

BETO Lesson Learned

Intergrated Biorefinery Lessons Learned Information						Filters				
Entry ID	CID	Recipient	Description	Impact	Suggested Mitigation Strategy	Internal/ External	Project Phase	Tag #1	Tag #2	Tag #3
16	* N/A *	Not Project Specific	Using an Engineering, Procurement, Construction, Management (EPCM)-type contract may be an inappropriate contract mechanism to scale-up new technologies.	Complete outsourcing of management of a project can result in the Owner losing control of the cost, schedule and quality of the work performed.	Owners need to clearly understand and select appropriate contracting mechanisms to balance the risks/rewards of outsourcing with the need to maintain quality and control of the project baseline. Higher risk scale-ups of new technologies require different balancing of risk transfer than standard engineering/construction projects.	External	Award Negotiation	Project Management	Project Team	Project Execution
30	* N/A *	Not Project Specific	Project schedules have been greatly impacted by both BETO and the award Recipient underestimating the level of NEPA analysis needed to get a determination and move forward with the project.	Underestimating time requirements to complete a NEPA analysis lengthens project schedules and can substantially increase costs. One project required an Environmental Impact Statement (EIS), which added nearly 2 years to the schedule and added unplanned costs the project.	Incorporating NEPA expertise during the FOA application merit review to evaluate the level of NEPA review needed for each meritorious project (e.g., if an Environmental Assessment or Environmental Impact Statement are required) would provide for early awareness to both DOE and the selectee of the potential impacts to the project baseline cost and schedule.	Internal	Merit Review Committee	NEPA	Schedule	Cost

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33	* N/A *	Not Project Specific	Projects request contingency reduction immediately following completion of construction/commissioning, which can result in underestimating the time and cost needed to address operational/shakedown risks. Recipients typically have cash flow issues during this time.	Initial contingency reduction proposals are typically too aggressive with limited justification due to cash flow concerns. Many Recipients believed that once mechanical completion was achieved, risks were substantially mitigated and the need for operational contingency was minimal. Experience, to date, shows this to be a misleading assumption. Commissioning, startup, shakedown and operational risks have proven to be considerably higher than estimated, resulting in the need to access significant contingency funds to address corrective actions, design changes and operations issues.	BETO has developed a methodology for analyzing requests for contingency reductions from integrated biorefinery projects. The methodology involves reviewing the Recipient's most recent risk register, having BETO and its independent engineer analyze each risk to assess the effectiveness of the mitigations employed and the claimed result (e.g., risk completely mitigated, risk not mitigated, risk partially mitigated), comparing the amount of risk reduction achieved to industry benchmarks, and balancing the assessed risk against industry benchmarks to determine DOE's independent estimate for contingency. This methodology is considered a best practice by BETO and Golden Service Center Procurement officials.	Both	Award Negotiation	Project Management	Project Execution	Financial
35	* N/A *	Not Project Specific	Recipients with limited project management discipline/experience view Risk Assessment/Mitigation as a one-time, check the box event instead of a living, high-value project management tool that is utilized throughout the project's duration.	A common weakness among several project developers is the ineffective use of a Risk Mitigation Plan and Risk Register and understanding the relationship between risk, control of the project performance baseline, and the amount of contingency required. The ineffective use of these tools resulted in several projects experiencing substantial cost and schedule impacts due to unrecognized or underestimated risks.	Risk tools need to be utilized throughout project execution. Best industry practice includes applying probability and impact analyses, including developing quantitative factors and cost estimates to gauge how much contingency needs to be set aside. Also, risk tools need to be actively used by project managers to aid in maintaining project configuration control. Risk mitigation plans and risk registers need to be tailored to the actual technology readiness level of the projects so that risks are less likely to be unrecognized or underestimated.	Both	Active Project Management	Technology Readiness	Risk	

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38	* N/A *	Not Project Specific	Reliable power from the grid during commissioning, start-up and shake down has been a problem for several projects. In particular, power was not sufficient to run all the equipment during shake down. These projects are often located in rural areas and the power supply companies were not aware that the plants' peak loads during startup and shakedown could exceed grid capacity (e.g., large systems coming online all at once).	Commissioning, startup and shakedown were interrupted, delayed and resulted in circuit breaker trips requiring re-setting of instruments and process units. This can also cause potential safety issues if power is lost for fans and heat exchanger controls.	Potential power outages should be addressed in the risk register. Negotiation of Power Purchase Agreements with power suppliers needs to clarify peak load needs during commissioning, startup and shakedown and facilitate coordination of power supplies during these events.	Both	Active Project Management	Technical	Regulatory	Project Execution
41	* N/A *	Not Project Specific	Applicants were ill prepared for the amount of documentation required to receive an award.	Resulted in delayed schedules and improperly utilized resources.	Use the Notice of Intent process to inform applicants about what documents will be expected and BETO's due diligence process. Including BETO's data mining sheet template as a requirement in the FOA is recommended.	Internal	FOA Development	Planning		
43	* N/A *	Not Project Specific	Analysis of Budget Period (BP) 1 costs shows that 10%-20% of total project cost is needed for setting the performance baseline, achieving an FEL3 level design (cost estimate within -5%/+15%) that can be used by EPC contractor for bidding purposes, permitting, achieving financial close, obtaining a NEPA determination, and other activities that enable readiness to construct the facility. Historically, BP1 costs and schedules have been underestimated.	Impacts of underestimating BP1 costs include: schedule delays; cost overruns; shifting funds from later phases of the project (e.g., BP2) to cover BP1 overruns; underestimating BP2 cost, schedule and need for contingency.	Validating the Technology Readiness Level (TRL) and project maturity (scale-up, continuous hours of testings, level of integration etc.) early in BETO's selection and negotiation process will better prepare both parties to understand the risks to project execution before investing significant funds.	Both	Award Negotiation	Validation	Technology Readiness	Project Execution

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44	* N/A *	Not Project Specific	Trying to force the design to be first to market is a fatal flaw. A fundamental risk to project success is the business case driving an accelerated schedule with an immature design basis and untested scale-up scope.	Chief among the negative impacts include the need to shift resources to run pilot plant tests to address design deficiencies and unanalyzed risks before finalizing the scaled-up design parameters while simultaneously executing construction of the next-scale biorefinery (e.g., demonstration or commercial scale). This occurred with a number of IBR projects and the impacts are consistent with risk assessment predictive analyses. Scope and design creep result in delays and higher costs, especially if construction is allowed to proceed prior to completing appropriate engineering/integrated pilot testing.	In a number of cases, BETO instituted stage-gate reviews involving additional pilot testing to increase confidence that the scaled-up designs were credible and valid. Reviews by the independent engineer revealed additional risks that were unrecognized or underestimated. In the future, BETO intends to conduct independent validation of higher TRL-level projects early in the FOA-award negotiation process to mitigate against any inadequate design bases and inform risk-based Go/No go decisions.	Both	Active Project Management	Technology Readiness	Project Management	
45	* N/A *	Not Project Specific	Change management procedures need to be used and reviewed (lower TRL projects tend to make design changes quickly, with limited on process and project scope configuration control and with limited analyses of schedule/cost impacts). Lower TRL construction efforts tend to focus on cost/schedule goals rather than validating a design in a pilot/lab unit. Hasty management decisions to move forward without validating design work lead to poor project performance outcomes.	Projects that are driven by schedule considerations before testing and final designs are completed cause schedule delays and increased costs, as well as the need for higher amounts of contingency. Decisions to begin construction before all testing and final design, along with purchasing untested used equipment have resulted in follow-on corrective actions and higher project cost and schedule variances.	Critical Decision 2 (CD-2 Approve performance baseline) reviews and Critical Decision 3 (CD-3 Approve start of construction) reviews need to assure that projects incorporate more formal project management best practices and lesson learned, including formal change control requirements, to improve the chances for project success. Also, BETO needs to incorporate into its CD process, key lessons learned and best practices as critical factors in assessing the readiness of Recipients to successfully execute new technology projects.	Both	Active Project Management	Technology Readiness	Project Execution	Project Management

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46	* N/A *	Not Project Specific	Contingency requirements need to be firm. Allowing non-cash sources has not been a successful option. The consequences of allowing non-cash sources for contingency were not well understood at the time of selections (ARRA). Allowing higher TRL projects to use guarantees may be acceptable, but allowing it for projects at lower TRL levels is inappropriate. For example, it has been seen that lack of clarity about the nature of "guarantees" proved to be a barrier in converting them into liquid funds to address unmitigated risks.	Lack of contractual and legal precedence on how to manage the Selection Official's minimum 25% contingency requirement led to Recipients being provided the contractual flexibility to demonstrate meeting the requirement using such non-cash mechanisms as performance (construction) guarantees from EPC contractors. This did not meet the real-world criteria for contingency that requires that it be immediately available, dedicated to the project, and liquid. Experience shows that using this type of "insurance" built into the EPC contract as contingency is insufficient and ineffective; especially when construction is complete and operational contingency is needed.	BETO best practice: The contingency clause has been strengthened and will not allow non-cash sources as contingency in future IBR awards.	Both	FOA Development	Planning	Programmatic	Project Execution
47	* N/A *	Not Project Specific	Cost estimate accuracy is very inconsistent. Many first-of-kind technologies experience higher costs in all phases of project execution.	Higher costs lead to delays in correcting cost-related issues.	Need to apply industry standards (FEL3) and make early-stage TRL projects aware of expectations, standards and risks.	Both	Active Project Management	Technology Readiness	Project Execution	Cost
61	* N/A *	Not Project Specific	BETO's experience shows that first-of-a-kind plants cost twice as much and take twice as long as a typical dry mill to get to the construction phase. BETO's experience also shows it will take closer to 9 to 12 months to get to design capacity instead of 3 to 6 months. Schedule and budgets are consistently underestimated with first-of-a-kind technology by substantial margins. Schedules are commonly too aggressive and many risks are underestimated. It is difficult to persuade the recipient that its schedule and budget are overly optimistic when balanced against the project risk.	Expect a minimum of 2 times the costs and 2 times the duration to complete a first-of-a-kind IBR pilot, demonstration or commercial-scale project.	Need lessons learned and best practices incorporated into the Project Execution Plan to improve IBR project performance baseline development and for estimating the schedule and budget of new technology. Use of lessons learned data should help BETO improve its ability to analyze Recipient estimates.	Both	Selection	Technology Readiness	Project Management	Project Execution

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63	* N/A *	Not Project Specific	Getting feedstock to the plant boundary has proven difficult in some cases and has stopped projects due to a variety of issues, for instance, not meeting plant specifications concerning: size fraction specification, moisture content, ash content, impurities, volumetric requirements, timing/delivery, etc.	Weaknesses in feedstock procurement specifications and mitigation requirements, along with quality control and enforcement of those requirements early in the operations can limit operations and result in delays and additional costs.	BETO's Independent Engineer will add more emphasis on feedstock procurement and logistics risks. BETO will emphasize review of these types of risks during its CD-3 and CD-4 Go/No go reviews.	Both	Active Project Management	Technical		
73	* N/A *	Not Project Specific	DOE and the industry do not necessarily share a common understanding of project milestone terminology; e.g., performance test, shake down, mechanical completion, commissioning, substantial completion, etc.	Without clearly defining common terminology for milestones early in the process, including completion criteria, acceptance of milestone completion may be compromised and potential schedule delays can be expected.	Terminology needs to be defined based on DOE requirements, as early as the FOA, and reiterated in more detail during each project's kickoff meeting. Agreement on common terminology and completion criteria needs to be addressed during the CD-2 (Approve performance baseline) review and documented in the approved performance baseline.	Both	FOA Development	Planning	Programmatic	
75	* N/A *	Not Project Specific	It has been observed that not properly establishing a project WBS to align with a code of accounts that follow GAAP standards has stopped projects while audits occur and/or audit findings are addressed.	Several projects were not allowed to invoice for many months until they were able to show compliance with GAAP to the auditors.	Aligning the code of accounts and WBS at a low-enough level within the project to assure GAAP standards are met must be discussed with projects before an incurred cost audit occurs. Achieving alignment early in the project is essential if invoice reimbursements by DOE are to be timely.	Internal	Award Negotiation	Regulatory	Financial	Review

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78	* N/A *	Not Project Specific	It has been BETO's experience that the technology readiness levels (TRLs) for most IBR projects are somewhat less mature than proposed in the applications. The evidence indicates that most times this is due to insufficient integrated piloting at an appropriate scale to test the heat, material and energy balances, as well as validate performance yield data, necessary to provide a valid basis for the next scaled-up design.	One major impact was that BETO required some projects to conduct integrated pilot tests to validate the design basis of scaled-up projects (e.g., demonstration and/or commercial scale), which added upwards of one year to the performance baseline. Another impact was that for some IBR projects that had sufficient pilot testing as a design basis, insufficient time was allotted in the performance baseline for commissioning, startup, shakedown and operations, resulting in substantial schedule and cost increases.	BETO has instituted as a best practice an independent validation and risk assessment leading to a Go/No go decision point early in the IBR award process. BETO is considering instituting an independent validation and risk assessment review as part of the FOA merit review process. This would include an analysis of the actual TRL level as compared to the level required in the FOA and an assessment of the risk to BETO to move forward should there be a gap in the actual TRL vs the TRL level claimed in the application.	Internal	Award Negotiation	Validation	Technology Readiness	Planning
83	* N/A *	Not Project Specific	A major reason some IBR projects did not move forward was due to the inability to secure adequate financing. A number of projects that were sufficiently funded before the financial crisis that began in 2008, suddenly found themselves in a very risk-averse financial market with additional barriers to obtaining capital over the next several years.	The major impact on these IBR projects was the inability to secure sufficient capital to fund the cost share and (if required) contingency to complete the project. Resources were diverted away from project execution to securing strategic investors and financing. Progress against approved performance baselines suffered delays and/or disruptions due to insufficient funds. Some projects pursued loan guarantees from either DOE or USDA. Some projects could not secure the cost share and the projects ended.	BETO needs to be assured that future IBR projects have secured financial resources sufficient to complete the project. This needs to be validated during the FOA process and then confirmed early in the award negotiations. Concrete evidence of sufficient financial resources dedicated to project cost share and/or contingency is required. This may take many forms, but must meet the standard set by DOE Procurement.	Both	Active Project Management	Project Execution	Financial	Project Management

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85	* N/A *	Not Project Specific	IBR project schedules are typically too aggressive and understate the costs and risks of scaling-up first-of-a-kind technologies. The driver appears to be the need to be "first to market," but the trend is to overlook the challenges inherent in bringing to scale new technologies.	Overly aggressive schedules typically reflect poor project baseline planning, a poor understanding of the risks to be mitigated and inadequate resource loading, resulting in schedule delays, additional costs, and corrective actions to address unmitigated risks. Several IBR projects experienced additional delays and higher costs due to overaggressive schedules, improper risk identification and management, and insufficient resource loading.	BETO has consistently required certain DOE critical decision points (Go/No go decision points) be included in the approved performance baseline, along with valuable project management industry best practices, such as Risk Mitigation Plans, Risk Registers, and contingency needed to mitigate risks. However, the effectiveness of these tools has been highly variable and frequently not valued by IBR Recipients as much as by BETO. BETO continues to emphasize the value of these tools in its FOAs and in its award kickoff meetings. One area where BETO is strengthening early implementation of risk-based assessments is by requiring an independent validation of the application. In this way, BETO is utilizing the Independent Engineer to provide its professional judgment on the effectiveness of proposed risk mitigation plans and risk registers by IBR Recipients before the project expends substantial funds.	Both	Active Project Management	Planning	Project Management	Project Execution

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87	* N/A *	Not Project Specific	Commissioning, startup and shakedown seems to take much longer (at least twice as long as planned) and is much more costly than expected. For example, many pilot scale projects required at least 2x the planned time to complete shakedown. Many of the projects struggled to complete the IE performance test because resources were expended during the commissioning/startup/shakedown phase addressing unmitigated risks through corrective actions and design changes. Many IE performance tests have not achieved continuous, steady-state conditions for any sustained period of time before an issue emerged to cause disruption to the test. Again, projects appear to be overly optimistic that once mechanical completion is achieved, that scaling up first-of-a-kind technology is not much riskier than commissioning/startup of commercial technology.	The impacts of underestimating the amount of time and money needed for the commissioning, startup and shakedown of first-of-a-kind IBR technologies ranges from 2-4 times as long and upwards of \$10M in additional costs.	Based on this experience, as well as learnings from the IE's experience and IPA benchmarks, BETO needs to more closely scrutinize the commissioning, startup and shakedown costs and schedule when conducting the CD-2 (Approve performance baseline) review. Also, risk mitigation during the construction phase needs to be monitored more closely to see if lingering problems will carry over to the commissioning /startup/shakedown phase. Simply achieving mechanical completion does not necessarily mean a risk is fully mitigated. CD-4 should have appropriate commissioning, startup and shakedown milestones/metrics to show a plant achieves steady-state operations. Tying DOE reimbursements to achievement of these milestones would be a logical incentive to drive effective commissioning/startup/shakedown using a realistic schedule and budget.	Both	Award Negotiation	Technology Readiness	Project Execution	Project Management

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96	* N/A *	Not Project Specific	Some projects entered operations in a single step and had a rigorous CD-4 before being allowed to move forward. Some projects were allowed to move into partial operations with a partial CD-4, while others were allowed to enter partial operations without a CD-4. These CDs occurred within BP2, BP3, or in between budget periods; essentially, BETO did not apply the CD-4 in a consistent manner. BETO needs to address this weakness in execution of its own process.	The impact of this weakness was that CD-4 was reviewed, but implemented unevenly across the various projects, especially as related to the different scales (Pilot, Demo, Commercial). The level of rigor and due diligence varied between projects.	A key learning for BETO was that the application of CD-4 for a pilot is different than for a demonstration- or commercial-scale plant. Essentially, CD-4 (Approving start of operations) for a pilot plant is actually closer to commissioning and starting up the plant for the first time. Shakedown is an outcome of pilot plant operations since it has never been done before at this scale. In contrast, CD-4 for a demonstration- or commercial-scale plant occurs after commissioning, startup and shakedown has occurred. Approval to operate at these two scales should be approval to move forward with steady-state operations and conduct the IE performance test. This will be clarified, both internally within BETO, and in subsequent FOAs. Additionally, alignment of the final budget period (BP3) with CD-4 should be standardized.	Internal	FOA Development	Programmatic	Project Management	
99	* N/A *	Not Project Specific	The value of the Independent Engineer (IE) has been demonstrated both to BETO and to many of the IBR Recipients. The interactions have been professional and provided many valuable insights. The IE's expertise, coupled with DOE's interest in balancing project risks while simultaneously assisting the IBR projects to be successful has developed into a strong collaboration.	The impact of engaging an IE to support BETO's IBR project due diligence has manifested itself in smarter, better documented decisions by BETO; whether those be at the Critical Decision Go/No go point, or at other points of a significant nature. BETO's credibility with the industry has also been improved and enhanced due to its use of the IE. Not surprisingly, banks underwriting IBR project loans subject to loan guarantees have relied on BETO's reimbursement schedules (prepared with the IE's assistance) as a basis for developing their own loan disbursement schedules.	BETO has learned the high value that comes with having an IE as part of its due diligence team and intends to have an IE contractor on board for all future IBR FOAs.	Internal	Active Project Management	Review	Project Execution	

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104	* N/A *	Not Project Specific	Different approaches have been used for establishing and negotiating reimbursement schedules. BETO has tried to be flexible to meet each IBR Recipient's unique cash flow needs, while maintaining consistent and effective control on funds reimbursement through contractual budget periods and detailed reviews of backup documentation for invoices (which includes the IE).	While no single reimbursement schedule model has been adopted, control of federal funds has been effective.	Best Practices - Requiring that the IBR projects submit all proposed invoices to BETO in draft before uploading to the invoice system, VIPERS, has allowed BETO and the IE to continuously improve the quality and effectiveness of federal funds control, especially with complex invoices.	Both	Active Project Management	Financial		
110	* N/A *	Not Project Specific	Having the appropriate skill sets during different phases of IBR projects is vital to success. Often, the team that developed the core technology does not also possess the skill sets to scale-up the process. This requires aligning with strategic resources that possess the requisite project management, financial management, business development, feedstock supply, product marketing and chemical process startup skills combined with the design, construction, commissioning, startup and testing expertise. To achieve a strategic fit takes time for relationships to evolve and become integrated.	In several of BETO's IBR projects, these strategic relationships were not sufficiently mature to manage a successful project and this led to cost-share issues and schedule delays due to the need to negotiate these partnerships.	BETO needs to emphasize the need to have strategic partnerships and financial arrangements fully matured at the time of application to a FOA so that time is not lost waiting on selected Recipients to negotiate non-disclosure agreements, financial commitments, RACI charts, performance guarantees, liquidated damages, etc.	Both	Active Project Management	Project Team		