"SRU/TGTU Project Execution and Startup Lessons Learned from Owner/Licensor Perspective"

Marcus Weber, Thomas Chow, Theresa Flood

Fluor Energy Solutions

Presented at the 30th Annual Brimstone Sulfur Recovery Symposium
Vail Colorado September 11, 2023

Abstract:

This presentation covers lessons learned from an Owner/Licensor perspective in design and construction of several 500-1000 MTPD multi-train SRU/TGTU projects. Implementation of these large, complex projects demand substantial costs and incur significant schedule duration. Due to the traditional lump sum EPC execution approach typically utilized, all participants are not always aligned in the best interest of the Owner. Even if design decisions are not based on transactional contract constraints, actions resulting from limited knowledge of design and operating parameters still can result in execution which is not in the best interest of the Owner. Examples of lessons and success stories are shared.

Licensors and Owners have mutually shared motivations for successful project execution, smooth unit operation and low lifecycle cost of ownership. Shared motivation supports both the Owners ongoing business success as well as the Licensor's reputation and pursuit of future work. Licensor's expertise, gained from multiple past projects, can be leveraged to act on the Owner's behalf and to avoid detrimental issues that can derail project success.

With large complex projects, execution is typically divided into distinct phases. It can be difficult to have the right discipline input, consistently over time as the facility goes through these project phases. It is not uncommon to have a shortage of personnel and can be difficult to arrange involvement of the eventual operations, construction and maintenance personnel, especially early in the project. Influence and ability to control costs greatly diminish as the project progresses. Frequently, simple expertise based feedback, if implemented at the right time point in the schedule, results in enormous project value. Advantages can be seen in the form of cost savings, schedule reduction, rework avoidance and lowering of project risk. Often, late changes in a lump sum execution environment are cost prohibitive to implement, resulting in the facility being trapped with known faults and constraints. Extended schedules complicate project execution; instead, bringing in the correct expertise at the right time mitigates project risks and enhances the likelihood of success.

Example categories of lessons to be covered include:

- Optimizing CAPEX/OPEX tradeoffs in operation flexibility and reliability in terms of processing capacity, number of trains, redundancy and turndown requirements
- Ensuring early and continued inclusion of Licensor expertise into the project design outside of the traditional deliverable based approach, such as 30%, 60% and 90% 3D model reviews
- Avoiding potential conflicting interests between Owner and EPC during lumpsum execution
- Familiarizing operations and maintenance with Licensor technology for best equipment and controls implementation
- Aligning layout of facility to assist with flexibility of operations, stability of process and transitory modes of operation such as turndown, startup and emergency or unplanned shutdown
- Including Licensor knowledge in design of DCS configuration, stream & alarm identifiers, and DCS graphics navigation for successful controls implementation
- Implementing safety with respect to the process, plant layout and operational configuration
- Improving Operator Training by involving the Licensor in development of the Operator Training Simulator and subsequent training classes

This paper highlights un-intended consequences of detailed design and construction developments during lump sum execution, and how these were addressed to achieve successful project implementation.

PAPER:

Sulfur recovery projects can be complex undertakings. SRUs are typically included as complementary units and as an enabling technology in larger petrochemical projects and it is not uncommon to see these either as new grass roots petrochemical facilities or as an expansion of existing facilities. As the industry strives to develop projects that will meet expectations on investment returns, a typical approach is to push for world scale facilities that can exploit economies of scale and flexibility in terms of feedstock and product slates. These large complex projects require significant planning to optimize scope and budget expenditures. Long project delivery schedules are typical as the project navigates the development timeline from conceptual planning and forecasting through multiple financial investment decision gates, detailed project development, construction, startup and a lifetime of operation.

Large, complex capital projects are typically executed in a gated approach where several phases of preliminary engineering are completed in feasibility studies accompanied with CAPEX estimates to prove out the investment decision. It is not uncommon that several rounds of preliminary project definitions are evaluated, typically with increasing detail and ideally with increasingly more accurate CAPEX estimates. During these feasibility studies, it is not uncommon that overall facility feedstock, facility configuration, product specifications, emissions regulations, or other project requirements result in an evolution of requirements for the SRU. For well performing economic investments, it is critical that all portions of the facility complement one another. Each unit or portion of the facility may limit the overall project's revenue potential if bottlenecks result in any unit or area, whether the lack of capacity is due to poor design, forced outages, or other limitations that result in decreased project overall facility capacity.

One strategy typically employed in world scale projects is scale of economy. Projects are increasingly developed with larger throughputs, and more complex or challenging feedstocks. This creates a range of operational requirements for individual units, such as an SRU. Operational flexibility is important, and as such, an optimization between CAPEX spend and ongoing OPEX cost is required. It is easy to install spare equipment, up to entire spare trains within units, however this comes at a large expense. Even with installed spared capacity, a cold spare unit is not instantaneously available for operation due to long temperature ramp up requirements. Alternately, maintaining spare capacity in hot standby results in increased utility costs without a corresponding product revenue, and even worse, results in wear and potential degradation of the unit.

During project development, these constraints are addressed. The extent to which this overall project optimization is successful sets the limit of the project's economic return. Challenging this overall project optimization is the long schedule duration and the involvement of multiple parties with design and integration of these facilities. Although required for a complex facility design, longer schedules tend to increase the number of parties involved with the execution of the project, which dramatically increases the interfaces and planning required to achieve success. Incorporation of technology can leverage investment return, however, this also increases the knowledge requirements for this integration.

Technology licensors have shared interests with project owners in the successful execution of projects. Owners desire both CAPEX and OPEX optimization for low lifecycle costs and execution of their projects within cost and schedule constraints established for expected economic return. Similarly, technology licensors desire the same outcomes for the projects they are involved with, as future projects are sold based on successful past project performance. Each Owner's success story becomes another differentiator for the reputation of the technology licensor.

Project execution requires cost, performance, and schedule certainty. For complex projects it is not uncommon to have multiple contractors involved. Work is typically executed sequentially, with frequent handoffs to other parties. For cost and schedule certainty, it is not uncommon for portions of the work to be executed on a lump sum basis. Once a contractor is selected and given notice to proceed under a lump sum basis, focus shifts to minimization of contractor costs, which is not always aligned with optimization of Owner's facilities. Similarly, it is not uncommon that minimum effort in understanding licensor's technology is spent to help control costs.

A lost opportunity in project development is the sequential nature of each package or phase's deliverable production. These are typically characterized by long bid cycles, complex contract negotiations and, as a result, time allocated for CAPEX/OPEX optimization is minimal. Commonly individual parties' deliverables are rushed from a schedule standpoint, and after long contractual negotiations, are included in the next phase's bid process. This tends to lock in standard, reference features, with minimal incorporation of individual projects uniqueness and opportunities. Overlapping these sequential phases with proper control of project updates allows for optimization and incorporation of the most up to date project information and knowledge. The ability to utilize the down times between phases is an opportunity to optimize the project and should be used for the project's benefit.

Technology as a Lever

Emphasis needs to be put on project configuration when selecting a technology. Technology is a lever that can both minimize CAPEX while at the same time minimizing OPEX. In an SRU, it is not uncommon to desire redundant trains, or at a minimum redundant equipment/instrumentation within operating trains. On the other side of the operational range, increased turndown capability is always a great operating flexibility.

Examples of where SRU technology can result in incorporating both of these benefits include:

- Oxygen enrichment incorporated to minimize equipment sizes in new projects or increase capacity in retrofit projects.
- Part time use of oxygen enrichment to allow for train redundancy. Normal operation on air minimizes oxygen OPEX cost; while during train turn-around, the remaining trains can operate with oxygen enrichment to maintain the same capacity as all trains operating on air only.
- Operational stability in reaction furnace control is improved even with small amounts of oxygen enrichment.
- Sizing and number of trains matched to facility needs; individual SRU/TGTU trains configured to operate well within their range of operation.

- Carbon capture can be incorporated into the SRU by utilization of 100% Oxygen enrichment (Oxygen Enhance Claus Carbon dioxide Recovery Process - OEC2RP®). This can be implemented from initial facility operation, included as a design feature to be turned on/off as necessary, or incorporated as a future operating mode.

- Hydrogen recovery from SRU. Operation of an SRU with OEC2RP® technology results in additional hydrogen production. Hydrogen can be separated for use, or if not required, incinerated for the production of additional high pressure superheated steam.

Carbon Capture and Hydrogen production via the OEC2RP® process can be summarized with the following example from a sour gas treatment plant. Table 1 shows the SRU amine acid gas feed composition. Table 2 shows the SRU feed streams and sulfur, hydrogen and carbon dioxide products.

AAG feed for OEC2RP® Example	
	Mol %
CO_2	22.16
H_2S	69.22
H_2O	8.23
COS	0.0003
Hydrocarbons	0.17
BTEX	0.16
Mercaptans	0.06
Total	100.00

Table 1 – OEC2RP® example amine acid gas feed composition.

SRU/TGTU FEED & PRODUCTS FROM OEC2RP® OPERATION		
Sulfur Capacity	MTPD	3,000
Oxygen	Nm^3/hr	42,200
SRU Tail Gas (From 3rd Condenser)	Nm^3/hr	180,700
TGTU Absorber Overhead	kmol/hr Nm^3/hr	2,260 50,600
TGTU Absorber composition		
H_2	Mol%	24.2
CO_2	Mol%	60.2
N_2	Mol%	1.7
H_2O	Mol%	13.8
COS	ppmv	240
H_2S	ppmv	270
Hydrogen and Carbon Dioxide product streams		
H_2	kmol/hr	546
CO_2	kmol/hr	1,360

Table 2 – OEC2RP® example feed and product streams.

- Use of formulated amines such as BASF/ExxonMobil's Flexsorb® SE, Flexsorb® SE Plus and OASE® Sulfexx can be beneficial for sulfur recovery efficiency, enabling meeting stricter SO_2 emissions requirements. Formulated amines typically reduce (or eliminate) utilities consumption.

Expertise at Critical Points in Project Schedule

World class facilities can improve project success, by breaking from the traditional mode of reviewing deliverables after completion. In this execution approach, little interaction is spent upfront with understanding the technology and its benefits. Work typically proceeds in isolation with documentation and deliverable review after completion. This mode of execution frequently can result in rework. Many times, opportunities are lost where it is cost or schedule prohibitive to incorporate. Due to lack of interaction, many times issues are discovered as part of a "punch list" style walk down at or near construction completion. Punchlist items are typically difficult to fix, result in significant cost and many times can impact project schedule. See Figure 1 for an example of a simple punch-list item. Many times, lost opportunities are simply not captured, or if discovered late in the project cycle become trapped as part of the facilities' permanent design. These can result in difficult or problematic startup or operation. In some cases, facilities are forced to operate at reduced processing capacity due to design deficiencies, incur higher utility consumptions due to use of lower efficiency equipment, or have increased need for maintenance, more expensive maintenance, and ultimately a higher cost of ownership.

Figure 1 – Example of a "punch-list" item discovered late in the EPC process. The amine acid gas line needs to be free draining towards the left. Note solution required cutting & re-welding numerous pipe sections, removing and reinstalling insulation, remounting valve actuator for clearance as well as re-routing electrical and instrument air connections. This facility had 3 trains with identical installations on each train. Issue was discovered after piping in several of the trains had already been insulated.

As an example, interaction of an Engineering, Procurement and Construction (EPC) contractor, with a technology licensor is typically limited to a subset of project drawings and documentation. Also, EPC contractors executing in a lump sum environment tend to limit interaction to more of a document review or punch list mode of operation. Past experience from a licensor perspective, is that if technology incorporation is limited, then the licensor's expertise is not always involved at the critical development periods of the design's evolution. If the requirements of the technology are not fully understood, implementation of the technology potentially leaves some of the CAPEX, OPEX and operational flexibility benefits unrealized. While this punch list execution mode does ultimately result in project completion, minimization of EPC contractor overall expense drives decisions. With this approach, many features, constraints, operational flexibilities, and/or lost opportunities are trapped as less optimal solutions in the facility.

A better way to execute projects and capitalize on efficiency is to bring expert knowledge in at appropriate times in the development cycle. This bridges knowledge gaps, accelerates best practice implementation, minimizes rework, and therefore improves efficiency. Understanding the technology features, even if only one parties' responsibility (such as in lump sum execution), increases the project's effectiveness and as a result, helps achieve certainty in the project's cost, schedule, and performance.

Simple interaction early in the development is the key to world class project execution. The licensor's knowledge of their process, how it starts, operates, and challenges in range of operation from turndown to plant full capacity can be a catalyst for EPC contractor's successful implementation of this technology. As an example, licensor evolvement in the unit's early plot plan development can help optimize equipment and instrumentation layout. See Figure 2. Convenient co-location of equipment, controls that complement the process, and layout that considers startup and shutdown procedures can be implemented from licensor early involvement in the plot design. Additionally, the licensor recognizes areas that are subject to corrosion and/or plugging and can ensure the design minimizes these risks to the facility components, avoiding high maintenance costs or potentially unsafe conditions. This early interaction is a win-win-win solution:

- EPC's detail design avoids rework and many times incorporates less materials and quantities,
- The Owner gets a facility that is easy and flexible in operation, while minimizing costly OPEX potential;
- The licensor gets the benefits of their technology incorporated into a world class facility that will have optimized lifecycle costs, thus sustaining their technologies' reputation.

While avoiding rework and ensuring lower material quantities may not be the direct responsibility of the owner under a lump sum execution approach, not focusing on these issues frequently results in cost or schedule overruns, which challenge all parties on complex projects.

Examples of Licensor knowledge transfer to EPC contractor:

- Plot plan development
- Model Reviews
- SRU/TGTU Operation Review
- Proximity of Equipment / Consider Layout Optimization for the process, for the Operators, and for the maintenance crews
- Access Requirements During All Modes of Operation; Bridges between Structures or ideally a common access structure in lieu of duplicates.
- Intent of Process/P&ID Requirements; requirements are listed, however intent and understanding is not always correctly implemented
- Best Practices
- Aligning Design of Facility for Flexibility of Operations, Stability of Process and Transitory Modes of Operation such as Startup or Unplanned Shutdown
- Most Times an Experience Based Solution is Lower Cost Option, but if identified late, Impact to Schedule becomes Prohibitive to any Changes. Instead Work Progresses Past Opportunity for Solutions and Improvements
- Control logic; safety and protective logic
- DCS configuration

Figure 2 - Reaction Furnace structure separate from Claus Reactor/Condenser structure. Combining/connecting these two structures potentially would have reduced construction quantities as well as saved operations staff the need to repeatedly climb up and down numerous stair towers.

Avoiding EPC Conflicts

It is important to configure EPC contracts for success. It is not uncommon to have some form of lump sum contract terms in place. Under these conditions it is frequently thought that changes in quantities fall to the responsibility of the EPC contractor. The EPC contractor is incentivized to minimize their costs by meeting minimum project requirements. From a Licensor perspective, specific technology related requirements or technology opportunities are described, but not always understood, or if understood, incorporated incorrectly. Frequently opportunities are missed or discovered very late in the project schedule, such that they go unrealized. This is typical of the common deliverable review process. This is a reactive, after the fact, review frequently done on a deliverable by deliverable basis. A much more proactive approach is to coordinate licensor input early in the design development. Simple, timely guidance can greatly accelerate project schedule. Incorporation of the technology licensor's multiple project experience base allows opportunities to be implemented. For many larger projects it is not uncommon to have multiple trains. Typically, the first train is designed and largely copied to subsequent trains. Lost opportunities with the initial train configuration/design are then duplicated to the remaining trains, making later optimization more difficult.

Strategies to provide win/win/win solutions for the Owner/EPC/Licensor include pre-negotiated requirements for interaction early in the development process. This interaction should focus on upfront guidance, as opposed to solely an after the fact review. Frequently these types of activities are limited based on perception of hours spent and cost of additional reviews, rather than on the benefits that can result. Simple misunderstandings that are not caught until an end of job construction punch list review can incur significant costs for field rework, even with only a single “punch list” item. Whereas, the costs for additional review alignment meetings is more than offset by avoiding a single “field fix”. Design mis-understandings and their cost greatly increase with unit complexity, size of the facility and number of trains. Issues becomes much more difficult, expensive, and schedule prohibitive to fix or optimize later in the process. Early feed back allowing influential input to an optimized solution results in increased efficiency of the work process.

Sub-optimal design impacts both CAPEX cost and OPEX cost. Simple issues such as equipment layout guidance can result in optimization of platform access, minimization of lines subject to corrosion and/or plugging, ease of access for maintenance activities and resiliency of the facility to upsets. Train startup, shutdown or turndown operations activities that need specific, sequential, or interactive attention from operations can be located in close proximity within easy access. This results in common operator actions being easily executed. Many times, these optimizations result in lower construction quantities, which again can be realized as an overall win/win/win solution. If these high level configuration features are not incorporated early, it is unlikely that they will be implemented as the project evolves, thus trapping a less than optimal solution into the final plant configuration.

Another area that early licensor involvement can be beneficial is where long project development schedule doesn’t allow for all Owner stakeholders to be present. An example of this is using licensor involvement to compensate for lack of operations participation in early project deliverables, model and safety reviews. If the owner’s operations and maintenance staff hasn’t yet been fully mobilized at the time of these reviews, the licensor can provide this feedback, such that experience gained from many past implementations of the technology are incorporated. Again, this is best done on an early proactive basis. If allowed to slip to an after-the-fact inspection and punch list item, frequently the opportunity is missed.

As there are frequently multiple sequential steps in complex project development, licensor input to each phase helps create a balanced schedule. There are opportunities where the large time lag between successive project phases can be utilized for optimization. For example, the licensor can focus on a specific optimization of design, such as reduction of water use while the Owner is negotiating contracts with bidders on the next phase. This creates opportunities to enjoy CAPEX and OPEX efficiency without impacting the overall project schedule.

Process Configuration Optimization

Prior to selection of an EPC contractor, it is important to optimize the implementation of the selected technology. It is important that the SRU feed is characterized and well understood. Importance should be placed on all expected modes of operation, range of operation and turndown required. This allows configuration optimization addressing reliability and redundancy, which enhances operations flexibility and reduces impact of upsets. This resiliency reduces the potential for unit trips or forced equipment outage as systems are more closely and easily maintained within their normal operating conditions.

As stated before with Oxygen enrichment technology, it is possible to both maintain all trains within operating conditions while providing for spare/redundant capacity by utilization of Oxygen enrichment incremental capacity. With the elimination of spare trains, more cost effective redundant equipment, instrumentation and analyzers can be incorporated into each individual train, again improving the operational and maintenance flexibility without having to install a complete spare train. See Table 3. All of these technology leveraging features must be determined early in the project development cycle to allow knowledge transfer and maximize opportunities for optimization of these features.

		Air Only Alternate	Oxygen Enrichment Alternate
Sulfur Capacity		1500 MTPD	1500 MTPD
Normal operation		3 x 500 MTPD operating (air), additional 500 MTPD train spare (4 trains total)	3 x 500 MTPD operating (air), redundancy provided by oxygen enrichment (3 trains total)
Operation with Single SRU train out of service		3 x 500 MTPD operating (air), 4th 500 MTPD train out of service	2x750 MTPD operating (oxygen enrichment); 3rd train out of service
Advantages	Operational Flexibility	Standby train requires several days warm-up period, if not maintained in operation	Capacity essentially instantaneously available with O2 introduction
	Carbon Capture	Requires separate post combustion system (expensive)	Inherently included at minimal additional cost

Table 3 – Example of SRU/TGTU train redundancy provided by part time oxygen enrichment; Both alternates provide 1500 MTPD sulfur processing capacity.

The process configuration optimization described above leverages technology and allows for detailed optimization of CAPEX and OPEX balance. Incorporating the capability for Oxygen enrichment and air operation and advanced TGTU amines, utilities consumptions can be optimized, and in some cases completely eliminated. Even if utilities are not eliminated, they can be minimized to the extent necessary to provide operational flexibility, address potential upsets and avoid the need for spare trains/equipment.

With large savings on equipment from the standpoint of spare trains or processing capacity, prudent decisions can be made on critical equipment such as key analyzers. With case by case critical equipment/analyzer redundancy or sparing incorporation, there is less requirement to take a train offline. With greater reliability of key equipment and controls, the process can be controlled more accurately, which minimizes the potential for upsets and process excursions. This minimizes maintenance and OPEX related costs incurred by process upsets, such as needing to replace catalyst degraded during an excess air upset caused by poor tail gas analyzer function. When individual trains are kept in operation, the number of startup cycles is minimized. This also lowers the number of temperature cycles that all the equipment items must transition through, and avoids the associated utilities required for these transitory modes of operation.

Distributed Control System (DCS) configuration

One area that licensor has found that requires specific attention is Distributed Control System (DCS) configuration. Frequently, the selected EPC contractor sub-contracts this task to a third party. Selection of a DCS subcontractor with this experience is critical; personnel assigned to the project should also have previous SRU/TGTU configuration experience. It is essential that the specific technology has been incorporated into the project documentation used for configuration of the DCS and that the personnel developing the DCS configuration have SRU experience. DCS configuration schedules typically require a design "freeze". However, the information needs to be complete as a package or this simply shifts the effort required to complete the missing information to a much later point in the project schedule. Modifications become more costly when done in the field and effort need to be duplicated across multiple trains on an individual field-change basis.

Simple DCS graphics configuration of the SRU/TGTU allowing easy maneuvering between process steps and across trains is essential. Mis-operation due to un-intentional control manipulations of the wrong train need to be minimized via distinct train uniqueness of the same control loops. Automation of frequently repeated tasks, such as incinerator and reaction furnace warm-up are beneficial if done properly and with smooth temperature ramp rates. Operator's attention is better utilized in an overall train/unit supervisory role. Poor DCS graphics configuration causes Operators to scrutinize individual controllers, rather than providing the Operators with a good overview of each train's performance.

Also important is detailed knowledge of the process from a safety and equipment protection standpoint. While smooth operation and avoidance of process upsets is the primary goal, safety and protective logic must prevent equipment damage and environmental release.

Operator Training Simulator (OTS)

Operator training simulators can be a great asset in starting up new SRU/TGTU units. With new facilities, there typically comes new operators. Even if operators have previous SRU/TGTU operating experience, they may not have experience with the chosen licensor's technology. Advance training prior to unit startup with the project's specific configuration, such as number of trains and mix of common/train specific equipment can greatly enhance unit initial commissioning and startup. This in turn leads to more quickly achieving unit capacity and performance.

An operator training simulator allows operations staff to become familiar with the project specific technology and process configuration. While operators may have SRU experience, ever increasing environmental regulations tend to increase SRU recovery efficiency requirements. This tends to increase requirements within the TGTU and forces recycle of many intermediate process and vent streams to the front of the reaction furnace. Control strategies between technology licensors vary even with fundamental air/oxygen control loops to the reaction furnace. It is important that knowledge specific to the project's selected technology is understood and ideally becomes second nature to the operation personnel. Past habits with different control strategies using different ratios, factors, or trims need to be relearned. Process control, setpoints, trip points and protective logic are all important to trouble-free operation.

One area that typically needs attention even from experienced operators is the unit configuration in multi-train SRU/TGTUs. There is typically a mix of train unique systems and equipment as well as some shared or common equipment and systems that interface to all trains. These systems are important to understand, as they have the ability to impact all trains in the event of a trip. Without understanding these critical interactions, intended sparing and redundancy may not be realized. A good working knowledge of common systems and their intended function is needed to prevent all trains tripping based on common system failure.

Operator training simulators can help familiarize plant staff in mapping train and unit capabilities, constraints and train-to-train interactions. One common concern is differentiation of the individual trains in a way that prevents unintended mis-operation of the same control loop in an unintended train. More importantly, OTS can train and help operators how to react to unexpected operation mode changes or unscheduled events. This assists with developing procedures to bring the operating unit back to stable operating conditions. Typically, the equipment and instrumentation tag numbering scheme assists with this, however color coding individual trains, and other unique train identification on operator workstations can assist greatly with this differentiation.

One opportunity that is seldom incorporated into SRU/TGTU DCS controls is feedback on overall cost of operation. Simple calculations that display overall unit efficiency and more specifically cost per unit of product sulfur produced, allows operators to connect actual operation configuration to its associated operating cost. Simple inputs, in terms of feedstock, consumption/production of utilities, consumption of catalyst and/or equipment life can be summarized on-screen, providing real time feedback to operators. This feedback provides a metric in terms of cost of operation and is a great help in OPEX optimization based on actual operating conditions.

Summary

In summary, complex projects require cost, schedule, and performance certainty to achieve their investment objectives. Owner and Licensor's have shared interests in the successful execution of projects. Sulfur recovery projects are increasingly being done under more challenging conditions. Incorporation of technology is a lever to reaching investment objectives, and can lower CAPEX as well as OPEX costs despite more challenging conditions. Ever increasing environmental regulations, and the push for carbon emissions reductions can easily be incorporated upfront, or as a future operating mode in SRU design. Proactive win/win/win interaction between the owner, licensor, and EPC contractor are critical to capture opportunities and avoid trapped inefficiencies within the project. Structuring project execution to allow time for optimization between the multiple project development sequential steps works well. Using the long negotiation periods between the individual project phases provides a schedule opening for this to happen. Incorporation of these lessons learned result in world class facilities that are resilient, providing the operational flexibility and reliability required of them. Using these techniques results in lower project execution risk and shortened overall project schedule, as well as lower CAPEX and OPEX cost.