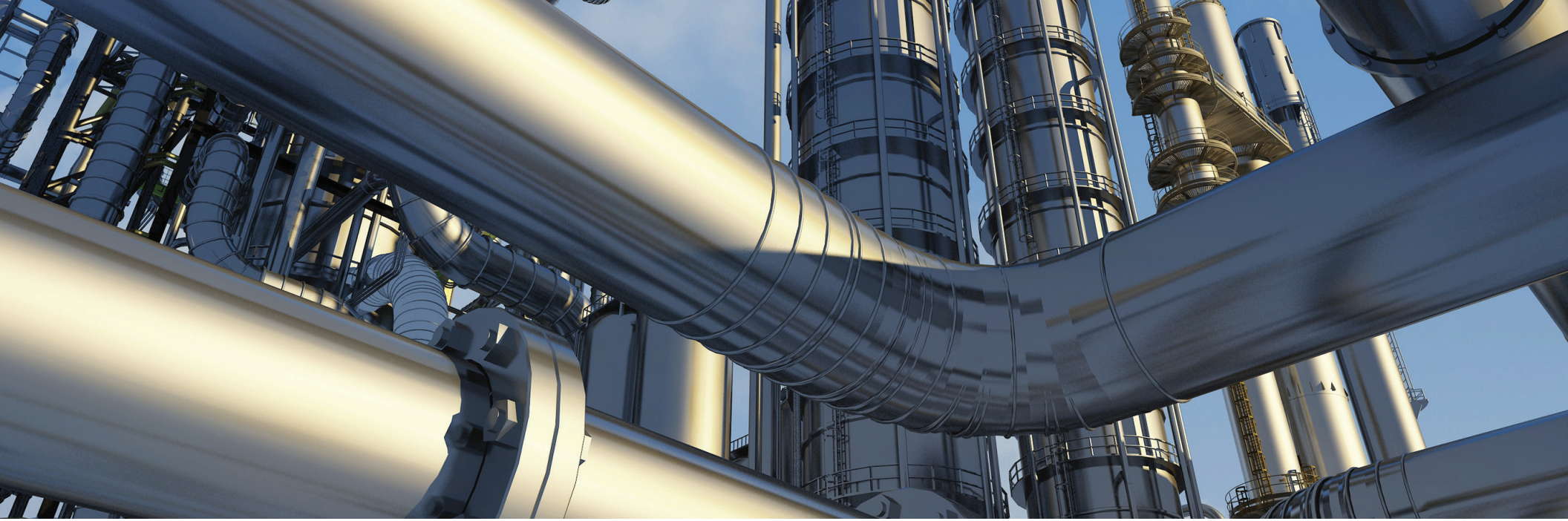


Figure 1: Tornado diagrams are a useful way to show the relative impacts of several different factors on a variable (in this graph, the net cash flow over six years). Varying the license costs from free to 100% has a small impact on the net cash flow. However, starting benefits captured has an extremely large impact, showing that controller design and the APC technology deployed matter significantly.



Ultimate Captured Starting Benefits

Incomplete controller design scope can lead to marginal value generation and production variability. Depending on the process unit, complexity and interactions, a controller could be only capturing 20 to 30 percent of its potential benefits. Even well-designed controllers typically degrade between 4 and 20 percent a year, so without maintenance after three years, the controller is only capturing between 50 to 80 percent of its potential benefits.

Figure 2 shows the different controller scope maturity levels versus the relative value capture. For example, companies at Maturity Level 3 are unable to continuously keep controllers at peak performance and capture somewhere between 70 and 90 percent of their potential value.

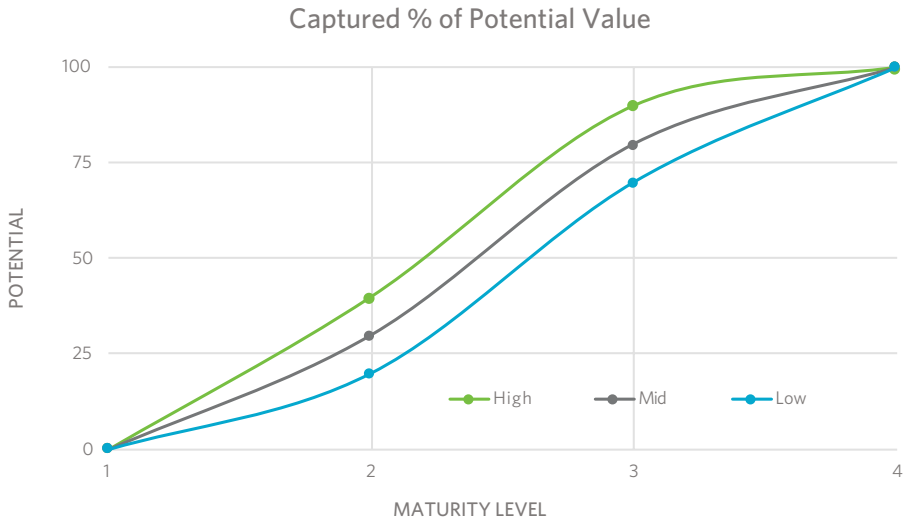


Figure 2: Higher APC maturity increases your ability to achieve and maintain the greatest possible benefits.

The following maturity model effectively segregates and describes this varying sophistication along the maturity spectrum:

- **Maturity Level One – No Advanced Process Controllers:** A distributed control system is in place with no advanced process controllers in place. Control loops are in the automatic mode. May utilize coded constraint-controllers to capture some minor benefits.
- **Maturity Level Two – Equipment-Based Advanced Process Controllers:** Utilize small, equipment-based advanced process controllers, thereby requiring several small controllers per unit. These small controllers control the unit but leave substantial benefits behind, and individual controllers can interact with one another. Limited operability and safety constraints are built into these controllers — for example, modeling the FCC reactor, regenerator, main fractionator and gas plant separately.
- **Maturity Level Three – Unit Advanced Process Controllers:** Process unit-wide advanced process controllers capturing all operation, safety and economic handles, providing the opportunity to capture the most economic benefit. In the FCC example, this would model the reactor, regenerator, main fractionator and the gas plant as a single controller.
- **Maturity Level Four – Adaptive Advanced Process Controllers:** Process unit-wide advanced process controllers capturing all operation, safety and economic handles providing the opportunity to capture the most economic benefit with models continuously being kept current through adaptive technology. Utilize key performance metrics (such as online benefit calculations, % uptime, % effective) to track real-time performance.

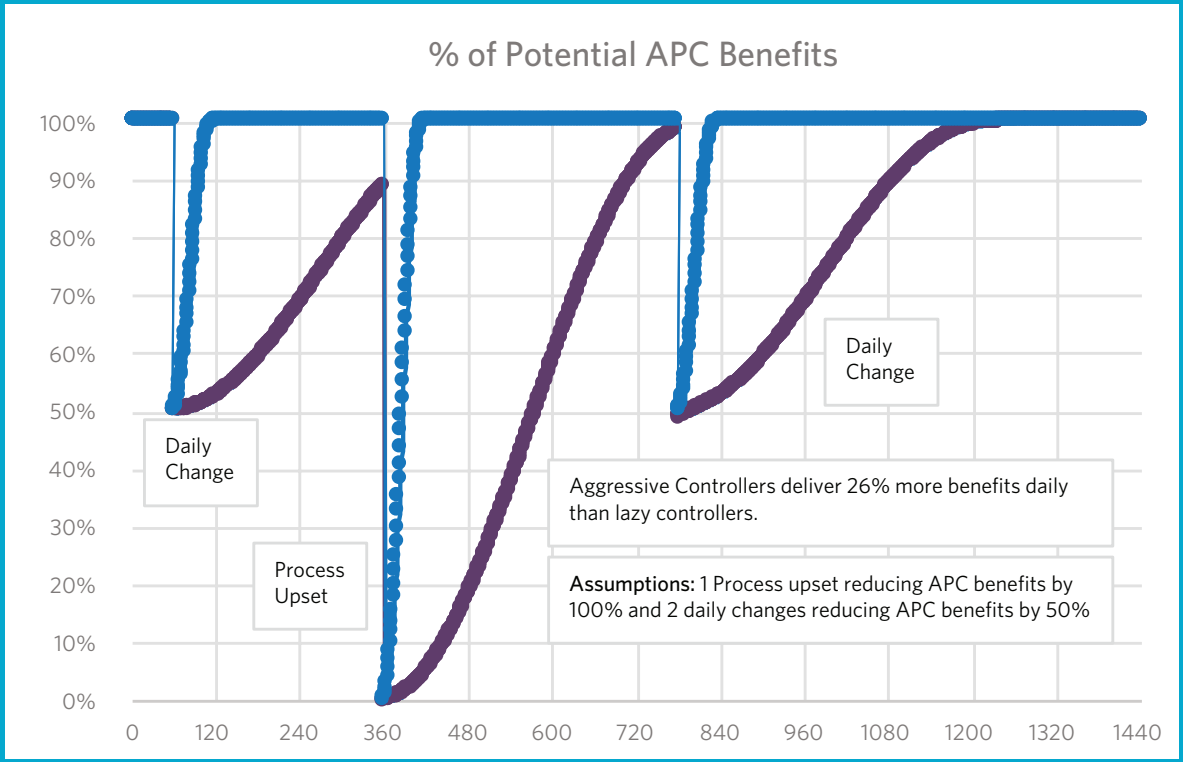
> **"Success is not easy and is certainly not for the lazy."**
>
> **– Samantha Saifer-Berngard**

There is a theoretical maximum benefit that an APC controller can achieve, defined in this paper as 100 percent. These benefits are achieved by having complete unit-wide scope with an aggressive controller.

In day-to-day operations within a facility, there are always process disturbances caused by night and day, weather, and upstream and downstream process events. Figure 3 shows the difference between an aggressive controller (which reaches steady state quickly, 1 time-to-steady-state [TTSS]) and a lazy controller (which reaches steady state in 6 TTSS).

In this example, the aggressive controller delivers 26 percent more benefits daily than a lazy controller. For a site with an APC potential of $25 million USD per year, that would equate to $6.5 million USD lost due to lazy controllers.

Figure 3: Aggressive controllers deliver 26% more benefits daily than lazy controllers.



Capture Benefits While Safely Testing Automatically

Safe testing is always paramount and must be considered first. The controller must keep the unit in a safe operating envelope while testing and have reliable ways to handle constraint violations. The controller must not give up on safety variables or key quality variables.

Should the controller find itself in an unsafe situation and unable to solve the problem while keeping the unit safe, it needs to turn itself off and notify the operator. Operators should trust the controller's testing algorithm, similar to the actual controller, for them to accept its testing of their unit.

Table 1: Various economic scenarios

	Scenario 1 Early Benefit Capture with Proactive Maintenance	**Scenario 2** Benefits Start at Commissioning with no Maintenance (8% Degradation)	**Scenario 3** Benefits Start at Commissioning with moderate Maintenance	**Scenario 4** Benefits Start at Commissioning with Proactive Maintenance
Net Cash Flow over 6 Years	44.7 M	30.9 M PROACTIVE MAINTENANCE	37.5 M	39.7 M
Internal Rate of Return	466 % ←	43% Impact of Capturing Benefits During Testing	43%	43%
Months to Cash Positive	<1	8	8	8

Table 1 shows the incredible impact of capturing value during testing on project economics.

- **Scenario 1:** Early benefit capture where the controller starts economically optimizing while it is testing with continuous proactive maintenance.
- **Scenario 2:** Traditional testing and deployment with no proactive maintenance program. A conservative 8 percent degradation was used for this economic analysis.
- **Scenario 3:** Traditional testing and deployment with no proactive maintenance program. A conservative 8 percent degradation was used for this economic analysis.
- **Scenario 4:** Traditional testing and deployment with a proactive maintenance program.

Besides improving the IRR from 43 percent to 466 percent, getting benefits while testing delivered over $4 million USD. Proactive maintenance delivered around $9 million USD. Choosing a technology that starts delivering benefits during testing and promotes proactive maintenance can be worth over $13 million USD over the six years (assuming an aggressive full-scope controller).

Degradation

In 2016, Aspen Technology conducted a survey around advance process control. Table 2 on the right summarizes some of those results.

There are several causes of APC degradation:

- **Process:** exchanger fouling, distillation
- **Economic:** feedstock selection; running for maximum production, maximum yield, minimum cost per unit
- **People:** change in support staff, poor operator buy-in, inadequate training

The creation of a smart APC KPI dashboard helps to quickly diagnose degradation problems and poor APC performance. 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. In conjunction with quarterly status reports, it will help maximize your site's profitability and convey the value APC is delivering.

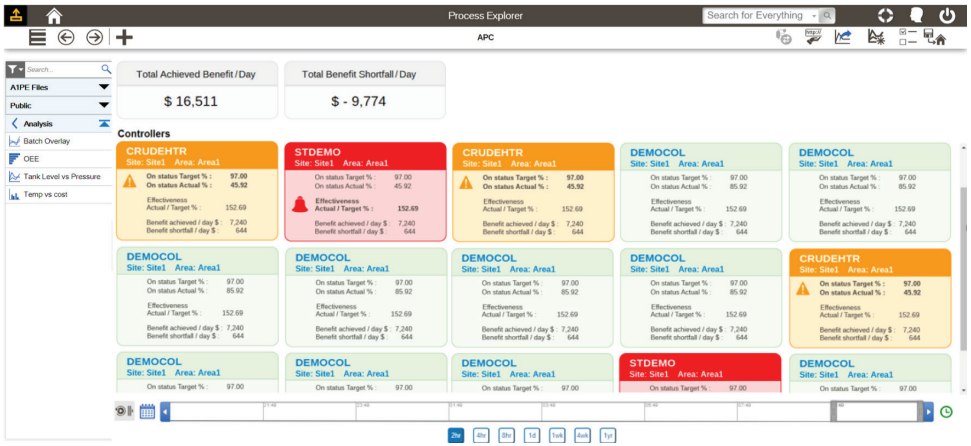


Figure 4: An example of what you can see on a smart APC KPI dashboard.

Table 2: Lack of maintenance impact on APC

Industry	Number of Responses	Average Degradation %
Bulk Chemicals	9	33%
Ethylene	14	23%
Midstream	1	40%
Other	4	40%
Refining	39	32%
Upstream	4	18%
Specialty Chemicals	5	32%
Total	76	30%

Question: "If no maintenance were conducted, what percent of the benefits would your site lose every year?"There are several categories of issues that cause of controller degradation.

People and Organization

One of the biggest barriers to implementing and maintaining APC is finding and keeping quality APC engineers. It is important to build an APC culture and deploy empowering APC technology.

The following points effectively segregate and describe this varying sophistication along the organizational capability spectrum.

- **No Advanced Process Controller Organization:** No formal group to implement and maintain advanced process controllers. Might have a dedicated individual at the site. They utilize whatever advanced control technology that was previously purchased. APC performance is not actively measured.
- **Static Advanced Process Control Organization:** Dedicated advanced process control team with a lead engineer. No career advancement once one enters the group. They have standardized on an advanced control technology. They create rudimentary APC performance metrics and management reports.
- **Robust Advanced Process Control Organization:** Dynamic team comprised of APC experts, young process engineers going through their rotation and operations experts on site. Seeks proven innovative control technologies to gain competitive advantage. For multi-site organizations, a corporate leader and group have been established. The team utilizes sophisticated performance metrics and management reports, such as online benefit calculations.

Improving the organizational capabilities increases advanced process control success, thereby maximizing potential margins. There is a large economic incentive to implement APC and keep it at peak performance.

Below are the results of a survey answering the question "Is it difficult to hire and keep APC Engineers?"

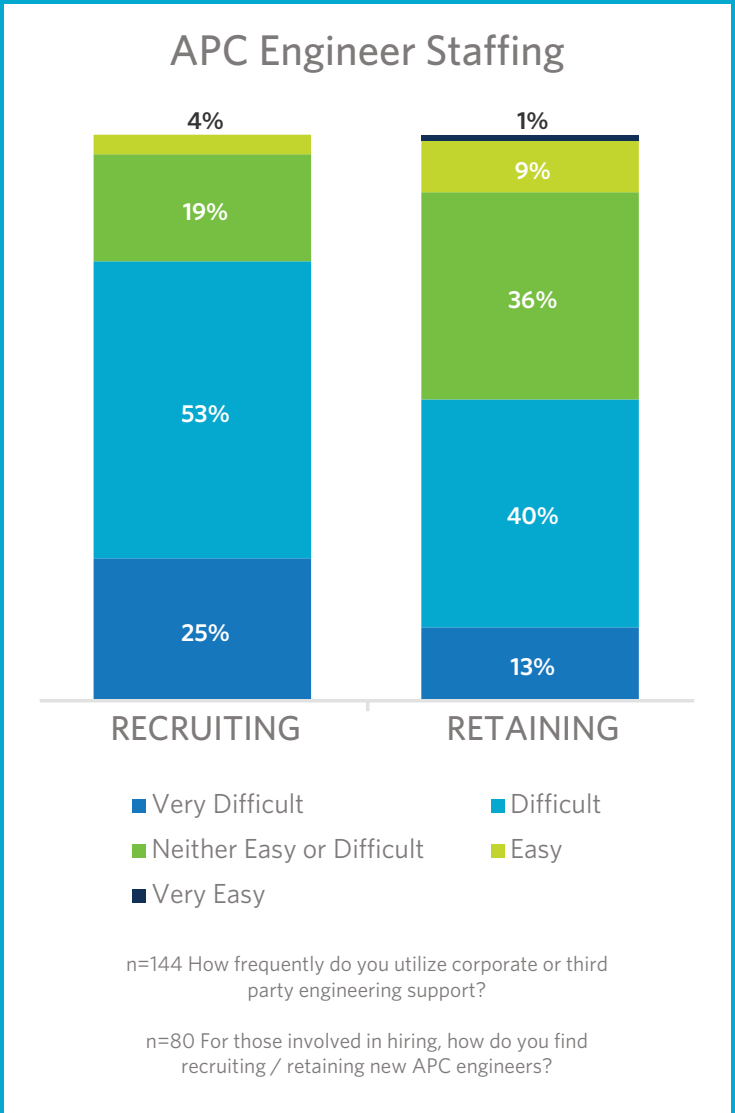


Figure 5: Most companies find retaining and recruiting qualified APC engineers to be difficult. This shows the importance of utilizing easy-to-use technology that empowers new APC engineers, thereby increasing the pool of engineers capable of implementing and maintaining controllers .

Once a company has decided to invest in advanced process control, a supporting organization needs to be developed in order to ensure the success of the program and the continued capture of the benefits. This is what is required:

- **Dedicated Team.** This should be a mix of advanced process control experts, young process engineers on rotation and tech-savvy operators. The number of manipulated variables per control engineer varies from 50 to 200 depending on the individual's capabilities and the needs of the process. Having a mixed team promotes skill development and knowledge transfer, helping to ensure success and keep the controllers at maximum performance.
- **Independent Budget.** The control group maintains a separate budget from the process units' operating budget for new controllers and controller revamps. Having an independent budget keeps controller projects from being deferred, allowing the complete capture of potential benefits.
- **Communication.** A tight-working relationship between the control group, operations, planning and scheduling allows for communication of constraints, turnarounds and economic targets amongst the groups.
- **Metrics on Performance.** Besides the simplistic on/off %, comprehensive metrics like "controller utilization," "manipulated variables effectiveness," "key constraints" and "benefits being derived" are captured. Such metrics facilitate the identification of poorly performing models within a controller and visibility to refinery management.
- **Adaptive Technology.** Utilize adaptive technology with the ability to test while still optimizing and minimizing the impact on operations, allowing the controllers to be frequently updated. Deploy technology that is easy and intuitive to use, enabling young process engineers to quickly make an impact to the bottom line.
- **Training Program.** The company sends new control engineers (young process engineer) to receive additional training. The individual is paired with an operator and has a designated expert mentor. These activities help develop new control engineers furthering the capabilities of the organization.

Figure 6: License and implementation costs have much less of an impact on an APC program's economics than other factors.

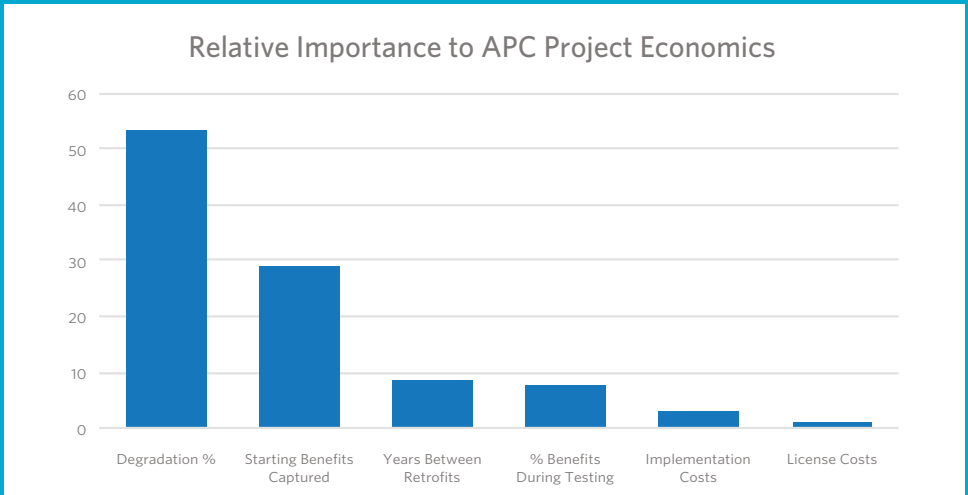
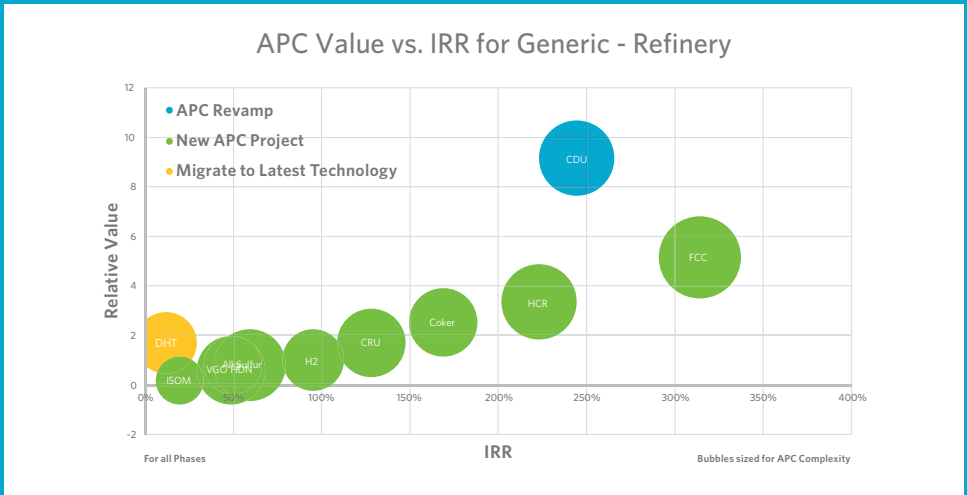


Figure 7: Use an economic evaluation as the starting point for prioritization.



Financial Aspects

The biggest impediment to having a successful APC program is inadequate management support. Having the APC dashboard brings visibility to degrading controllers, an insufficient proactive maintenance program and lack of adequate engineering resources to address the economic impact of performance degradation, as shown in Figure 6.

The second-biggest impediment is the lack of adoption of state-of-the-art APC technology that aggressively captures all the potential value. The third-biggest is the ability to capture benefits while testing, which greatly alters the individual project economics. A point of interest is that license and implementation costs have minimal impact on an APC program's economics.

To prioritize the schedule of new APC projects, revamps and migrations, evaluate each unit's economics and their individual metrics. As displayed in Figure 7, 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.

Summary

In order to achieve operational excellence, you must have APC across your site. A successful APC program should:

- Capture all the potential benefits with aggressive full scope controllers
- Start capturing benefits during testing — safely
- Have a proactive maintenance program with a KPI dashboard
- Create an APC culture and organization
- Prioritize project and revamps based on financials

Contact AspenTech today to schedule an APC Benefit Acceleration Program review.

aspentech | Technology That Loves Complexity

About Aspen Technology

Aspen Technology (AspenTech) is a leading software supplier for optimizing asset performance. Our products thrive in complex, industrial environments where it is critical to optimize the asset design, operation and maintenance lifecycle. AspenTech uniquely combines decades of process modeling expertise with machine learning. Our purpose-built software platform automates knowledge work and builds sustainable competitive advantage by delivering high returns over the entire asset lifecycle. As a result, companies in capital-intensive industries can maximize uptime and push the limits of performance, running their assets safer, greener, longer and faster. Visit **AspenTech.com** to find out more.