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IPA Newsletter

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Changing Portfolios Require a **Robust Development Process**

By Allison Aschman and Deborah McNeil, Directors, IPA Capital Solutions

Growth and new types of projects are changing the portfolios for many companies that execute capital projects. This was the main finding of a breakout session at IPA's annual meeting of the Industry Benchmarking Consortium in March 2023 (IBC 2023) in which IPA clients shared the challenges they face in establishing and managing their capital project portfolios.

The breakout session involved project professionals who are involved in their company's portfolio process. A third of the breakout session attendees are directly involved with establishing and developing their company's portfolio, while another third contribute to portfolio decision making. The remaining third have less decision-making authority but provide information to develop their company's portfolio and are affected by high-level portfolio decisions.

The Role of Portfolio Management

Our goal for the breakout session was first to explore the role of portfolio management in achieving project system excellence. What we need and want our project system to do is fundamentally driven by the portfolio of projects that the company plans and executes. And, as shown in IPA's

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Project System Excellence Model (PSEM®) framework, portfolio creation (selection of opportunities) kicks off the process that eventually results in business value delivery by the company's projects (See **Figure 1)**.

Our overall objectives for the session were to:

- Understand industry approaches and norms to establish and manage the portfolio
- Identify current and potential portfolio creation Best Practices
- Consider those aspects of portfolio management, focusing on portfolio creation, that maximize the value a company can realize from its capital investment
- Generate a framework or model for portfolio management excellence, starting with portfolio creation

Fit-for-Purpose Project System

A project system must be fit for purpose. A project system that is too onerous or does not fit with the company's organizational structure—even if it reflects industry Best Practices—will not be implementable. For a system to be truly usable, it must avoid being bureaucratic and focus on being value adding. But the process and organization cannot become so simplified that the system does not meet its purpose, which is to provide the mechanisms—instructions, assurance, and competencies—to drive successful projects. The system must consider the businesses it serves and what outcomes are expected or required to make projects successful.

As companies deal with rapidly changing portfolios—including new energy and sustainability projects, new products and new regions, portfolio growth, or scaling back—this fit-for-purpose quality becomes even more important. In our breakout session, 59 percent of participants indicated that their company's portfolio was seeing significant changes, including incorporating new businesses, technologies, or products. In addition, for those whose main businesses are not changing, 29 percent said their portfolios are growing. (See **Figure 2.**)

IPA Project System Excellence Model (PSEM®)

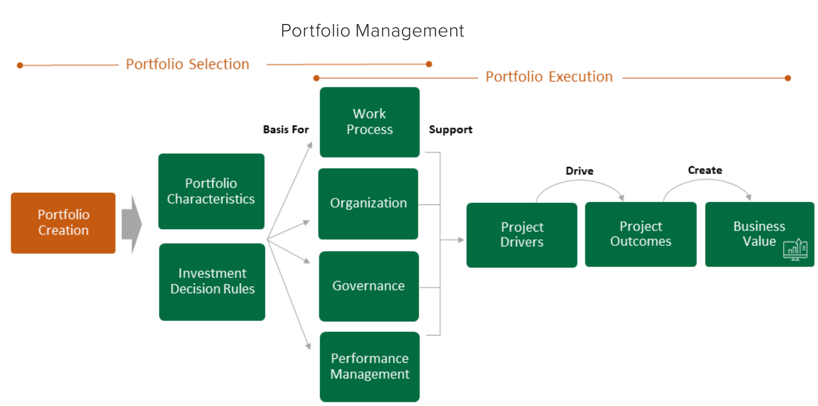


Figure 1

Portfolio Creation Objectives

The goal of portfolio creation should be to maximize the value of a company's capital investment. There are several important things to keep in mind while developing a portfolio. The best fit-for-purpose portfolio generation process will:

- Identify the most valuable opportunities: This entails connecting the portfolio strategy to the company's capital investment to achieve company goals through capital expenditure.
- Develop a robust basis for selecting the right opportunities and deselecting the wrong ones: This portfolio assessment step must identify potential returns (value) and risks for informed decision making to maximize value delivery.
- Promote capital governance: Enhance transparency and accountability for capital investment decisions. Obtain buy-in from all internal, legitimate stakeholders as starting point to provide a stable foundation for project planning and execution.
- Leverage (often limited) resources: For optimal project performance, the portfolio system must make the best use of the available resources.

What's Happening With Your Company's Portfolio?

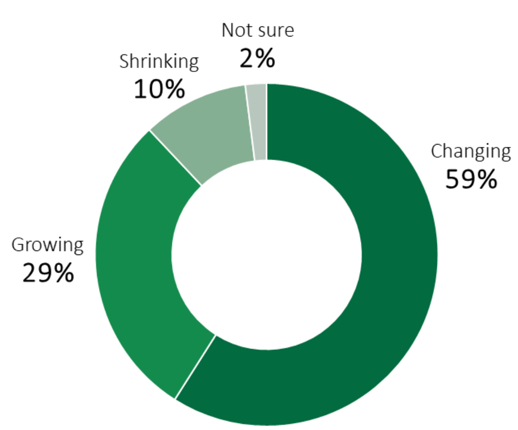


Figure 2

Portfolio Management/Long Range Planning Framework

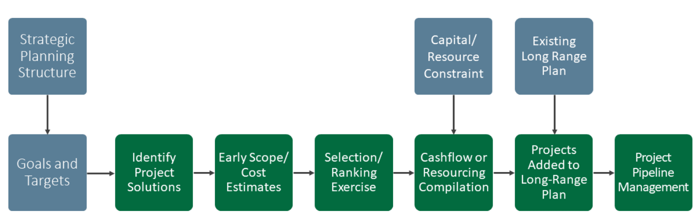


Figure 3

Portfolio Creation Workflow

Determining the investment needed to deliver strategic goals and meet regulatory compliance and facility reliability sustainment investment needs is a difficult task. The process is summarized in the Portfolio Management/Long Range Planning Framework shown in **Figure 3**.

Starting with the first element in the framework, effective portfolio creation requires effective strategic planning that provides goals and direction. However, when asked to describe the strategic planning structure of their company, more than half of our breakout session participants said that their company structures and processes for defining strategy were missing key elements and that it was unclear how the elements (strategies, assessments, plans, etc.) come together to fully inform portfolio decisions. Only 14 percent said their company had a well-defined strategic planning structure, with about a quarter of respondents saying the structure was defined but missing key elements. In other words, the majority found their company's portfolio strategic planning structure to be lacking.

As shown in the framework, portfolio creation then requires that some important questions are answered:

- Is there a clear definition of success for capital investment?
- Where, within the organization, are portfolio goals set?
- Does the company have both corporate and business goals?
- How are facility needs brought into decision making?

From this starting point, companies identify project solutions, develop cost estimates and early scope for these projects, and select which to move forward by ranking the opportunities against each other. Decisions made here can be affected by capital or resource constraints and feed into the company's short- and long-term financial plans.

Each element in the Portfolio Management framework poses challenges to effective execution. In subsequent articles in this series, we will discuss these challenges as well as Best Practices as we examine each element in detail first for site-base/small project portfolio management and then for large project portfolios.

Contact Allison Aschman at **aaschman@ipaglobal.com** or Deb McNeil at **dmcneil@ipaglobal.com** to discuss your portfolio management challenges.

Getting Large Projects **Back on Track in Mid-Execution**

By Ronell Auld, Senior Project Analyst

Business leaders increasingly want to know how to rescue projects that are going off track in mid-execution. Although businesses never plan for their projects to go off the rails, it is not an unusual occurrence in the capital project world. Large schedule deviations (e.g., above 25 percent) are the most common signal that a large capital project (i.e., above US$50 million) is going *off the rails*. Based on IPA's research, about one in four large projects go off track by slipping the schedule target. Large cost deviations (e.g., above 25 percent) are less common but do still occur from time to time. High cost growth tends to throw one out of eight large projects off-the-rails in execution. (See **Figure 4**.)

COVID-19 and its after effects have only magnified these risks as the pandemic disrupted already strained labor availability and material supply chains across all major industry sectors (e.g., refining, chemicals, midstream and distribution, mining/metals/minerals, pharma/consumer, civil-infrastructure, and IT/data centers). These unusual labor and material supply chain disruptions have led to a less predictable execution environment and increased the need for strategies to effectively rescue large projects that have gone off course during execution. Businesses and project teams affected by the pandemic's aftershocks are finding it increasingly more difficult to effectively estimate and control detailed engineering, procurement, and construction.)

Why Do Projects Go Off the Rails?

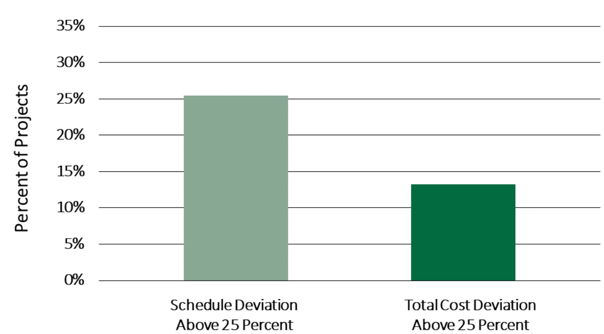
Project execution can be unpredictable, and projects can have uncompetitive results even when business leaders follow Best Practices before authorization (e.g., enabling good team development, good definition, and good controls). Sources of execution disruption include:

Force Majeure: Unexpected events can stop businesses from executing projects effectively. For example, hurricane and flooding events often prevent labor and material suppliers from fulfilling their contractual obligations. Force majeure risk is not limited to acts of God (e.g., natural disasters and pandemics). Some force majeure events are created by humans, for example through war/military conflicts (such as the Russian invasion of Ukraine) and labor strikes. By their nature, force majeure events are impossible to predict and cause projects to deviate significantly from plans.

Team Member Turnover: Turnover of critical team members (business sponsor, owner project manager, lead engineer, or construction manager) is damaging to projects in mid-execution because key team members take with them a lot of institutional knowledge and political capital when they leave a project. Project teams require time to rebound, and thus spend more after a turnover because the turnover tends to trigger memory loss among key functions (i.e., informal agreements with operations and maintenance representatives tend to fall apart, and formal agreements with engineering and construction contractors often lose efficacy).

Late Major Changes: Major changes to project scope (e.g., adding capacity or functional options) and project design (e.g., modifying equipment layouts) generally require

Schedule Slip and Cost Growth Risks



Based on IPA's research on large projects (e.g., above US $50 million)

Figure 4

remobilization (or at least re-focusing) of engineering, procurement, and construction resources, which often adds more to the cost and schedule than expected, causing projects to go off the rails. After controlling for cost and schedule deviations, major changes to design and scope in execution are still associated with higher total spending and longer schedules compared to industry average.

How Can Projects Recover During Execution?

It can be very challenging to get a large project back on track once execution is underway. Although IPA normally conducts project evaluations to address execution risks before the funding authorization—which is the best time to ensure project success—business leaders also use IPA's services when they find themselves needing to rescue projects going off track in mid-execution.

A first step is to get an up-to-date picture of the project's current state, including what schedule slip and cost growth has occurred to date and whether the team has experienced key team member turnover or other disrupting events. Once this is done, the project's schedule and cost can be re-baselined, allowing owners and contractors to align on the new plan to completion and avoid further inefficiencies. Risk can and should be reassessed and mitigated and updated recommendations put into place.

For example, IPA helped refining and chemical industry leaders to recover their projects during and after COVID-19 lock down by providing consulting solutions that quantified project engineering and procurement status, re-baselined estimates, and measured potential effects on construction. In another instance, IPA helped a specialty chemicals company to recover a large project after the contractor filed for bankruptcy. IPA provided the owner team with tools to effectively re-baseline and re-staff the project, which enabled the project to complete the remaining execution work effectively.

Recovered projects may not be able to meet their original objectives—and will likely still have cost overruns and schedule slip. However, developing an updated and structured approach to project completion from the point of project crisis can help companies avoid outright disasters.

How IPA Can Help

IPA's project analysis and consulting services for Mid-Execution Recovery analysis cover multiple facets of execution risk:

- Forensic project evaluation to identify the root causes of the current situation
- Team Functionality survey to assess the team's perception across critical project elements, including leadership, team communication and alignment, and project development
- Benchmarking analysis to provide cost and schedule metrics: re-baselined should-be cost and schedule estimates
- Projected cost and completion date (an estimate of the project's likely final outcomes) based on key risk factors
- A set of actionable recommendations for the remainder of execution, based on the root cause analysis and Team Functionality results, that can be applied to the project to improve its chances for better outcomes

Although changing the trajectory of troubled projects is inherently more difficult in execution, it is not impossible. Across all major industry sectors, businesses have leveraged IPA's project database and consulting services to help their organizations recover projects that are already in execution. More importantly, by evaluating the root cause when projects go off track, business leaders gain knowledge necessary to avoid the same issues in the future.

CCUS Project Cost & Schedule Norms

The complexity of CCUS projects presents many challenges. Any company involved in CCUS projects needs unbiased data to successfully navigate the complexity. With industry-level data from IPA, you can validate your early CCUS project estimates and establish a baseline for performance improvement.

Contact Adi Akheramka at **aakheramka@ipaglobal.com** for more info.

Renewables Industry **Trends and Lessons From PVA**

By Michael Mace, Research Analyst

Introduction

As IPA sees more Low Carbon Energy (LCE) projects, we look to better understand the struggles that companies face when trying to implement them. Companies endeavor to tackle projects on the path of carbon reduction, but these projects often tend to be marginally economic at best—and heavy losses at worst. Reverse auctions squeeze project economics on renewable energy installations. Many carbon capture, utilization, and sequestration (CCUS) projects have to trade substantial carbon abatement with low costs, with only a select few projects achieving both. All of this then sits on the backdrop of ever-changing regulations that may add extra costs and lower the economic breakpoint. If companies are going to start tackling LCE projects sooner rather than later, handling the shaping is critical to project success. Therefore, IPA has taken a broader look into the non-technical shaping issues and business contexts of these projects. Through surveys and internal data, as well as in-person discussions with clients, we sought to ascertain where the industry stands when it comes to LCE context and provide insight to our clients. Building on Jon Walker's Transitioning to New Energy: An IPA Energy Company Survey, we highlight some of the most striking trends we saw in our exploration.

Data: Both Qualitative and Quantitative

As part of our survey of 15 owner companies, we gathered information on LCE projects related to a company's portfolio strategy, any external and internal barriers to project implementation experienced, their company's gated process, and aspects of their early decision-making process. This survey laid the groundwork for further data gathering, because we could work to verify the survey results.

Secondly, we reviewed our database of LCE projects to find areas of struggle and success early in the Front-End Loading (FEL) stages. Our LCE dataset has more than 50 projects and includes several technologies: biofuels and biomass; CCUS; solar installations, both commercial and community; onshore and offshore wind; hydroelectric; and green hydrogen, both alkaline water and proton exchange membrane. We assessed the projects using our Project Viability Assessment (PVA) metrics. In basic terms, the PVA evaluates several factors—business basics, financial conditions, site factors, and scope framing—to rate the quality of a project's business case as it stands after a Gate 1. The methodology is technologically agnostic because all questions surround the business case and the quality of FEL work completed up to that point.

Not only could we compare the various categories of technology—biofuels, CCUS, and renewables—but we could also compare the LCE sample to an industry sample: the model itself was built around a large dataset with a standard mix of oil and gas, chemicals, mining, and other sectors. In general, the PVA results for renewables were worse than the industry sample; however, CCUS projects were almost identical to overall industry performance, if not slightly lower, with renewables and biofuels each having equally poorer performances. (We describe the factors that lead to this lower performance later in this article.)

Finally, we held roundtables with owner organizations from our Industry Benchmarking Consortium (IBC) and Upstream Industry Benchmarking Consortium (UIBC) to get their specific insights into the state of LCE projects. These insights elaborated on the more general responses in the survey. The major insights from those discussions allowed us to further verify the survey results and make more conclusions based on our PVA sample's results.

Areas of Struggle for Our Clients

We highlight five areas our clients' LCE projects struggle with:

1. Economics
2. Basic Data
3. Gated processes
4. Permitting
5. Personnel

Economics–The most important pain point from the survey was project economics, either in the form of an internal rate of return (IRR) or net present value (NPV). From our PVA data, only 25 percent of LCE projects modeled either an expected IRR or NPV by the first decision gate. This is striking against the 67 percent of companies in the overall PVA industry sample that modeled IRR or NPV. Companies we interviewed echoed this economics concern. Even worse, some companies in the roundtables stated their current IRR or NPV calculations are unreliable or overly optimistic due to a combination of too many assumptions and targets for the best case scenario only. It is a clear indication that the path forward is cloudy when such a common success metric either cannot be calculated or, when calculated, is considered likely inaccurate.

However, one thing that came up time and time again is the fact that economics was often not the main driver of these projects. For our clients, LCE projects stand as opportunities of strategic importance or rely on the availability of government stimulus to succeed. To be clear, our clients are still selecting projects based on profitability; the pattern we are describing merely shifts the focus away from maximizing profits to other, subjective elements. This leads to the question: If economics is not the main driver, why is it such a pain point? One answer lies in the gated process, which is discussed later. Briefly, economics is such a major focus in gated processes that it is still the focus even when it is not the main driver. We recognize that another component of economics is Basic Data, which we touch on later in this article. With that said, when the economics are the key input into the go/no-go decision, changing that standard to reflect the strategic value of LCE projects is still an important change for companies. Again, we are not saying economics and profitability are no longer a factor. Rather, some companies are acting on this concept and changing their gated processes to weigh other opportunity factors, such as business case clarity, equally or greater than economics.

Basic Data–As mentioned earlier, a key issue that affects the economics is Basic Data availability. In this case, Basic Data are any information needed to properly define the technical requirements and economics of a project. Some examples include the average wind speed at hub height for a wind farm, the solar radiance at a photovoltaic farm's location in summer versus winter, or the price and harvest consistency of a feedstock such as soybeans or corn. For our clients, the phrase *known unknowns* came up many times in the IBC and UIBC discussions. How can a company define a good project without having the data necessary to do so?

We saw several interesting consequences of these Basic Data issues. One is closing scope. About 40 percent of LCE projects did not provide outside battery limits (OSBL) scope, and about 20 percent still had open inside battery limit (ISBL) scope, after the first decision gate. The other trends are related to the detail of a project's economics. While 93 percent of LCE projects had cost estimates going into the scope development phase of Front-End Loading, only 63 percent were good quality—cost breakdowns that showed detail in major categories, such as construction labor, equipment, and bulk materials, not just high-level categorical summaries. We also saw a decreasing trend in companies' first gate analyses: about two-thirds of the sample performed an economic analysis, while less than a third did a comprehensive market viability assessment. For comparison, in the PVA industry sample, 78 percent of projects performed an economic analysis with only about 70 percent both setting an acceptable price and completing a competitor analysis. However, LCE projects that performed a competitor analysis were likely to have performed the previous three analyses (if they reached acceptable price, they completed the first two analyses, etc.). Getting more in-depth with the analysis provided a better business case but that depends on the ability to get Basic Data.

Gated Processes–In the gated process, it is clear that inconsistency is rampant. Survey respondents and several IBC and UIBC companies said they had adopted a different gated process, as recently as 2022 in certain cases, and others are still developing a unique process. The remainder said they used the same gated process as other projects for LCE projects; however, these same processes were, as admitted by those companies, actually somewhat different, entirely ad-hoc, still in development, or just had their check gates effectively bypassed by upper management—this top-down push was echoed by IBC attendees. So, are the gated processes really the same in those situations? General consensus is that LCE projects need their own, dedicated gated process tailored to the technology. We recognize the value in this decision though still warn companies not to reject or expedite the gated process. (See Mitigating Risks of Early Commitment in New Energy Projects to understand how to handle the body of FEL work with an early commitment date.) Some IBC respondents that adapted newer gated processes still agreed that a gated process provided value to projects and, therefore, was vital despite its changes.

Beyond the first-hand accounts, what did the data say? Of LCE projects that had a Gate 1 (88 percent), nearly three-quarters had what IPA would consider a strong Gate 1: a gate that is approving and interactive between the project team and management to ensure alignment. However, a concerning statistic challenges the strength of those gates: only 16 percent of LCE projects established clear exit criteria for their project at or after Gate 1 (compared to Industry's 44 percent). While some projects established rough cost ceilings related to retail price at Gate 1 (about 30 percent of projects), explicit kill criteria—in the example of a cost ceiling, something like a true, hard-stop price—were not explored or reported. In addition, a majority of LCE projects in the database had unclear or vague business objectives; this aligned with companies listing business objectives as an internal struggle. These factors, combined with a lack of basic data, will lead to many weak projects passing Gate 1, which will result in an arduous process from business case approval through scope development and FID.

One last concern with gates is making sure the right people are at the table. Getting the right expertise, both on a business and technical level, is key to aligning on a business case and making the right decision on a project. As companies continue to reform their team formation and gated processes, we may start to see smoother workflows with more informed, complete pictures of the project scope.

Permitting–Another factor greatly restricting LCE project adoption is permitting concerns: rapid changes to policies and lack of knowledge from the governing bodies enforcing them make the process tenuous and lengthy. Many companies agreed on these external risks to projects. Our PVA data showed that 57 percent of LCE projects had identified and applied for their necessary permits early in FEL 2. In fact, about 27 percent of projects had their permits already in hand at that time. However, almost every interviewee at IBC and UIBC maligned the permitting process. The uncertainty, the irregularity, the involvement of third-parties—all these factors add up to a system that is difficult to navigate. Permitting is so lengthy, in fact, that some IBC respondents would rather pause a project than pause the permitting process for said project.

We expect there may be some bias in our data sample: projects that were able to begin the permitting process or to receive permits were more likely to move forward and seek an IPA risk evaluation than projects that were still being assessed. We would expect companies to apply for their permits around FEL 3 once scope selection and some definition work has occurred. This reality changes with early commitment projects, which may be required to have permits in hand before making a bid, often midway through FEL 2. Some IBC owner companies pointed out a troubling conundrum they face in these situations: in order to bid on a project, you need permits; in order to apply for permits, you need to provide a scope; in order to have a scope, you need to know the terms of the regulation or agreements; in order to know the terms of the agreement, you have to get the bid. With all this in mind, we encourage companies to enter discussions with regulatory bodies as early as possible. Building those connections with the regulatory bodies will be critical to working through this conundrum and allow both parties to agree on a particular solution. Though, again, this may be difficult when regulators themselves do not know what the rules are. IPA hopes to track major policy changes to help investing companies understand the regulatory landscape better.

Personnel–One last key struggle identified in our surveys, interviews, and data was staffing an LCE project team properly. There is a point of discussion whether to train internally or seek expertise externally, though the former requires balancing the demands of employees' current work and the latter risks putting strain on potential contractors. Also, whether LCE projects get their own dedicated teams is still internally debated in several companies; some companies are making central LCE teams, while others are putting together teams of qualified employees ad-hoc. The IPA data support the many personnel concerns: only about 42 percent of renewables projects have key resource personnel identified. Related to this, as few as 26 percent of renewables projects provide clear roles and responsibilities documents. Both CCUS and biofuels projects saw better performance in both of these categories. However, across all LCE projects, only 20 percent identified and described the applicable project experience for each of the core team members. With how nascent some of these technologies are, finding and using talent is an area that continues to elude our clients. Through continued project data collection, we expect to be able to provide more applicable staffing and personnel guidance that builds on our current staffing understanding.

LCE Project Strengths

IPA notes the LCE database outperformed Industry in several ways. LCE projects had comparatively better risk management plans than the rest of Industry. This may be due to the uncertainties we mentioned previously, resulting in more in-depth analyses and numerous project mitigation strategies. LCE projects are also better at defining facility unit capacity than Industry—almost 100 percent of LCE projects do this versus Industry's 75 percent. Lastly, while LCE projects included operations and maintenance on the project team less frequently than Industry (63 percent of the time versus 80 percent), they did identify the project's operational needs more often (68 percent versus Industry's 28 percent). In the LCE Industry, where projects are driven by getting the best levelized costs, both CAPEX and OPEX, these operational needs will be critical; the data show that companies recognize this importance by their operations analyses. However, there is a catch: trying to identify operational needs without proper Basic Data can lead to potentially significant missed scope (see Early Operations Integration Is Key to Meeting Production Targets in the Renewables Business.) IPA seeks to collect OPEX data to better understand its contribution to business and project decisions.

Conclusions

Clearly, LCE projects face a lot of uncertainty—and therefore risk—both internally and externally. Governance processes, economics, permitting, Basic Data, and personnel are the biggest problem areas that need to be addressed. Some companies address these problems internally while others look for external aid. IPA continues to use our data and work with our clients to better target and address these vexations. We have developed tools like the PVA to help make the business case's strengths and weaknesses clear. IPA is also developing other means of evaluating greater shaping issues: we are actively developing the Shaping and Viability Evaluation (SAVE) to directly gauge the various shaping and context issues of LCE projects. Combining the PVA analysis with SAVE will provide our clients a deeper analysis of how shaping manifests in the business case. With time, collaboration with our clients will continue to improve our capabilities and therefore better aid their needs to overcome these hurdles in the LCE space.

Project Viability Assessment (PVA)

The Project Viability Assessment (PVA) measures the strength of your project's business case, shares insights into the likely outcomes, and provides actionable recommendations for improvement. Use the PVA determine if your business case is strong enough to set your project up for success.

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The Lost Art of Technology Innovation in the Process Industry

By Michael McFadden, Deputy Director, Research

The push for greener products and processes is leading many companies to introduce new technology or new feedstocks to existing processes. While everyone recognizes that implementing first of a kind technology poses risk, most companies do not have the experience to understand the magnitude and consequences of these risks and lack the systematic technology maturation process and associated governance to mitigate them. IPA has seen companies with deep commercialization expertise and routine deployment of new technology in the 1980s and early 1990s gradually lose this capability during the 25 years that followed (see **Figure 5**).

In addition to lack of experience and inadequate governance, new technology projects often suffer from a combination of insufficient resources, undue schedule pressures (driven by the desire to be first to market), and reputational pressures from promises made to shareholders. The recent uptrend in the deployment of new technology combined with the lost art of commercialization sets up the potential for costly mistakes and puts the decarbonization transition at risk.

An additional challenge to the emergence of new process technologies is the desire (and suggestion by many consultants) to leverage processes used in the recent success of information technology (IT) innovations for the deployment of new industrial process technologies. Although some practices might apply, by and large using the framework in its entirety is not appropriate and will lead to failure. Unlike IT projects that may be able to release a product and fix bugs or update functionality afterwards, spending tens or hundreds of millions of dollars on a commercial process plant that does not operate with the plan to fix bugs or change functionality is a disastrous approach to innovation. All of these attempts in our database led to facilities with extraordinary costs and durations to fix in the best cases—and total walkaways and/or industrial accidents in the worst cases. IPA's mantra is to, "Make your mistakes on a small scale and make your money on a large scale."

What works in the process industries? IPA has evaluated the implementation of first of a kind technology in more than 1,000 commercial process projects and identified the Best Practices required to have a successful new technology process at a commercial scale.

A recent IPA article outlined some of the organizational, work process, and governance requirements that companies need to follow to commercialize new technology projects. These are foundational elements for success focused on the organizational side of commercializing innovative processes. To be successful, we also need to know the Best Practices for the technical side of innovation in terms of the piloting pathway for any new technology process. This article discusses some of the technical dimensions of industrial process technologies that affect the development and piloting pathway needed to commercialize new-to-industry technology. Underpinning this framework is the finding that the development pathway needs to be built around the nature of the new technology and employing the wrong approach (e.g., the IT development framework) will lead to failure.

Process Attributes Determine Best Practices for New Technology Process Development

The need for piloting and the nature of the piloting requirements are major considerations that balance development time and costs versus the risks of having an unsuccessful commercial plant. The process can range from piloting of individual unit operations that often focus only on the new step or steps being introduced into a process up to a fully integrated pilot plant that, apart from scale, matches the commercial process. The differences in piloting approach have large implications on the time and cost of development. Knowing when an integrated pilot plant is required and when it is not is critical to getting it right.

Through researching new technology projects in our project database, we have found several attributes of the process that help frame the need for a particular piloting pathway. The goal of having a commercial plant

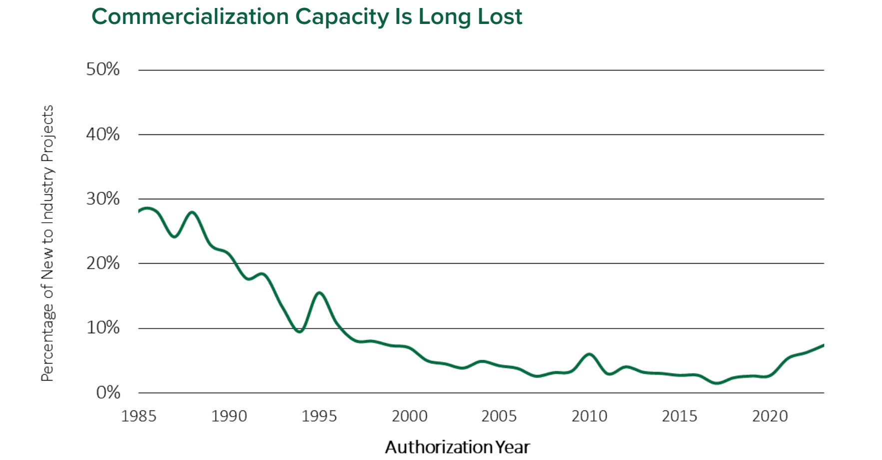

Figure 5

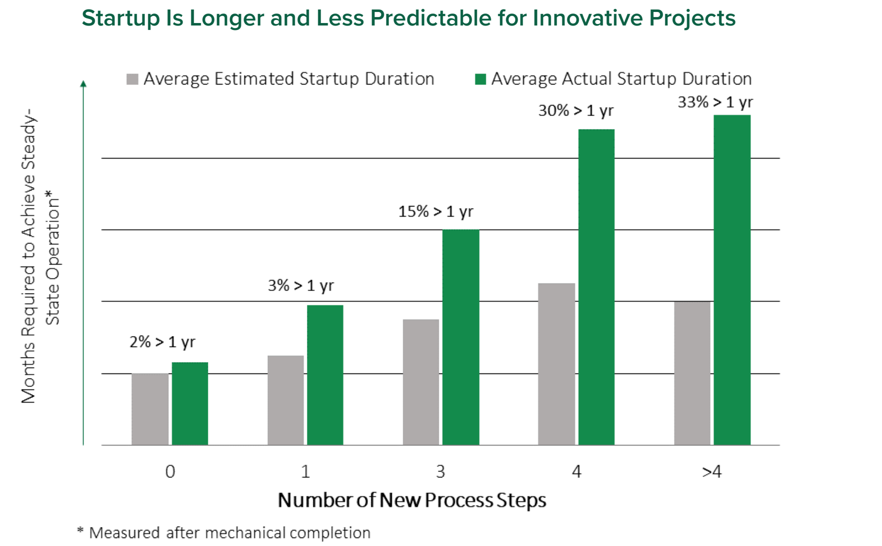

Figure 6

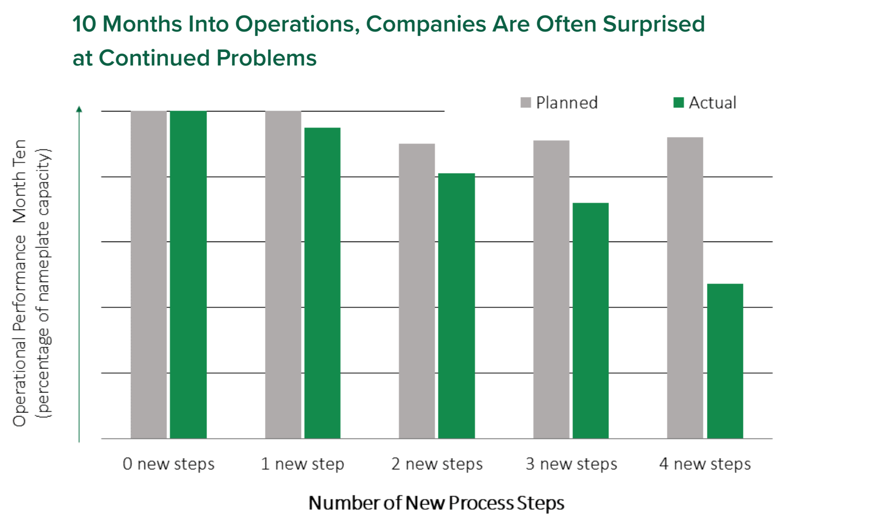

Figure 7

that can operate 24/7 and consistently produce on-spec products within an economic envelope that makes the plant profitable requires a development and piloting process that is appropriate to the technology. Sometimes, there is neither the appetite for the time and cost required to go through a potentially lengthy development phase nor an understanding by R&D of what is required to get to a commercially viable plant.

Below we present four attributes that have consistently shown up in our data to drive a need for more extensive piloting. There are several other attributes that contribute to piloting requirements, but those are more nuanced. The key is to match the piloting approach to the technology and nature of state of the materials.

Process Complexity—The first is the complexity of the process. Although this seems obvious, it is often not considered when the piloting plan is developed. IPA defines complexity as the number of continuously linked process steps that include a reaction, separation, or change of phase. IPA found there is a complexity count above which skipping an integrated pilot plant leads to major issues with, or outright failure of, the commercial plant. In contrast, simple processes and batch processes that have breaks between the process steps have a lower need for an integrated pilot plant. Bypassing the integrated pilot plant when it is needed often leads to protracted startup times for trouble shooting and major additional capital (fix it projects) to correct or modify the plant. In some cases, the commercial entity has been a walk away that did not produce a single unit of saleable product.

Number of New Steps—A second attribute is the number of new steps (commercially unproven process steps) included in the overall process. The addition of each new process step creates additional uncertainty in the overall process. As with process complexity, there is a threshold of new process steps that, when exceeded, indicates the need to use an integrated piloting approach. As shown in **Figure 6**, the number of new steps increases the time required for startup of a commercial plant and the actual operational performance is, on average, far lower than expected as the number of new process steps increases. Note, the graph only includes projects that actually did start up—those that never reached steady state operations (i.e., infinite startup duration) could not be included in the averages. (See **Figures 6 & 7**.)

Intermediate Recycle Stream—Another attribute that informs the piloting pathway is the presence of an intermediate recycle stream; this is further complicated if there are also impurities. Processes that have a recycle stream create the possibility of buildup of impurities or side products over time. The implications of these on the

operation of the process cannot always be anticipated from piloting a once-through unit operation step. The addition of a recycle stream, particularly if there are impurities, is another attribute that informs the need for an integrated pilot process that includes the recycle stream as well as sufficient continuous operation of the pilot process to understand the effects of the recycle stream on the steady state operation of the process.

Feedstock—A fourth attribute that informs the piloting pathway is the feedstock state. Feedstock that is a solid creates more uncertainty in technology development and scale-up than feedstock that is a liquid or gas. Although a lot of attention is given to the chemistry, the processing of solids and other problematic feeds and intermediates (slurries and non-Newtonians) is difficult to model and therefore anything more than a modest scale-up can result in problems like bridging, plugging, erosion, and channeling. In addition, raw solid feeds (e.g., run of mine or agricultural/forest waste) create an additional dimension from the variability in the feed itself. Piloting is needed to comprehend the variations in the feed. Often times, piloting with a limited sample of the feed leads to surprises during operation of the commercial plant when the feed has variations not seen in the pilot operation (size, shape composition, impurities, moisture, etc.). Again, an integrated pilot process that is run with representative samples of feed and includes enough run time is required to fully understand the effects on the design and operational parameters of the process.

How IPA Can Help

Understanding these four attributes of the technology is critical to identifying the basic technical data required to design a functioning commercial operation, and consequently informs the design of the pilot facility and, equally importantly, the type and extent of piloting activities. IPA's New Technology Commercialization Workshop is designed to identify and characterize these attributes, along with other more nuanced attributes, and help design an ideal commercialization path that balances resources and probability of success according to a company's risk appetite. The workshop also provides key stakeholders with an understanding of the organizational requirements specific to the technology and quantitative benchmarks from the effects of the new technology on cost, schedule, and early operational performance. This information is imperative to balance the risks of different choices for commercialization and piloting approaches and to navigate the commercialization path.

UCEC 2023 Annual Meeting Brings Members Together in Houston

This year's annual meeting of IPA's Upstream Cost Engineering Committee (UCEC 2023) will be held on Thursday, June 15, 2023, in downtown Houston, Texas. In addition, live webinars will be held for key presentations following the meeting for those who cannot attend in person.

The objective of the UCEC is to improve upstream business results by improving cost engineering and project control functions and processes. The committee's primary focus is the development and sharing of hundreds of metrics, tools, and research. The UCEC cost, schedule, and quantity-based metrics are used by member companies to validate their internal estimates with industry data. UCEC also provides research into practices and project characteristics that drive better cost and schedule outcomes.

The annual meeting is an opportunity for the member companies' cost engineering professionals to gather and review the latest UCEC metrics packages prepared by IPA. IPA will share the updates and highlights of this year's metrics program in addition to research topics listed below:

- Market Trends
- Estimate Validation and Review
- Project Controls Organizations

As part of UCEC 2023, IPA analysts will also present help sessions and case studies to demonstrate how to best use UCEC metrics and tools. The meeting will wrap up with a metrics and research brainstorming session.

IPA Events and Presentations

Upstream Cost Engineering Committee (UCEC)
June 15, 2023
Houston, Texas

The UCEC strives to improve upstream project and business results by providing metrics for better cost engineering. Member company representatives gather once a year to learn about and review new UCEC metrics packages prepared by IPA. The upstream metrics packages are used by companies to compare their upstream project cost and schedule outcomes with industry cost and schedule norms and, in general, boost business project estimate assurance and evaluation quality. Contact Shubham Galav at **sgalav@ipaglobal.com** for more information.

Cost Engineering Committee (CEC)
September 19-20, 2023
McLean, VA

The CEC assists cost engineers by providing metrics and tools that offer an unbiased snapshot of industry cost and schedule estimates and trends. The CEC focuses on all aspects of cost (or investment) engineering, including cost estimating, scheduling, and project control practices and metrics, with the goal of expanding the owner cost engineer's capabilities. The primary vehicles for accomplishing these objectives are validation metrics, Best Practices research, and practice sharing. Contact Shubham Galav at **sgalav@ipaglobal.com** for more information.

Upstream Industry Benchmarking Consortium (UIBC)
November 13-15, 2023
McLean, VA

The UIBC provides an independent forum for each participating exploration and production (E&P) company to view key metrics of its project system performance such as cost and schedule, Front-End Loading (FEL), and many others against the performance of other companies and share pointed and detailed information about their practices. The consortium highlights Best Practices, reinforcing their importance in driving improvements in asset development and capital effectiveness. Contact Andrew Griffith at **agriffith@ipaglobal.com** for more information.

Upstream Project Team Staffing Assessment

Does your staffing plan set your project up for success or failure? Find out with IPA's new Upstream Project Team Staffing Assessment.

Contact Katya Petrochenkov at **kpetrochenov@ipaglobal.com** to evaluate the staffing plan for your next project!

IPA News Highlights

Ed Merrow Shares Contracting Strategy Insights in Podcast Interview

Ed Merrow was the featured guest on a recent episode of the Oil and Gas Upstream Podcast hosted by Elena Melchert! The interview focused on his book, *Contract Strategies for Major Projects*, and how contract strategies are less about legalities and more about human behavior. The podcast airs on the Oil and Gas Global Network, described as the "largest and most listened to podcast network for the oil and energy industry." You can listen to the full 30-minute episode here.

Natalia Zwart Appointed to Director Role

As Director of Chemicals, Life Sciences, and Consumer Products, Zwart oversees IPA's global work across these industrial sectors. In her new role, Zwart will continue to broaden IPA's global Chemicals, Life Sciences & Consumer Products business, guide intellectual property development to address the sector's most critical issues, and engage with client leaders to support delivery of successful project portfolios.

Ken Ingersoll and Paul Mulgrew Join the IPA Board of Directors

Ken Ingersoll will assume chair of the Audit Committee, replacing James Russo, who is stepping down after 15 years of service. Ingersoll served as IPA's Chief Financial Officer (CFO) from 2001 until his retirement in 2020. In his almost 20 years as IPA's CFO, Ingersoll oversaw the treasury, accounting, budget, tax, and audit activities of the company, as well as the financial and account system controls and standards.

Paul Mulgrew is deeply knowledgeable in software development and will have applications development as his remit on the board. Mulgrew has over 25 years of experience as an executive at The Bureau of National Affairs—Bloomberg Industry Group. Software solutions are a key area of concentration and growth for IPA, and Mulgrew's professional experience will help steer IPA in this strategic direction.

Aditya Munshi Discusses Capital Projects Market Trends in Breakbulk Magazine

In a special article for Breakbulk Magazine, IPA's Aditya Munshi discusses the market outlook for capital projects by highlighting the global macroeconomic trends, capital investment and commodity price trends, and supply chain conditions. Read the full article at www.breakbulk.com.

2023 IPA Institute Course Schedule

In-Person Courses	Dates	Language	Click to Register
Contracting Strategies for Major Projects **Abu Dhabi, United Arab Emirates**	October 9 & 10	English	REGISTER
Best Practices for Site-Based Projects **New Orleans, LA, USA**	October 17 & 18	English	REGISTER
Megaprojects: Concepts, Strategies, and Practices for Success **Houston, TX, USA**	December 5–7	English	REGISTER
Virtual Courses	**Dates**	**Language**	**Click to Register**
Gatekeeping for Capital Project Governance	June 27–29	English	REGISTER
Project Stakeholder Alignment Through Successful BEAM Implementation	September 7	English	REGISTER
Gatekeeping for Capital Project Governance	September 12–14	English	REGISTER
Front-End Loading (FEL) and the Stage-Gated Process	September 19 & 21	Portuguese	REGISTER
Front-End Loading and the Stage-Gated Process	September 27 & 28	English	REGISTER
Project Management Best Practices	October 2–6	English	REGISTER
Capital Project Execution Excellence and Project Controls	October 11 & 12	English	REGISTER
Front-End Loading (FEL) and the Stage-Gated Process	October 24 & 26	Spanish	REGISTER
Project Stakeholder Alignment Through Successful BEAM Implementation	November 1	English	REGISTER
Gatekeeping for Capital Project Governance	November 7–9	English	REGISTER
Capital Project Execution Excellence and Project Controls	November 28 & 29	English	REGISTER
Project Management Best Practices	December 4-8	Portuguese	REGISTER
Project Management Best Practices	December 11–15	English	REGISTER

THE IPA INSTITUTE
Advancing Project Knowledge

About the IPA Institute The IPA Institute is the training and education division of Independent Project Analysis (IPA), the world's leading advisory firm on capital projects. Our courses equip industry leaders and capital project practitioners with Best Practices for projects, portfolio, and project system management/delivery. All course instruction, presentations, and supplementary course materials are rooted in IPA's unparalleled capital project knowledge and research, and based on data from IPA's proprietary project database.