Industrial & Energy Technology Project Finance

A Startup and Developer's Guide to Scaling and Commercial Success

New Energy Risk
The Power Of Certainty™

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Executive Summary

New Energy Risk helps accelerate the global transition to sustainable technology by supporting emerging industrial and energy technologists and developers. This guide draws upon decades of combined commercial experience of the New Energy Risk team partnering with and supporting nearly a thousand projects across dozens of technology verticals, many that are first of a kind. Read on for the details, challenges, opportunities, and solutions to successfully scale pre-commercial industrial and energy technology companies in the context of project finance.

Project finance is a powerful fundraising and corporate development structure for companies that are commercializing industrial and energy technologies. Upon completion, project finance provides access to large pools of lower cost, non-dilutive capital. Traditional equity capital providers and senior lenders must assess investment risk; project finance contractual structures and related risk management standards, when properly structured, proactively mitigate both of these capital markets' key investment risks. Thus, project finance solves major capital sourcing problems and greatly reduces frictions in the technology commercialization and scale-up process.

Historically, project finance has served large infrastructure projects with total installed costs (TIC) in the hundreds of millions to low billions of dollars [1] and has been funded by the municipal bond market and multi-national banks. In recent years however, project finance has been adapted to smaller technology projects with funding sources expanded to non-bank counterparties. Yet typically lenders do not finance technology risk. Government loan programs such as the US Department of Energy Loan Programs Office (DOE LPO) were created to solve this problem. Private market pathways also finance projects burdened with greater technology risk.

For those with technology risk, this guide presents a series of tools and best practices to increase an industrial or energy technology company's chance of securing project finance and discusses how to save months of pre- and post-commercial development time, expense, and equity dilution.

While this guide focuses on emerging technology project finance, more comprehensive resources on general project financing are:

- A Typical Project Finance Terms Sheet – Verdigris [2]
- A Guide to Project Finance – Dentons [3.1]
- Project Finance in Theory and Practice – Gatti [4.1]
- Project Finance for Construction and Infrastructure – Pretorius and Lejot [5.1]
- Project Finance: Practical Case Studies, 2nd Edition, Davis [6.1]
- Corporate and Project Finance Modeling – Theory and Practice – Bodmer [7.1]
- Project Finance Structuring and Risk Analysis – Bodmer [8]
- Project Finance 2020 – Chambers Global Practice Guides – Sorj et al. [9.1]

Chapter 1
Introduction

Definition and Short History of Project Finance

Project finance has several definitions, some more legally descriptive than others. It is basically a single-asset limited-recourse financing with a construction phase, purposely structured to separate the credit quality of the project asset from the credit quality of the sponsor. This allows development stage companies with limited credit to access the broader debt capital markets. In other words, and in the context of this guide, project finance is the financing of the construction of an industrial or energy infrastructure facility, majority funded by debt, which will utilize cashflows generated by the infrastructure asset to repay the debt.

Limited-recourse finance—whereby the lender has limited claim against the sponsor should debt repayment be insufficient—originated on ancient Roman cargo-carrying merchant ships, whose voyages in the Mediterranean were backed by a fernus nauticum (sea loan). Yet this type of finance did not take off in the modern sense until the late 1970s, concurrent with the development of the mortgage-backed securities market and globalization [10]. Applying the principles of securitization to single-asset risks enabled lenders to assume greater risks than before due to advancements in financial contracting. This led to the financing and construction of much larger projects such as off-shore US Gulf and North Sea oil platforms [3.2].

In the 1980s, practitioners with project finance origination and structuring capabilities multiplied, and the project finance model was rapidly adopted across the public infrastructure sectors (hospitals, bridges, tunnels, roadways, pipelines) [3.3]. However, project finance did not become widely applied in private industry for yet another decade, and even then, was only used in OECD countries by the largest banks with project finance origination and structuring capabilities. Consequently, project finance largely remained in the realm of Fortune Global 500 companies with multi-national banking relationships.

In the 1990s, a handful of clean energy projects including hydropower, geothermal, and waste-to-energy technologies were project financed typically as public-private partnerships (PPPs) focused on power generation assets [4.2]. It was in the aughts when project finance for other renewables such as wind and solar greatly expanded. According to ETH Zurich, as of 2004, project financings accounted for 16% of renewable energy transactions globally, but by 2015, they accounted for more than 52% [5.2]. In the 2010s, project finance became utilized for newer clean technology deployments including Nth-of-a-kind facilities (NOAK) and more recently for first-of-a-kind facilities (FOAK) [6.2, 7.2].

The project financing of assets bearing greater technology risk has gained interest in the last 10 years with global efforts to combat climate change. Given government priorities to deploy meaningful climate change projects, the financing of these emerging technology projects has traditionally been funded by state and local development banks with political mandates to assume these risks. However, technology risk financing has been more broadly enabled through the advent of private market solutions. These include technology performance insurance, which transfers technology risk from the capital markets to the insurance markets. Technology risk insurance is thus viewed as a keystone that could allow emerging energy technologies to be more quickly and broadly deployed.

Project finance is built upon the free market principles of property and contract rights. For example, large oil and gas infrastructure projects are massive capital outlays that rely on debt to meet total capital requirements and risk adjusted equity return hurdles. They also rely on long-term contracted cashflows to ensure debt repayment. If contract rights are at risk, these projects are much less likely to secure financing. OECD countries have therefore had more success with project finance due to their stronger and more reliable property and contract rights.

Special Considerations for Technology Project Finance

Technology project finance is a subcategory of the project finance market referring to the project financing of new technologies. It is distinct from the rest of project finance because of the introduction of asymmetrical technical risk perception between technology developers; engineering, procurement, and construction firms (EPCs); and capital providers.

Capital providers require high-standard EPC contracts, which only transfer risk from the EPC to lenders and investors after the commercial operations date (COD). However, some EPC contractors are either (a) unwilling to assume technical risks through COD due to their unfamiliarity with the proposed technology or (b) if they do assume the technology risk, (i) the EPC contract price is exceedingly high, which invalidates investor returns or loan repayment profiles and/or (ii) EPCs may demand intellectual property transfer, which is untenable for technology developer management teams and investors. Capital providers also require detailed technical due diligence to overcome the assumption of technology risk. Diligence may require months of independent engineering review and EPC discussions.

A technology project finance transaction relies on convincing lenders to assume well mitigated technology risk. It is the developer's responsibility to ensure efficient and effective communication of complex technical information.

Project Finance Conceptual Framework

Project finance theory is primarily based upon the conceptual foundations of the *nexus of contracts* and *comparative advantage* theory. Second order supporting theoretical concepts include *complete contracts, principal-agent theory,* and *shareholder/stakeholder theory*. Most discussions within project finance development and execution can be reduced to these core concepts.

The *nexus of contracts theory* asserts that corporations are nothing more than a collection and summation of contracts between parties including shareholders, directors, employees, suppliers, and customers. The firm bargains with each individual stakeholder group over a set of rights that will protect the firm-specific assets that it makes available for production.

Comparative advantage theory states that certain actors produce more of a good at a relatively lower marginal cost than their competitors. These actors can realize this cost advantage through the amount of land, labor, capital, entrepreneurship, and technology, with higher margins when trading with other parties. Likewise, advanced technologies provide superior capital and operational efficiencies within free market economies, which establishes the development of these technologies as the foundation for a comparably higher company equity internal rate of return (IRR). This is independent of government subsidies and support and relates to emerging energy technologies because they are commonly thought to rely on government incentives to succeed. However, the most promising technologies will generally be the least reliant on government subsidies.

Complete contract theory is based upon a scenario in which an agreement could fully define counterparties' respective rights and duties to account for every possible future state of the world, hence making their contract 'complete.' In other words, a complete contract would spell out the relative rights of the counterparties for any physically possible risk that could materialize. Under a complete contract, counterparties are protected from all contractual risks. However, because it would be prohibitively expensive to create and execute such a contract, contracts in the real world are usually incomplete. When structuring project finance, the goal is to build a set of contracts that are as complete as possible, to provide protections in as many scenarios as possible. This maximizes counterparty confidence to partake in the project.

Principal-agent theory describes a relationship that can result in moral hazard and incomplete contractual scenarios, which occurs in most cases. The *principal* refers to an entity that is seeking representation or to have decisions made on their behalf such as shareholders. The agent refers to the entity acting or making decisions on behalf of the principal, although not always legally obligated to act as a fiduciary, which allows the agent to act in their own best interest. Moral hazard materializes in finance or business when an agent has incentive to accept greater risk exposure on behalf of the principal than they might take on themselves; there would be little recourse and limited downside potential to themselves if the risk materialized. Protections put in place throughout the project's contractual structure can limit the ability for a single agent to influence the project's overall success.

Shareholder theory suggests that a corporation's managers have a duty to maximize shareholder returns such that a corporation is primarily responsible to its stockholders. In contrast, *stakeholder theory* suggests that a corporation's managers have a duty to consider the interconnected relationships between a business and its customers, suppliers, investors, and the surrounding communities, and should create value for all stakeholders, not just shareholders [9.2]. By way of methodically structuring project finance, the *nexus of contracts* strives to achieve a tolerated balance between shareholder and stakeholder motives. Public relations, permitting, and government incentives are also necessary for successful project execution and are based upon foundations of *stakeholder theory.*

The Project Finance Goal: Highly Creditworthy Stand-Alone Credit Profile

While project finance is now a common and well-established financing standard, technology project finance is relatively new. Regardless, the goal is to create a stand-alone entity, the project company, whose stand-alone credit profile (SACP) is derived from its contracts rather than the credit of the sponsor. If that SACP is investment grade, it is referred to as 'highly creditworthy' (HC-SACP). HC-SACP is a signal of superior project technical and commercial quality.

Project finance is like a securitization of a physical operating asset that includes a construction phase, in that it limits lender recourse to assets within a financed single-purpose entity. The assets' value is typically comprised of contracts which, once executed and performed, result in the creation of tangible property and inventory and intangible stakeholder relationships such as raw material supply and product offtake contracts. Whether a project's financing is feasible depends on the credit quality of each of these contracts versus the risk appetite of the capital available to finance such a project . Ultimately, project finance should result in a superior cost of capital relative to the next-best financing alternative, regardless of the type of capital deployed. Project financing can achieve this superior capital cost because, like securitization, it separates asset credit quality from the "whole", such as from a lower credit-quality corporate holding company balance sheet.

By separating unrated sponsors from their project's SACP, project finance can be a useful tool for smaller or unproven project sponsors. Project finance is especially beneficial for smaller technology developers that might not have substantial balance sheets or previously demonstrated project success. Additionally, the introduction of technology risks greatly elevates project risk profiles, but pathways still exist to execute project finance transactions for first commercial technologies.

The HC-SACP standard allows for faster technology deployment and other competitive advantages. The full benefits of the HC-SACP are summarized below:

Greater debt. By signaling that a project has ideal risk mitigation, an HC-SACP attracts larger quanta of debt and higher debt-to-equity ratios. More debt reduces the need for equity, increases levered returns, and reduces sponsor dilution. More debt can result in a greater plant size and commercial scaling, which also reduces dilution by limiting the need for intermediate-scale facilities.

Greater scale. With creditworthy customer demand comes the investment capital to support this demand, which translates to investment in larger projects.

Faster execution. Companies achieve greater scale faster than the competition. The technology and commercial development process to achieve an HC-SACP will result in the highest standard of construction and process engineering available. These efficiencies are critical to scaling a technology company without underperformance or other operational disruptions.

Higher returns. Because scale can be achieved rapidly with less dilution, comparatively higher long-term operational and risk-adjusted returns can follow. As an example, project finance allows early Series A funded project development companies to close on Series D or E capital amounts, while not experiencing Series B through D dilution and operating risk. An HC-SACP can permit what would typically be viewed as a development-stage company to raise uncharacteristically large capital amounts for a subsidiary in which it owns a large amount of the common equity. This structure means the holding company experiences minimum dilution.

New to credit ratings, or looking for more detailed reviews of how the large rating agencies view project risks within different ratings bands? The following resources provide an in-depth look at the ratings agency criteria used for judging project finance transactions:

- Standard & Poor's Project Finance Ratings Criteria Reference Guide – S&P Ratings Service [11]
- Counterparty Risk Framework: Methodology and Assumptions – Mitchell and O'Neill [12]
- 2015 Annual Global Structured Finance Default Study and Rating Transitions – South and Gurwitz [13]

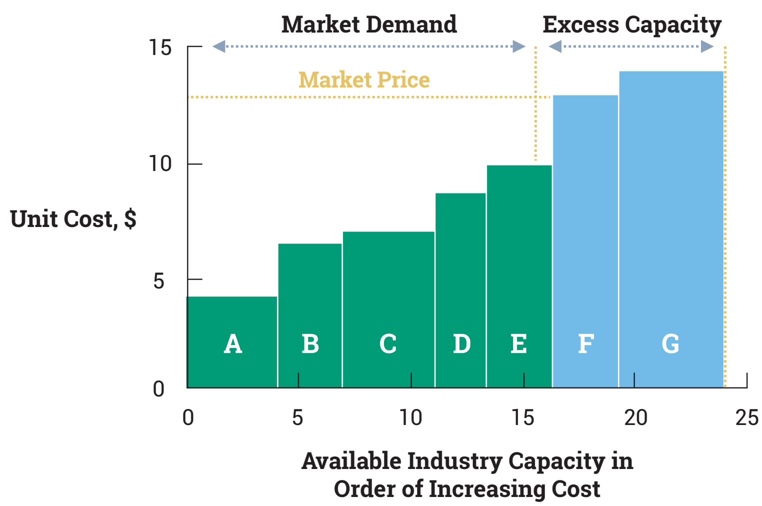
The Appendix of this guide also includes an abridged version of factors that may negatively affect a project's credit profile.

Technology Project Finance: Integrated Project Management

A project management framework for achieving an HC-SACP must account for both the *technical* and *commercial* aspects, related workstreams, and team capabilities necessary to execute a technology project financing.

The framework benefits developers deploying FOAK commercial-scale facilities that would be deemed 'unproven' by traditional capital markets. If project risk-mitigation targets are achieved through the technical and commercial development process, the project reaches the ideal finance transaction profile, an HC-SACP [14].

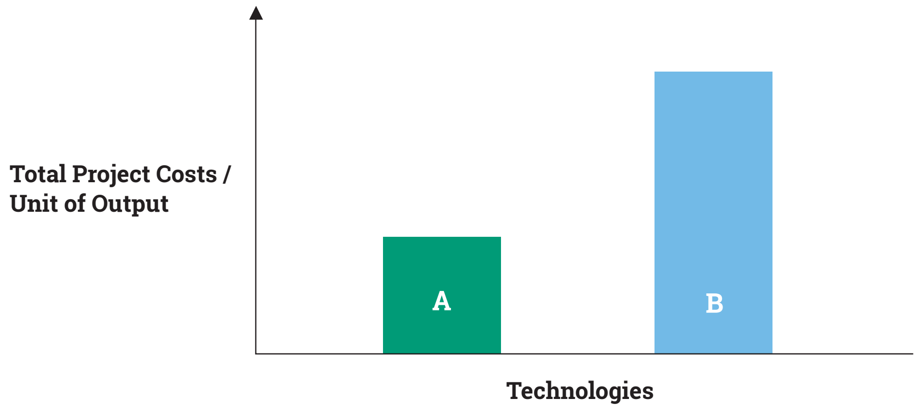
Project *technical* development is reviewed in Chapter 2 through the lens of the front-end loading (FEL) framework. The objective is to establish comparative advantages measurable via IRR calculations. Specifically, the goal is to ensure that one can credibly demonstrate that a technology is both (i) comparably lower in capital intensity (i.e., dollars invested/capacity output) and (ii) that its total production costs are on the low side of the industry production cost curve. Because lenders and investors see numerous project transaction opportunities within individual industry verticals, the ability to demonstrate the comparative advantage and merits relative to the next best competing technology can make or break a lender or investor's interest in supporting a project. The greater merit that is established, the wider array of debt and equity investment markets one will be able to access.



Customers will rank suppliers by the overall lowest total production cost. In this figure, suppliers A through E will get sales while suppliers F and G are too expensive for their capacity to be utilized.

Source:
https://www.mckinsey.com/business-functions/strategy-and-corporate-finance/our-insights/enduring-ideas-the-industry-cost-curve

Figure 1. Production Cost Curve Example



In a competition between two technologies, denoted here as 'A' and 'B', Technology 'A' will have a superior IRR and a shorter technology investment payback.

Figure 2. Capital Intensity Example

Project *commercial* development is reviewed in Chapter 3in the context of the finance timeline. The objective is to establish one's comparative risk profile using project risk-mitigation standards through contractual structures and provisions. This is where many technologists and inexperienced developers stumble because they are unfamiliar with what risk-mitigation strategies, contractual structures including specific legal clauses, and third-party validation reports are required to establish a commercially distinctive project. This includes focused, strategic business development, and contractual measures to mitigate construction, supply, offtake, operational, and market risks. Equally important is a thorough understanding and communication of counterparty credit risk profiles and the credibility of a project to repay any borrowed funds.

The FEL and finance processes run concurrently and are strongly inter-related. FEL is discussed at length in Chapter 2.

While the substance of a project's HC-SACP will always be a leading indicator of project success, people matter significantly, too. A common trait of successful project developers is that they demonstrate credibility and commercial sophistication in front of institutional investors. After all, capital providers will be entrusting developers with millions of dollars, so the ability to effectively communicate risk is necessary. Since project development is an interdisciplinary activity, project development teams must have both commercial and technical expertise. We review these varied skillsets below. Lastly, project finance developers will need to 'expect the unexpected' as project development will undoubtedly progress in steps forward and steps back. Notwithstanding, a well-organized and experienced team with project-relevant skills and capabilities will increase a development team's probability of success.

Teams ideally have two leads: one commercial and the other technical with core capabilities, networks, and relevant experience to execute their respective commercial and technical workstreams.

Key Skillsets for a Project Sponsor Team During Commercial Project Development

Process Chemistry – Expertise with the specific fundamental chemistries used by the technology, and analytical techniques required for qualifying quality or on-spec nature of feedstocks, products, and intermediates.

Experimental Theory – Experience with design of experiments (DoE) and the needs of research for process development unit (PDU), pilot, and pre-commercial demonstration-scale facilities.

Process and Process Integration Engineering – Commercial-scale expertise with unit operations (or experience with the closest prior-existing analog of a technology's unit operations if novel).

Environmental Health & Safety – Significant experience building a culture of meticulous workplace safety, carrying out HAZOP reviews, evaluating failure model and effects analysis (FMEA), and operationalizing of standard operating procedures for expected and unexpected procedures.

FEL – Developing, structuring, and executing the engineering process necessary to deliver a high standard EPC contract.

Business Development – Networking, building connections with prospective project partners and capital providers, identifying market opportunities, and client origination.

Project Development – Experience with project management, contract negotiation, land development, coordinating audits, permitting, working through logistics of utility supplies, public speaking.

Project and Corporate Finance – Structured finance, experience with entity formation, partner screening and selection, capital raising, fluent with corporate, strategic, and manufacturing and operations finance.

Operations Management – Experience coordinating facility operations and maintenance, experience training and managing operators and technicians, building a culture of thoroughness, efficiency, and raising concerns.

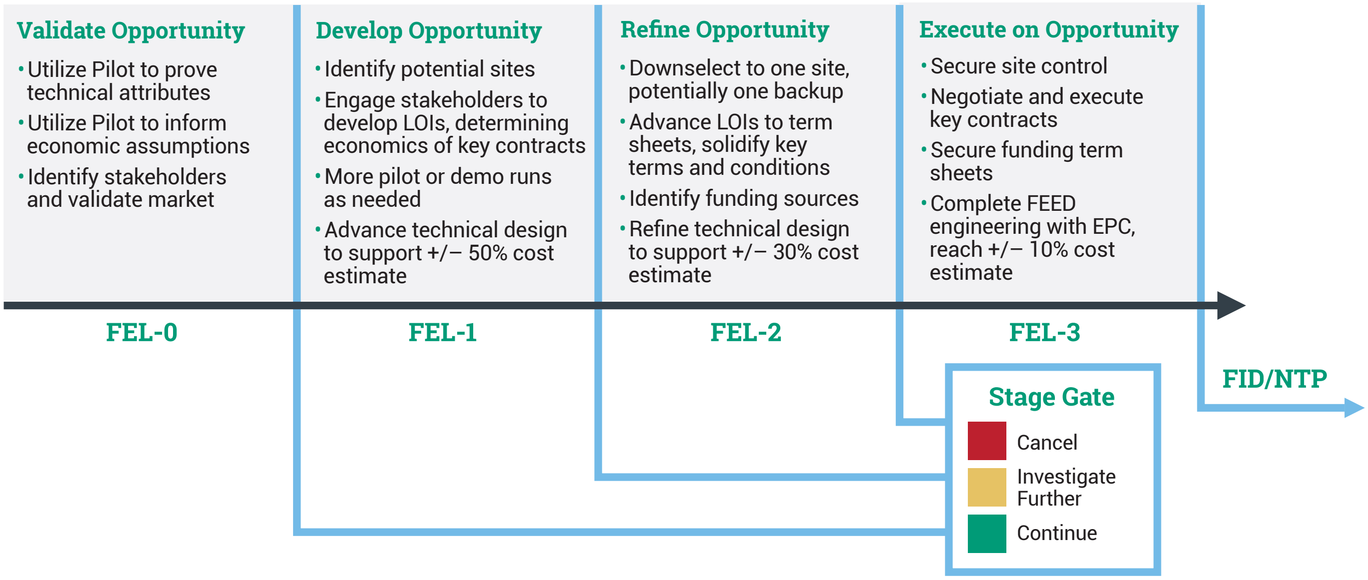
Industry Expertise – Expertise with market dynamics, network maintenance with key players, vendors, technology suppliers in the sector, ability to establish presence of the project/project sponsor in the space, and ability to identify emerging opportunities.

Chapter 2

A Framework for Technology Project Development: The Front-End Loading Process

Front-end loading (FEL) is a step-by-step deliberate process that provides a framework to engage in technology project and related EPC contract development. This ensures project technical risks are properly identified and mitigated prior to the deployment of large sums of funding. Although particulars of technology development standards and timelines are industry- and technology-specific, lessons here are generalized.

FEL is a stage-gated technically-focused project management process in which the decision to continue to pursue a project is revisited at several points. The process is broken into multiple, distinct stages: FEL-0, FEL-1, FEL-2, and FEL-3. These progressively detailed project and engineering design stages have increasing accuracy of project cost estimates. Moving forward to each subsequent stage requires larger capital investments to complete, and therefore greater stakes, but also provides continual certainty regarding the merits and challenges of a project. The FEL process starts with a conceptual project and ends at notice to proceed (NTP) and/or final investment decision (FID). At that point, the end of FEL-3, roughly 20-40% of engineering design-level documentation is complete and cost estimates have been narrowed to a +/- 10% accuracy. In this chapter, we focus on the technical milestones associated with the FEL process. In Chapter 3, we overlay the commercial and financial milestones that are a core part of the FEL process.



The FEL process has four stages, numbered zero to three. Each stage includes both engineering and commercial goals; when these goals are met, project maturity increases and project risk decreases.

Figure 3. Stages of the FEL Process

The goal of stage-gating the development process is to "fail fast," which refers to the process of discovering potential failure mechanisms and commercial challenges as early as possible, at a time when they can be mitigated with the least cost and effort. If they cannot be acceptably mitigated, then the project is called off before too much capital has been committed. All parties anticipate a potential no-go decision at each stage.

Some industries or segments utilize a process known as front-end engineering design (FEED), which is roughly synonymous with the technical milestones present in FEL-3. The successful completion of FEL-2 would result in the engagement of a FEED contractor to complete FEED as part of FEL-3. Upon completion of FEL-3 including FEED, design documents are completed to be consistent with what is known in some industries as a "Class 1" cost estimate, which has a typical accuracy of +/- 10%. Even at this relatively incomplete level of design, the level of engineering development is sufficient to enable an EPC contracting process that is suitable for a project finance transaction to reach financial close. It is usually not until after financial close that the EPC will take the FEED/FEL-3 deliverables and build out completed construction drawings and specifications.

Different norms for the FEL process exist for different sectors. The FEL process is described here as it is utilized broadly for intensified industrial infrastructure projects, particularly in energy and oil/gas, and is generally applicable across technologies and disciplines. However, other processes that perform the same function as FEL may be equally useful in developing projects in a methodical manner. For example, the commercial real estate sector often uses systems where 100% of design documentation and drawings is completed during their equivalent of FEL-3 due to the low levels of technical risk in office construction. The industrial sector is distinct in that detailed design occurs after FID and execution of the EPC contract. For more information on the industrial FEL process, see *Front-End Loading in the Oil and Gas Industry – Towards a Fit Front-End Development Phase*, G. a. van der Weijde [15].

Competing Strategies: Build-Own-Operate vs. License Out

There are generally two ways a technology can be brought to market: development of a basic engineering package (BEP), which enables the technology to be licensed out to project developers, or directly building and operating commercial-scale facilities with project development kept in house. The former is usually only afforded to developers with a history of successful technology commercialization, and with at least the FOAK built and operating. Early technology companies that hope to rely on licensing often find themselves in a catch-22 situation—early technology companies that hope to rely on licensing often find that potential licensees seek data from prior commercial deployments prior to investing the time and money to pursue a license. As a result, many early technology companies are confronted with the need to develop their own projects, at least at first, to stimulate demand for licenses. This can present challenges if, as is often the case, the leadership of these companies does not come with project development experience.

Proving Technology Performance at Scale

To discuss the FEL process, it is important to understand how FEL differs between true FOAK projects and those that come later. Because of the financial resources required to build a commercial facility, capital providers must have comfort that technology performance has been demonstrated and that any remaining scale-up risk for the facility is defined and acceptable. It is therefore incumbent on the technology developer to understand that, upon embarking on the FEL process for a FOAK project, significant time and capital will likely need to be deployed throughout the FEL process to enable its first project finance transaction. Subsequent projects generally move significantly faster by utilizing much of the development and demonstration work undertaken as part of the FOAK project financing.

Technology performance must generally be demonstrated through successful operation of the technology, often in pilot campaigns that meet pre-determined key performance indicators (KPIs). KPIs can be split into two general categories: those which measure performance during operation, and those which measure operation uptime. While KPIs vary by technology type (see box), the state of technology development across sectors can be generalized by using the technology readiness level (TRL).

KPIs: Different Performance Criteria for Different Industries

Although KPIs for various technologies differ, their overall function can be generalized. KPIs for successful process integration include:

- The ability of a facility to produce the quoted quantity of product from feedstock (volume or mass per unit time, often in tons/day and tons/year, or gallons/day and gallons/year).
- The ability to achieve target product specifications or purity levels.
- The ability to achieve continuous operation without interruption over certain hours or months.
- The facility's 'uptime', plant availability, or plant operating hours between shutdowns.

Because of complex dynamics resulting from the integration of process units, data confirming performance and successful test campaigns in a fully integrated pilot is the best way to prove a technology.

The specific KPIs that should be developed for a pilot or demonstration test campaign are technology and use-case specific. It is up to the technology developer, who understands these requirements best, to develop a set of KPIs that will be useful later in demonstrating performance and enabling project finance. For example:

- For wind and solar, the capacity factor is constrained by availability of the renewable resource (intermittency) and the demand for produced electricity (curtailment). As a result, KPIs focused on performance over dynamic loading conditions are appropriate.
- For industrial application, such as biorefineries, feedstock supply and product offtake are usually contractual and thus plant availability is constrained by disruptions in steady-state operations or maintenance shut-down needs. KPIs focused on mean-time between shutdowns is more applicable here.
- For processes that convert a feedstock to a product, KPIs related to conversion efficiency (percent of input converted to output) as well as the relative production of various end-products is useful.
- When feedstock quality is poorly understood or controlled, KPIs around the ability of a process to handle multiple inputs, and the rate at which the input can change without process upset, become important.
- Battery and other energy storage technologies' KPIs include energy as a function of cycle count, power as a function of cycle count, reliability or mean time to failure, round-trip efficiency, coulombic efficiency, and system availability. KPIs under different operating conditions corresponding to different grid-services, use-cases, and environmental conditions are often critical to demonstration.

The TRL system, originally developed by NASA in the 1970s to unify spacecraft maturity language, is an oft-used method of measuring technology development [16]. Numerous TRL scales have since been developed for a variety of industries and use-cases. The scale adapted by J. Harmsen, tailored to the development of sustainable industrial technologies [17.1], is particularly useful in the context of FOAK project development, and is used here. Harmsen defines the completion of commercialization (TRL-9) as a fully-functioning, commercial-scale facility meeting all specifications. However, given the significant process and efficiency learnings that occur during construction and operation of the first few facilities, TRL-9 should not be considered achieved until the technology has achieved three or more years of commercial experience at two or more full-scale facilities. Only at this stage of TRL-9 is a technology considered mature and proven in the eyes of the capital markets.

TRL Level	Description
TRL-0	Idea stated
TRL-1	Experimental proof of principle individual key novel process elements
TRL-2	Process concept design provided
TRL-3	Proof feasibility process concept design by techno-economic assessment
TRL-4	Process experimentally validated by integrated mini-plant experiments
TRL-5	Process techno-economics assessed by professionals in process industry
TRL-6	Process technology demonstrated in industrial environment by pilot plant
TRL-7	First commercial scale demonstration plant in operation
TRL-8	Learning points demo-plant incorporated in commercial process design
TRL-9	Commercial process operation meeting all specifications

TRL is a summary means of describing the status of a technology's development toward full commercial deployment.

Figure 4. TRL Definitions for Sustainable Process Technologies, reproduced from Harmsen 2014 [17.2].

For new technologies, or new deployments of established technologies in different geographies or under different operating conditions, the TRL is lower than TRL-9, requiring further mitigation during the project development process. In general, technologies below TRL-6 are not appropriate for project finance beyond FEL-0 (discussed below),and need further development. Technologies at TRL-6 may commence FEL-1 and beyond. Successful commissioning and an extended operational campaign of a first commercial facility may bring the technology to TRL-8.

Although stories of shortcuts through the technology development process are available, developers of new technologies should be open-eyed and clear-headed about the timescales and capital requirements needed to reach TRL-7 and enable financing. Attempting to cut corners or skip steps on the way to project financing usually results in an unfinanceable project that is unable to attract key stakeholders or capital providers.

The Stages of FEL

The stages of the FEL process, described in summary here, provide the requisite structure to ensure a project does not miss key risks that would inhibit a successful project finance transaction.

Prior to FEL-0, it is expected that a technology project developer will ensure there is market demand for the potential project's product, and that access to this market would be assured through development of their technology. The market should be expected to have unmet or inelastic demand for the foreseeable future. Lab-scale experiments—e.g., batch reactors or small-scale continuous-flow reactors—will have been developed and operated to show the merits of the technology against initial costs. Once technology development has progressed and business assumptions are defendable, then development can proceed to FEL-0.

FEL-0 includes the engagement of key project stakeholders (i.e., offtakers) to validate commercial-scale interest, develop a master plan with key risks (discussed in the next chapters), and assemble high-level cost estimates. Stakeholder engagement is important to develop a better understanding of needs, which will help shape the target facility scope. At this stage, the expenditure of funds needed to build a sub-scale process demonstration unit (PDU) is approved; key stakeholders may even participate in funding the development of the PDU. In general, the PDU will have throughput approximately one to two orders of magnitude larger than the lab-scale reactor, and likely an order of magnitude below a commercial unit. Significant process learnings may drive partial redesign, which typically result from early PDU experiments. Analyzed data from later PDU experiments help to refine the business model. If conservative extrapolation of findings from this process still points towards viable commercial scale facilities, the process can proceed to FEL-1. In general, the FEL-0 stage will encompass most of the early years of a new technology company's life, multiple funding rounds, and significant learnings about the technology and its application.

In FEL-1, the conceptual project is fleshed out in considerable detail, taking the project from a generic plan to one rooted in specifics. Sites are identified and commercial feasibility is established. Work plans, permitting studies, and risk management plans are refined to verify that the project should initiate contracting and design. During this stage, the project companies are incorporated, key contracts (i.e., product offtake and feedstock supply) are brought into focus through letters of interest (LOIs) or term sheets, an EPC firm is identified to carry out FEL-1 and FEL-2 activities, and facility regional siting is settled. During FEL-1, the process configuration is finalized through the development of a block-flow diagram, and equipment types for key unit processes are identified to gain an early indication of capital costs. With a commercial unit process and sizing established, an integrated pilot or pre-commercial demonstration units may be required to demonstrate the key integrations or process-steps beyond the capabilities of the PDU. As more project partners and counterparties are brought on to the project, they may be approached for development capital to fund pilot programs and commercial development. FEL-1 results in a "Class 4" cost estimate with typical accuracy of +/- 50%. These inputs are combined with economic assumptions derived from the stakeholder LOIs to refine the financial model. If the model, combined with a realizable mitigation plan for the various project and development risks identified during FEL-1, indicates a strong commercial-scale business case, the project continues to FEL-2.

Pilot and Demonstration Program Development

There is little that can substitute for a fully integrated demonstration facility. Successful integration of a demonstration facility's unit operations includes the achievement of reliable, steady state, continuous flow operations that can successfully handle, pre-process, and convert feedstock into product, then store that product on a continuous basis. KPIs for successful integration of unit operations are physical in nature as the plant achieves nameplate operational metrics.

A first-pass approach to sizing of intermediate pilot facilities starts with the end goal (i.e., target target full-scale facility size and capability) and works backward to identify relevant scale-up sizes. In general, a scale step-up ratio of 10:1 is the maximum factor commonly utilized for individual process steps, however larger scale-up ratios may be utilized for well understood processes that have analogs in other industries. For example, if a bench scale device utilizes a 25g/hr batch reactor, then a lab scale unit might be 2.5kg/hr, and the PDU might be 25kg/hr. If the commercial-scale unit will be 600 tons/day (25 tons/hr), the PDU alone will not be enough to demonstrate the technology and enable financing. In this case, funds to build a demonstration facility will be needed, and back-tracking can determine that the demonstration facility should be 2.5 tons/hr. This large scale-up from the PDU (100x) may require an intermediate step at 250kg/hr to reduce technical scale-up risk at the demonstration unit. Further, starting with required capability of the commercial-scale facility in mind is helpful in determining design and instrumentation requirements of earlier stages.

Because of the significant increase in cost per data point with each step-up in pilot facility scale, it is common to go back and carry out additional testing with smaller-scale equipment before engaging test campaigns on the larger units. This allows for higher throughput and lower-cost data collection. Execution of the development program can take many years and iterations to build a thorough understanding of the technology and gather all data needed to prove the technology at pre-commercial demonstration scale.

Although different stakeholders will have different standards for what level of testing is needed to 'prove' a technology and achieve TRL-7, Section 9003 of the Farm Bill Energy Act of 2008, the USDA's Federal Loan Guarantee program authorization, is often used as a basis. The second phase of the program's application process includes technical and environmental assessment reports, including standards for technical feasibility, among other metrics. The program specifies that a 120-day continuous, steady-state production run in a fully integrated demonstration-scale unit is required, along with operational performance data over the course of the 120 days in 30-day intervals. Performance data is expected to include demonstrated utilization of project- relevant feedstock and produce products at a yield, unit production level, quantity, and quality consistent with the design basis of the project while meeting operational duration, quantity, and quality specifications [56].

FEL-2 and FEL-3 incorporate iterative and increasing detail into the project, including the technical design and commercial structure. It is during these stages when demonstration facilities are exercised to test key operating parameters of the technology that may impact commercial operation and to generate product samples for review by the offtaker. Conversations with key stakeholders continue, LOIs or term sheets are advanced, and contracts are developed. These contracts collectively form the draft term sheet used for project financing, as discussed in later chapters. The site, and possibly a back-up, is brought under control of the developer, and long-lead permits are filed. Contingent on successful pilot trials, the EPC will carry out FEED activities, integrating data from the trials. FEL-2 normally results in a "Class 2" or "Class 3" cost estimate with typical accuracy of +/- 30%, while FEL-3 culminates in a "Class 1" estimate with typical accuracy of +/- 10%. During the FEL-3 process, an independent engineer (IE) is often engaged on behalf of potential financiers to develop a comprehensive report establishing the merits, risks, and potential challenges of the planned commercial facility. During FEL-2, conversations with potential funding sources commence, and are progressed during FEL-3. With FEL-2 and FEL-3 complete, including a finalized term sheet and receipt of relevant permits, a project is ready to proceed to financial close. Negotiations can then advance with lenders and investors. Once the FID is made, implementation is initiated with an NTP sent to the EPC with detailed design, procurement, and construction instructions as outlined in the EPC contract. During this stage, the role of the developer changes drastically from working to develop the various aspects of a project to a focus on scheduling, budgeting, and close communication with the EPC to ensure a smooth construction and commissioning process.

Development Program Planning: Rules of Thumb

- Build in contingency to work through the unknown unknowns. Contingency allows for under-promising and over-delivering to investors.
- A new technology can take 10 to 20 years to commercialize; plan accordingly and ensure funding requests are sized to enable the full FEL process.
- Modular process intensification through numbering up (enabling multiple modules or reactors to operate in parallel) can reduce the final commercial-scale size and reduce the upfront need for more pilot units, however there may be a tradeoff between additional cost per module and savings of reduced time to market, leading to an optimal number of modules per commercial-scale facility.
- Because of the interplay between thermodynamics, fluid dynamics, and chemical kinetics, modeling has some, but limited merits. Empirical demonstration of KPIs can better gauge behavior and performance of the next scale-up step.
- Although it may be a moving target, starting with the full-scale facility throughput and capability requirements can inform pilot and pre-commercial demonstration sizing and instrumentation requirements. Technology development works best if the final commercial goal is well defined.

Chapter 3

Project Phasing

Introduction

When discussing a project financing with an investor or lender, they are more likely to recognize a different set of terminology than the FEL process, discussed in Chapter 2. A project phasing timeline will better facilitate the approach and communications with capital providers. The timeline is gated by financing events and dependent on the projects' core workstreams.

The two core project development workstreams are commercial and technical. They run in parallel and ideally finish at the same time to achieve financing milestones. The commercial workstream focuses on stakeholder contracting and financial structuring while the technical workstream, per the FEL process, is gated by cost estimates of increasing accuracy.

Project finance is divided into two distinct phases: pre-development and development. The pre-development phase culminates with a project development scope, budget, and schedule. The development phase executes on this scope. Pre-finance is prior to permanent capital term sheet receipt and 'in-finance' is post receipt of equity and/or debt term sheets. The development phase culminates with a project financial close commonly referred to as the final investment decision (FID). The project construction phase follows FID. Commissioning extends through project production ramp-up to its nameplate (expected) capacity production, which occurs on its COD.

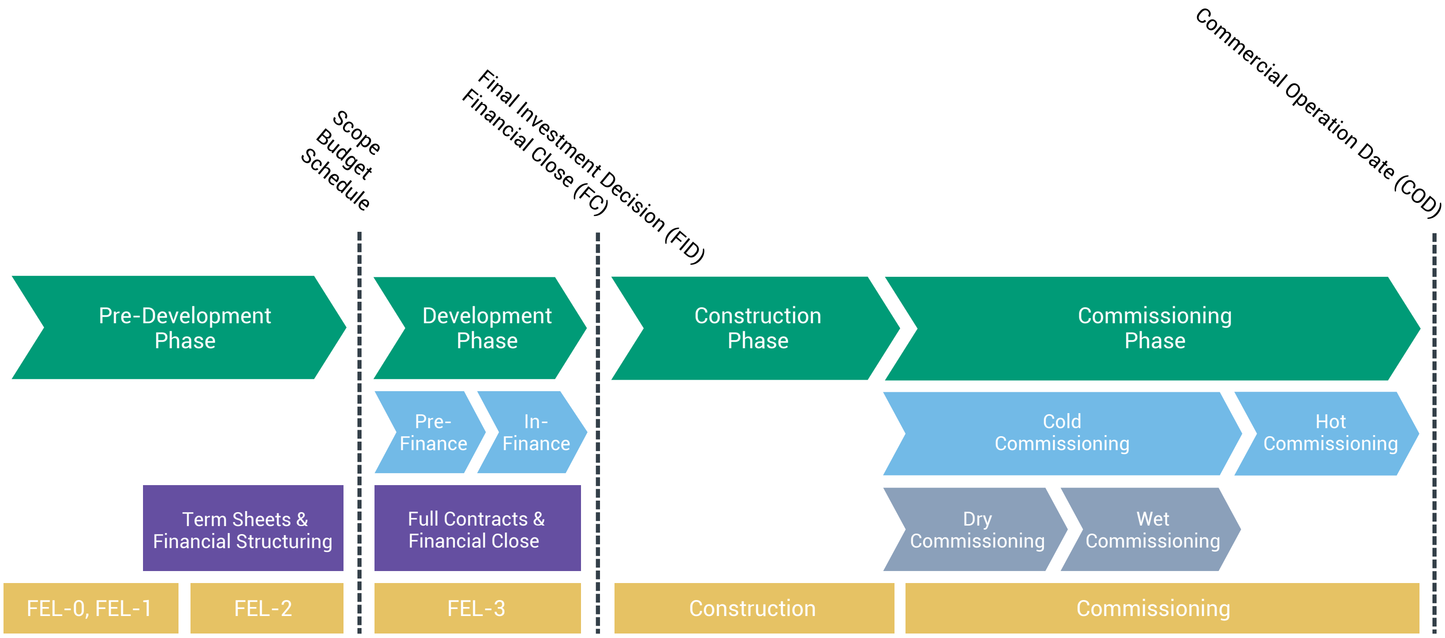


Figure 5. Timeline for a Project Financing

Pre-Development Phase

During the pre-development phase, a budget for the development phase takes shape and evolves as the FEL process proceeds. These considerations and related assumptions convey credibility, play a foundational role in a project's financial model, and ultimately convince key project stakeholders of the substance underlying a proposed project financing.

The development phase scope, budget, and schedule's accuracy are especially related to site selection and project engineering status. No individual project development phase scope, schedule, and budget is credible or complete without a site and a proposal for a FEED study (front-end engineering design) provided by an EPC. The pre-finance phase also includes standard project development operating requirements, as well as more detailed financing-related workstreams. Many developers consistently underestimate financial close dates due to inexperience with the complexities and circularities of these workstreams.

Scope

Site selection, a process engineering package, commonly known as a process design package (PDP), and an updated firm scope of work are gating items to finalize a project's FEED study scope, as any project process engineering package must be integrated with a site. Thus, no FEED study may start without a site or a process engineering package. Developers need a written FEED-phase scope from the EPC contractor to have a credible development-phase scope. The FEED study culminates with a finalized EPC contract.

Simultaneously, the project management team develops its operating workstreams to progress project stakeholder relationships and documentation from memorandums of understanding (MOUs), LOI's, or term sheets to full contracts. The management team plans to work with IEs, market and financial model consultants, and corporate and transaction lawyers to prepare for and negotiate project financing agreements with its permanent equity and debt capital providers.

These three work scopes (*FEED, key stakeholder contract fulfillment,* and *project financing agreements*) ultimately converge and culminate with executed documents at FID.

Schedule

Project engineering during the FEED study has the most significant impact on a project development-phase schedule. Special attention should be given to the sequential time required to update and confirm the scope of work during the FEED process, perform basic engineering, iterate on the contract price, and finally negotiate the EPC contract. This process can take anywhere from six to 12 months depending on a project's complexity and will culminate with executed documents at FID.

Budget

The FEED study is the largest individual expense for the development phase. Additional development-phase technical expenses include monthly costs for process equipment engineering, an owner's engineer, site, and environmental consulting and permitting costs, raw material feedstock and offtake sampling and testing, construction sub-supplier diligence and contracting, land acquisition costs, and power purchase agreement down payments.

Commercial expenses are largely related to financing and management team expenses. Common management team expenses include salaries, travel and entertainment, consultants, and public relations. Financing expenses include IE and market report costs, external financial model development, project level financing and key stakeholder contract legal fees, corporate level legal fees, board expenses, consultants, insurance consultants, investment bankers' or lenders' engagement fees, and technology performance insurance engagement and related expenses.

Banks and equity investors also typically require developers to pay their due diligence and transaction fees, which are added to closing costs during financial close. Thus, one would pay up to three times the costs for key independent reports, including one set of reports for the project company and one set of reports for the bank, which may or may not be shared with equity investors.

The most credible development-phase budgets have underlying contracts to support these efforts as well as a contingency for unforeseen expenses.

The Development Capital Round: Funding the Development Phase

The project pre-development phase culminates with a development-phase scope, budget, and schedule. These elements are communicated, alongside the project SACP, to raise funds for the development phase.

Project development capital is challenging to secure, but the most credible projects have some capital provided by project stakeholders, which shows strategic interest in the project's success. Such capital is typically provided as engineering fee deferrals, fee conversions to debt or equity, in-kind engineering contributions, or direct capital injections. Otherwise, private equity (PE) funds, venture funds, family offices, and angel investment funds fill this financing gap.

By this point in a project's lifecycle, a developer may or may not have an indication of interest for permanent project capital. If a project is at FEL-2 engineering status and on path to a near-HC or HC-SACP, that project should be able to receive an indicative fixed-price EPC contract quote from a leading EPC contractor with the understanding that it will include a large contingency to account for the fact that the project FEED study has not been completed. In such case, together with the HC-SACP, a developer could then approach investment banks for a capital raising engagement, or permanent capital providers for soft indications of interest. This may be a letter of interest, engagement letter, or state tax-exempt bond financing allocation. In the best case, one receives firm interest via permanent equity and debt capital term sheets, which greatly enhances chances for successful financing. Those projects that have firm equity and debt interest proceed directly to the 'in-finance' phase, while others continue to the 'pre-finance' phase.

Development Phase: Pre-Finance

Most projects do not progress to the development phase because they cannot secure a FEED contract, develop a near-HC or HC-SACP, or raise development capital financing. Those that do raise development capital proceed to the development phase and are nearing completion.

In the development phase, the owner's engineer leads the FEED process with the EPC contractor to integrate the process engineering package with the site. In the initial weeks and months, updates to the project scope of work confirms the building plans. The last few weeks are spent on EPC contract price finalization, contract negotiations, and engineering optimization.

Some projects, depending on where they are on the SACP spectrum, may not have either permanent equity or debt capital firm interest at the start of the development phase. Those that are borderline bankable need to convince the capital markets that their project budget is firm. That is, they need to know an EPC-quoted TIC of the facility. Otherwise, it is challenging to request a capital provider to spend much time on project diligence and relationships when the EPC contract price is subject to such without uncertainty and potential for fluctuation to avoid invalidation of investor return or debt repayment profiles. The optimal timing to receive a formal fixed price EPC contract is after FEL-2 but prior to initiating the FEED study, at the latest, and as early as possible in the EPC contract discussions, accepting that it will include a large contingency.

The debt and equity financing process begins with a bank book package that both summarizes and details the HC-SACP.

The Bank Book

The bank book is a document used in project fundraising to provide a capital provider with a project overview alongside necessary details. The bank book includes the following documents:

- Financing teaser
- Pitch deck
- Confidential information memorandum
- Financial model
- MOUs/term sheets
- Independent reports

A one or few-page investment opportunity description called the teaser and broader information-containing pitch decks lead to introductory meetings with potential project lenders and equity investors. The capital providers with further interest will follow-up with non-disclosure agreements and data room requests. To manage financial market information exchanges, developers create an organized bank book stored in an online data room to share with potential lenders and investors. The data room contents include the remainder of the bank book including the confidential information memorandum (CIM), financial model, MOU's/term sheets, and independent reports. The CIM expands the pitch deck into a discussion detailing a project summary and its stakeholders, contracts, technology, feedstock and offtake markets, financing sources and uses, financial model pro-formas and related scenario results, management, and transaction risks and mitigants.

Project financing preparation, including HC-SACP, simultaneously solves two key financing problems. Preparation to achieve a bankable HC-SACP signals high-standard risk mitigation efforts sufficient to secure loan financing. Furthermore, this debt availability incentivizes equity investors to participate in a project given a levered investment return opportunity.

The bank book sufficiently supports both debt and equity raise efforts, with slight, but key, target audience messaging modifications. The debt and equity capital raise effort culminates with the issuance, negotiation, and execution of individual debt and equity term sheets.

Development Phase: In-Finance

Projects that progress to the in-finance phase have executed term sheets with debt and/or equity providers and have a clear path to financial close. Risks to closing largely involve management, stakeholder, market, and/or regulatory uncertainties.

Extending the time to financial close can potentially expand project costs or prevent the project from closing. At this point, lawyers work quickly to draft, negotiate, and execute financing agreements, adding to transaction and corporate legal bills. Developers and their boards work in tandem to fulfill term sheet conditions including converting all project MOUs or term sheets to full contracts. Equity investors, lenders, and/or other financial stakeholders, together with their lawyers and trust account partners, work with their investment and risk committees to ensure satisfactory financing documentation and internal control process completion including final approvals and financing contract signatures. Management teams and financing counterparties complete funding conditions precedent, sending wire transfer details that conclude in final funding.

Term Sheet Documentation Requirements

The project finance process for emerging industrial and energy technologies requires permanent debt and equity capital. Such capital's indicative offers are documented with term sheets. It is the term sheet that demonstrates a project's progression to the permanent capital 'in finance' underwriting phase. The term sheet identifies key contracts, conditions precedent, loan covenants and parameters, and representations and warranties required to reach FID. Once the term sheet is signed, contracts and due diligence reports are then further developed, negotiated, and signed with respective counterparties, and then reviewed by the lenders or investors to underwrite and fund the capital.

Typical documents required to source a term sheet include:

1. EPC contract or term sheet based upon a received guaranteed max price TIC offer (along with completed FEL-2 deliverables)
2. Offtake agreement term sheet or LOI
3. Key supply agreement term sheet or LOI
4. O&M agreement term sheet or LOI
5. Land agreement option
6. Permits in place or in process with a credible timeline established
7. Insurance program summary
8. IE Report
9. Project introductory presentation
10. Information memorandum
11. Financial model

The lender term sheet will include sections such as:

- Minimum equity investment percentage
- Debt tenor, interest rate, amount, repayment profile
- Representations and warranties
- Conditions precedent to close
- Conditions precedent to funding
- Covenants
- Cashflow waterfall
- Events of default
- Hedging strategy
- Debt service reserve account requirements
- Construction and commissioning performance bonds/insurance
- O&M performance bonds/insurance [55]

Final Investment Decision

The development phase culminates with FID.

Despite the significant challenges in completing a term sheet, achieving financial close can be even more arduous because each contract counterparty needs to skillfully craft, negotiate, and document their individual contract. The developer's intent is to achieve the most power-balanced, interest-aligned, efficient project possible. The process can be iterative as decisions are made to mitigate or transfer additional risks from the project to another party. Ultimately, all parties meet conditions precedent, in which the lender/investor and the project will agree to close. During the process, the term sheet documents transform into a series of contracts and more detailed documents.

The loan agreement documentation closing list often includes:

1. Draft EPC contract (along with FEED deliverables)
2. Offtake agreement
3. Key supply agreements
4. O&M agreements
5. Land agreements
6. Permits
7. Lender's Independent Engineer report
8. Independent market report
9. Insurance program report
10. Loan agreement
11. Information memorandum
12. Financial model

Once financial close is completed and all contracts are executed, the EPC must be given NTP, which allows the EPC to initiate the construction phase, entailing detailed design and commencement of building the site. Timing becomes key: The debt is available for drawdown over a specific period and debt service payments must follow a contractual schedule, thus the project wishes to avoid any delays that would increase budget cost overruns or liquidity risks.

Chapter 4

Project Commercial Development & Structuring

Introduction

To achieve the ideal transaction profile of an HC-SACP, commercial development requires disciplined execution. This chapter will focus on project finance contractual, risk mitigation, and due diligence expectations and standards.

First and foremost, every project begins with the customer. The most compelling technology with robust economics is not enough to achieve an HC-SACP. The customer is the foundation of a project finance transaction, and their needs will dictate the product specification, quantity, and delivery timelines which the project must meet. The customer is also the foundation of the revenues and resulting cashflows substantiating a project's credibility to repay its debt. It is thus the role of the developer to build the project to satisfy both the customer's and the bank's parameters.

Ensuring the project is financeable is the key problem to solve, rather than optimizing for project economics. It may seem counterintuitive, but a project with the best technology or seemingly the best return may not be the most financeable. These returns must be risk adjusted; a creditworthy project customer (offtaker) is critical to achieving an HC-SACP. If the offtaker is not creditworthy, the project's ability to repay debt will be greatly diminished, as will the developer's ability to finance the project.

This credit-centric understanding and perspective must then be replicated to each of the project's key stakeholder contracts, which will eventually comprise the project's contractual structure. These stakeholder contracts, in addition to the core offtake contract, will include the: 1) land site, 2) EPC, 3) feedstock supply, and 4) operations and maintenance (O&M) contracts. The project's credit profile will begin to take shape with these fundamental contracts in MOUs or term sheet form, conceptualized and structured to mitigate lender risks. Structural enhancements will compliment and strengthen the project credit profile.

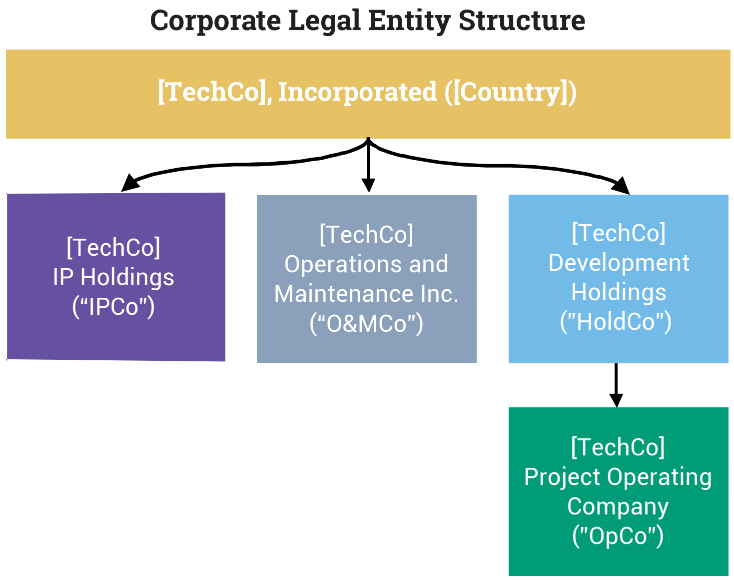
Structuring the Project Companies

Success for a project company is dependent on executing project elements prior to engaging with the equity and debt financial markets. Because companies and developers rarely have multiple chances to make a positive impression with the financial community, it is imperative to complete at the highest standard as many transaction elements as possible prior to engaging with funders. It is best to communicate with the financial community only after completing the below 'setup,' carefully considering each project transaction element.

Figure 6 shows a general schematic of a project finance transaction structure. The parent holding company is defined generically as the TechCo, which is responsible for technology research and development. Below the TechCo are three subsidiaries. The first is a subsidiary holding company (IPCo), which holds the company's intellectual property (IP). It is structured and held separately from the holding company for both tax purposes and to manage corporate asset and cashflow comingling. This subsidiary will license its technology to individual projects (OpCos), though this licensing is not necessary for a project financing if a project instead licenses technology from a third party. The second subsidiary is a company related to the O&M function of the company (O&MCo). This subsidiary, like the IPCo, is structured separately from the TechCo to manage corporate asset and cashflow comingling. The O&MCo will contract its services to OpCos, though this is not necessary for a project financing if a project will contract its O&M services from a third party.

The third subsidiary within the basic project finance transaction structure is the development holdings company (HoldCo). The HoldCo is structured separately from the other subsidiaries and siloed as a single-asset company responsible for owning and equity financing the OpCo. Below the HoldCo is the OpCo, which is 100% owned by the HoldCo and is responsible for constructing and operating the intended project. Equity investors will form the board and hold the corresponding control rights for the OpCo. The OpCo is typically established within a TechCo as a separate cost center and given specific resources to develop the project. Common equity is typically contributed from the HoldCo to the OpCo. The OpCo will receive debt finance directly from lender(s) while pledging its common equity as collateral to the lenders.

A long-term goal of this company structure is to manage a technology company's scale-up across multiple projects.



A typical project financing structure utilizes several independent but contractually-related companies.

Figure 6. Simplified Generic Corporate Legal Entity Structure of a Project Financing

As the OpCo is responsible for constructing and operating the intended project, it is the central legal entity that contracts with key project stakeholders. Figure 7 shows a general schematic of the OpCo, detailing contracts that result in cashflow to and from the OpCo.

The OpCo's legal and operational foundations are built upon its network of contracts. The materiality of each contract to a project's risk profile is unique for each project.

Figure 7. Contractual Structure of the Project Finance OpCo

The OpCo is the center of the nexus of contracts that comprises the project. The substance of the OpCo's stakeholder relationships will manifest in five key development-phase elements including: (1) stakeholder creditworthiness, (2) the contracts themselves, (3) quantitative values within such contracts which will comprise assumptions and the resulting financial model including (a) sources and uses and (b) cashflows, (4) third-party reports, and (5) structural enhancements.

The cumulative strength of each of these elements will establish the project's SACP. Those structured with the highest standards can achieve an HC-SACP.

1 Stakeholder Creditworthiness

Project stakeholders' credit profiles will largely define the project's overall credit profile. Therefore, it is advisable that every project stakeholder have an investment-grade credit profile from a major rating agency. A bank will defer to the lowest stakeholder credit rating for a project, lowering a project's credit profile to the lowest credit rating within the contractual group. An investment-grade stakeholder credit profile is especially important for a project offtaker. Many months of development time and expense can be saved by focusing business development and contracting with investment-grade stakeholders. There are many examples of projects that spend months negotiating with non-credit worthy counterparties only to have lending counterparties decline to finance projects whose offtakers have poor credit profiles.

2 Contracts

Contracting is fundamental to project finance, forming the relationship between the OpCo and external stakeholders. Contracts must communicate indicative terms by the end of the pre-development phase, as expected by project development finance counterparties. Correctly sequencing individual project contractual relationships and indications will help build momentum, reducing the time to financial close.

Contract Format Progression

Contract format will develop from initial MOUs or term sheets to full contracts by FID. A project's contractual process will be dictated by its development phase.

The pre-development phase contracting process begins with a business development effort to secure executed MOUs or term sheets. These will convert and expand into full contracts during the development phase after receipt of debt or equity financing term sheets.

Pre-development phase contracts are typically not fully developed due to project delay risk. Contracts exposed to delay risk may be withdrawn due to non-performance, which can complicate and damage important relationships. For example, a project offtaker may cancel a contract due to non-delivery per contractual schedules, at which point the project takes on the expense of replacing that stakeholder. A withdrawn contract runs the risk of potentially delaying a project for months given the time and expense related to contracting with an alternative stakeholder. This risk also elevates the potential for stakeholder relationship deterioration due to not meeting relationship expectations.

Project developers and stakeholders alike need to manage operations and stakeholder relationships. Realistic project timelines often differentiate experienced from inexperienced teams, building credibility with stakeholders. Expectations mismanagement is commonly referred to as 'deal fatigue,' which is common to some extent on any project, although it is the responsibility of the developer's management team to manage such frictions.

Deal Fatigue

Mismanagement of expectations can plague development efforts. With origins in mergers and acquisitions (M&A), the phrase applies to the process of settling any contract. Joe Hellman, CPA, defines deal fatigue as:

> *"The mental and emotional exhaustion that sets in as a transaction stretches on. Deal fatigue can cause sellers to 'shut down' (stop engaging in meaningful conversations) due to feelings of frustration, irritation, and helplessness, creating new barriers for the deal and exacerbating one that might already exist"* [60].

Hellman goes on to list common causes:

- Changing details mid-deal
- Inability to stick to schedules and timelines
- Incomplete, inconsistent, or inaccurate financial statements
- Indecisiveness among the contract parties

...and means of preventing it:

- Setting realistic expectations
- Being prepared with completed timelines and tidied financial statements
- Assigning a single point of contact
- Holding regular, concise status calls
- Developing an internal support team to discuss deal strategy to allow for quick response times
- In the context of M&As (where a single deal will last many months), taking time off before starting the process to avoid burnout

Typical Key Project Contracts

The OpCo is the central legal entity that contracts with key project stakeholders. The substance of these relationships will manifest as: (1) commercial contracts and (2) quantitative values within such contracts, which will comprise assumptions and the resulting financial model including (a) sources and uses and (b) cashflows.

Entity Formation Documents

The project financing-related company formation documents are the first contracts executed. These documents establish the company common equity ownership, board of directors, management, jurisdiction, charter, and bylaws. The relevant jurisdiction issues a certificate of incorporation, and the project will receive a tax ID. Further investment into any of these entities typically amends these documents' provisions. Tax advisors can best direct owners and developers on what type of entity to establish, such as an LLC, S-Corp, or C-Corp.

Technology/IP Rights

IP rights allow a project to implement and operate facilities utilizing proprietary technology. These rights are typically contracted via a technology license between either a project sponsor or external technology developer. These rights are a focus of the lender because they will need to be unencumbered and collateralized as part of a lender's recourse to operate the project in the event they may need to 'step in' to cure an underperforming project. IP rights will need to extend, at a minimum, through a project's expected useful life.

Operations and Maintenance Contract

O&M contracts come in two forms. The first is between the technology developer and the project when the project developer is the operator. It sets forth requirements in an O&M manual specifying the operator's operational and maintenance activities which must be carried out on a specified basis for the technology provider to continue to provide support to the facility and for insurance contracts to remain valid. The second type of O&M contract is between the project and a third-party company that carries out operation and maintenance services. This contract lists the services to be provided by the maintenance firm for their agreement. This type of O&M contract also clearly defines the quantity and price of labor operating the project, as well as a proactive maintenance program including related manuals, spare parts, and safety monitoring and control protocols.

Many emerging energy technologies do not have commercial precedents or a well-developed surrounding industry. Because of this, there might not be existing companies that offer maintenance services for this technology. Sometimes there are adjacent industries with enough mechanical understanding to offer their services. If this is not the case, the developer may need to act as the O&M operator, which lenders may see as a risk to the project. If so, they will imagine what would happen if the project sponsor were unable to perform its duties and what other party could take over.

Land Contract

Land is either owned or leased through a long-term contract. The two common forms of land leases are private versus government port and terminal concession agreements. Concession agreements can be more attractive to a project if a municipality is courting a certain industrial activity such as clean fuel production. If private land must be leased, brownfield sites can be attractive if already properly zoned and equipped with existing equipment and utility tie-ins.

Land lease tenors ought to extend past the expected project life. Another important site procurement consideration is to align the project's site acquisition, permitting, and preparation with the project's construction phase to avoid lengthening development timelines. Understanding these nuances can save months of a project development phase. Additionally, it is important to negotiate a site 'option' to reserve the rights to the land in the absence of capital prior to FID. The project site and resulting conversion to site ownership with liabilities then transfers at financial close.

Permits

Site regulatory permitting at the local, state, and national levels must receive priority attention during land contract structuring. Developers need to carefully consider project and land permitting requirements versus existing site permits. Developers, along with the assistance of a site consultant or EPC, typically create a project permitting matrix to review and analyze these regulations. Permitting is a circular problem for many developers with greenfield sites because the permitting with various regulatory constituencies can last for six to 12 months and can only begin at the beginning of the FEED process. Thus, developers must consider land permitting at a project's earliest stage of development.

Construction Contract

The project's EPC or construction contract (CC) is one of the project's most important and expensive contracts. There are several EPC contracting frameworks that fit into the project finance model. Some of the common contract types include EPC lump sum turnkey guarantee (EPC-LSTK), EPC-guaranteed maximum price (EPC-GMAX or EPC-GMP), EPC and construction management (EPCM), and open-book cost plus pricing (CPP).

CC frameworks are unequal from lender and investor perspectives. An EPC-LSTK is considered the gold standard because of its lender risk mitigation standards. Although EPC-GMAX contracts are also financeable if technology risk is appropriately mitigated. On the other hand, EPCM projects can be substantially more difficult to finance due to their greater construction integration risks and lack of LSTK or GMAX terms. The other contract types are generally considered unfinanceable under the project finance model.

Three fundamental tenets of EPC contracting specify that the EPC contract guarantees:

1. a fixed price to complete the scope of work, usually including staffing through the completion of facility commissioning;
2. a fixed schedule upon which mechanical completion and substantial completion will be finalized;
3. and performance metrics, specifying operational KPIs such as capacity factor as a percentage of nameplate capacity.

These three key contract provisions are critical because they transfer technical risk to the EPC and other project counterparties and away from the project sponsor. Figure 8 details the high-level risk ownership by contract type and Figure 9 details the risks transferred by CC type. Figure 9 also notes the general and expected credit-related assessment from Standard & Poor's, a leading credit rating agency (CRA).

Importantly, EPC contracts include a maximum limit of liability provision. Further sub-limits define financial responsibility for particular causes of loss such as material or design defects, negligence or gross negligence, force majeure, delays, and performance liquidated damages.

To make good on liability provisions and elevate these contracts bankable status, EPC contracts also specify the form of project EPC contract liability recourse. Bonding capacity forms generally include a demand bond or line of credit. Notwithstanding the bonding capacity form, the draw conditions are a key negotiation point. Regardless of the form, lenders and investors prefer bonding capacity that is the most immediately accessible form in the event of contract underperformance.

Contract Type	Construction Cost	Engineering Cost	Project Scope	Project Schedule	Plant Performance
CPP (Cost Plus Pricing)	Owner	Owner	Owner	Owner	Owner
EPCM (Engineering, Procurement, and Construction Managmement)	Owner and Contractor	Owner and Contractor	Owner	Owner	Owner
CC (Construction Contract)	Contractor	Owner	Owner	Contractor	Owner
EPC-GMAX (Engineering, Procurement, and Construction with Guaranteed Max Price terms)	Contractor	Contractor	Contractor	Contractor	Owner
EPC-LSTK (Engineering, Procurement, and Construction with Lump Sum Turn Key terms)	Contractor	Contractor	Contractor	Contractor	Contractor

Different construction contract types place various risks either on the owner or contractor. In project finance, more risk transfer to the contractor is advantageous.

Figure 8. Risk Ownership by Construction Contract Type, sourced with permission from **Biotechnology Commercialization Roadmap, Mark Warner, Warner Advisors LLC, 2021**)

For a more thorough comparison of EPC and EPCM contracting, refer to **Worlds Apart: EPC and EPCM Contracts: Risks and Allocation** [18], or **DLA Piper's report, EPC Contracts in the Power Sector** [19]. For a graphical comparison guide, see **Ausenco's, EPC or EPCM Contracts** [20].

Common Contract Name	Guidance	Assessment
EPC-LSTK (Engineering, Procurement, and Construction under Lump Sum Turn Key terms)	All of the Following: • The contractor agrees to complete the project to a fixed prices and certain date and has a very high incentive to perform a fixed schedule aligned to the project goals; • The contractor guarantees "fit for purpose" backed by compensation for the project for the present value of any underperformance against a completion test". Fit for purpose will be determined contractually by a performance test. For the test to be effective, it should be conducted under normal operating conditions at full capacity for a period long enough to be representative of normal operating performance; • There is limited relief for unexpected events, and modifications can only be requested under a strict regime, these factors reduce the risk of any price increase or delays	Highly regarded by S&P
EPC-GMAX (Engineering, Procurement, and Construction, under Guaranteed Max Price terms)	• Engineering, design, procurement of materials, construction, and management are risks borne by the contractor either through its own labor or subcontractors based on an agreed scope and specifications and with little project involvement • The contract is for a fixed price and a schedule with limited risk of variations (change orders) to affect a project's costs and time to completion • A major contractor coordinates all construction activities and has moderate to high alignment with the project goals • The Contractor has a high incentive to perform	Moderate to Highly regarded by S&P
EPCM (Engineering, Procurement, and Construction Management)	• This contract is similar to an EPC-GMAX contract but with greater sharing of management risks with the projects's management (OpCo) • The project's management takes greater risk in managing the variety of procurement and contract interfaces and the consequences of any failure • The project's management takes a greater risk on price and time to delivery without the buffer of a major contractor coordinating all activities	Moderately regarded by S&P
CC (Construction Contract)	• The contractor agrees to build to a design supplied by the project or its agent and limits its responsibility to quality of workmanship and does not warrant failure of the design to meet project objectives • There is a greater risk of change orders or variations • Incentives are limited to liquidated damages and warranties on workmanship	Poorly to Moderately regarded by S&P
CPP (Cost Plus Pricing)	• Contractor paid on cost er volume or unit of work such as in earthworks or rail-track laying • Low incentives and alignment with project goals • This contract type only provides the requisite certainty when used for simple linear construction tasks where the length is known with a high degree of certaining (such as pipelines), or railway tracks across a flat predictable terrain	Poorly regarded by S&P

Figure 9. Degree of Risk Transfer by Contract Type, recreated from Table 7 in **S&P's Project Finance Ratings Criteria Reference Guide**

It is crucial to find EPCs with the most relevant experience in technology fit and scale to minimize project costs. Firms with experience building similar technologies at similar scales will likely have already developed a base level of engineering to determine a bankable fixed-price contract with more competitive pricing.

Developers looking to build FOAK facilities might face difficulties finding a firm that will be willing to engage in an EPC contract due to the heightened technology risk. It may be difficult to find an EPC willing to provide LSTK terms or even GMAX terms for an emerging technology with high technology risk or complex construction. If an EPCM contract is offered and the facility simply integrates established unit operations in a slightly unique configuration with their own warrantees, then the integration risk might be tolerable enough for an EPC to provide an EPC-GMAX contract instead. This contract would then benefit from a well-structured technology insurance policy to mitigate lender exposure to technology risk.

It is recommended to work with two separate EPCs through the FEL-1 and FEL-2 process. This will result in long-term benefits despite an increased upfront cost through optimized project engineering solutions, a competitive front-end engineering and design FEED process, and the procurement of a bankable lower cost and higher value EPC contract.

Material Supply Contract

Sometimes called the feedstock supply contract, the material supply contract should guarantee a material specification for a long period at a fixed or indexed price per unit of feedstock. There will usually be multiple supply contracts in addition to the key feedstock supply contract for all major consumables such as catalysts, sorbents, reagents, and other required materials.

Many biorefinery technologies utilize distributed biomass feedstocks such as pre-commercial forest thinnings or agricultural residues. It may be difficult to attain an HC-SACP in this case because most forestry companies and farmers are generally not highly creditworthy. Another approach for this scenario is to contract one of the few creditworthy forestry entities to manage feedstock aggregation, such that if one forester operation shuts down, the feedstock supply continues. If the facility converts distributed agricultural residues such as wheat straw, a creditworthy grain co-operative could be contracted to manage aggregation and transportation to the facility.

Equipment Supply Contract

Equipment supply contracts cover engineering, procurement, construction, and delivery of key project equipment as well as maintenance and warrantees for this equipment. These contracts are for equipment supplied by external technology developers separate from the EPC. They usually include terms specifying delivery timeline requirements and the cost of the equipment. Equipment contracts can be ‘split’ from the core EPC contract or procured as part of the EPC contract. For equipment procured as part of the EPC contract, these contracts are written directly between the EPC and the equipment supplier, bundled with the EPC contract, and delivered to the project.

Often, emerging energy technologies piece together processes that utilize equipment from numerous technology providers. Ideally all suppliers would be highly creditworthy, but this may not be possible due to the relative novelty or specialization of this equipment. The next best solution is to aggregate and pass-through individual equipment contract terms to the project via the EPC contract such that the project's primary credit risk is with the EPC. This structure also limits construction ‘interface’ or subcontractor disputes in the event of contractual underperformance.

Utilities (Including Electric Power)

Many industrial activities that consume substantial amounts of electricity (i.e., some percentage of the local grid's capacity) will require contracts provisioning the power price and required electrical supply. Such an agreement provides certainty for facility availability and to reduce environmental hazard and safety, such as the release of a pollutant if a scrubber or other process system loses power. These contracts will define electrical supply capacity requirements, modes and timing of usage, and the period of engagement. These contracts are between the project OpCo and the regional power authority including a regional transmission authority, independent system operator, or a community choice aggregator. Some power contracts can also be 'interruptible' and provide for a lower per-unit power price. The power contracts will specify such interruptions' forward notice period, total amount per year, and individual periodic duration. A line of credit may be required to secure power in some instances.

Utility Power Transmission Contract (Supply-Side)

A contract may be needed for greenfield sites requiring new transmission infrastructure or for brownfield facilities requiring expanded or refurbished transmission infrastructure. These utility power transmission contracts specify details of the power supply required, price and timing, where the supply lands, the associated substation and or switchgear, and other transmission infrastructure logistics. Power transmission may be included with the power purchase agreement (PPA) in certain geographic jurisdictions or utility regulatory zones.

Product Offtake Contract

The product offtake is a project's core operating contract. It defines a project's profitability and credibility. The product offtake will be expected to be a long-term contract at least covering the project debt weighted average life. Ideally it will also be a fixed-price contract, although it is more common to secure contracts with prices fixed to an index thus transferring some level of market risk to a project. However, power generation projects typically have fixed-price PPA offtake contracts.

Other key offtake contract provisions include the product specification, payment terms, termination clauses, assignment, and renewal periods, which should have long notice periods to minimize offtake switching costs.

Loan Agreement

The loan agreement refers to the set of debt-related contracts between the project and debt lenders. In addition to the core loan agreement, other loan related contracts will include the trustee agreement, collateral agreement, and direct agreement providing lender step-in rights in the event of certain outcomes. All core project contracts will form an appendix to the loan agreement.

Key debt contract terms include the debt amount, interest rate, repayment date, and reserve requirements. These contracts also contain details on cashflow waterfalls, repayment obligations, lender rights, conditions precedent on drawdown of debt funds, reserve account requirements, minimum debt service coverage ratio and other financial covenants, escrow management provisions, collateral provisions, indemnities, other conditions precedent, project and lender representations and warranties, project reporting, and events of default.

Equity Agreement

Investors contribute equity to projects in either preferred or common form. Standard equity financing documentation includes a share purchase agreement, the rights agreement, shareholder and board consents, and the amended and restated certificate of incorporation. The end result is a company with a post-money valuation.

Project finance equity investing typically includes a capital injection at the HoldCo, which is contributed to the OpCo as a lender takes a security interest in the capital contributed to the OpCo. Therefore, a lender's collateral is simplified to one investment contract versus multiple investment contracts.

Chapter 6 includes a detailed discussion of project equity investment structures.

Technology Insurance Policy

Technology insurance is likely required to access the debt capital markets for technologies newly deployed or with notable past technology risk. Insurance policy contracts specify terms such as coverage limits, timing of coverage, conditions precedent for claims to be filed, terms for policy payout, policy exclusions, policy premium, expiration timelines, reserve and experience account requirements, and minimum debt service coverage ratios.

Working Capital Contract

The working capital contract establishes terms of the short-term or revolving loan financing facility required to support ongoing day-to-day project production and operational activities. This contract is typically written between the OpCo and a commercial bank and is intended to manage operating cashflow from the purchase order agreement through accounts receivable collection.

Incentives Agreement

Projects bring substantial construction and labor resources to sometimes disadvantaged locations. Local governments are therefore incentivized to offer financial support to attract projects. Incentive agreements detail such public support between the government entity and the project. Numerous incentives are available such as land grants, direct loans, equity investments, guarantees, labor training, tax incentives, zoning, transit fee reduction, advantaged power rates, etc. These packages are likely to be voted on and or debated at local city and regional council meetings. Packages are also sometimes tied to the number of jobs created or the project capital amount spent on construction. Project developers typically speak at legislative meetings in support of their project.

Reserve Account Structure

Lenders and insurers typically require that the OpCo builds and maintains a reserve account(s) for unexpected cash needs. The reserve account(s) acts as a pool of contingent liquidity that remains with the project even after construction and commissioning are completed and lasts until full debt repayment. This is especially relevant in the absence of a completion guarantee from a highly credit worthy project sponsor.

Lenders and insurers often require that the reserve account(s) is sized to cover some minimum period of debt service payments. A six-month debt service reserve is a typical lender requirement. Newer technologies or projects requiring greater structural enhancement, given a lower SACP, should expect to fund a larger reserve or one that is specific to an identified risk. Thus, lenders and insurers sometimes each require their own separately specified reserve accounts.

Reserve accounts are typically funded at financial close. Lenders may permit reserves to be unfunded when providers such as an insurance company or bank are highly credit worthy.

Contract Sequencing

The sequencing of project contract development depends on which stakeholder relationship a developer should first pursue. Typically, the offtake customer contract leads as its indication of interest is an important validation for the technology developer, its product quality, and the project's credibility. Thus, the prospective offtaker's indication of interest is typically the contractual priority and the initial stakeholder relationship to pursue. Many other project stakeholders may require this demand signal to initiate contractual discussions. In the event a developer does not yet have an offtaker, prior to engaging with the offtaker, it is important to be able to credibly explain to this counterparty what product volume would be available and when' to constructively progress this conversation.

Another key early contract is for the project site/location, which requires a permitting plan involving project engineers and relevant regulatory authorities. This signals the project's relative development phase based upon the completion of environmental, construction, and other permitting milestones. Projects without a permitting plan can experience significant delays given the time needed to properly site the project. Thus, some stakeholders may request that developers finalize their site selection or permitting before negotiating additional contracts.

Difficult-to-procure and/or key material contracts generally should be completed early in project development. For example, certain waste-to-product feedstocks are scarcer than others, as might be certain local utility PPA sources. It would be important in these situations to evidence this type of relationship as early as possible to build momentum in other project stakeholder discussions.

The last project contract to be completed is typically the EPC contract, which is significant to a project's financing uses and quantum, risk profile, and its construction-phase performance. The pre/budgetary engineering including a FEED package takes multiple months and must be completed prior to finalizing the price of the contract, hence this contract's later time sequencing. A bank will not be able to lend based on a project's internal project cost model calculations, so finalization of terms with the EPC is necessary to receive a bank term sheet.

Contract Terms

There are several key contractual terms that define a project's 'bankability.' These include *product specification*, *price, term, termination, payment terms,* and *assignment*.

Product specification defines the specific exchange of value within a project and forms the foundation for project engineering. Any material-related contract will include a product specification, typically as an appendix to the contract. A supply contract must reliably and explicitly communicate a product description including product quality, material handling, storage, safety, and other precise details for what will be purchased. This description will be validated by the EPC, lender's engineer, and other financing parties to assess the credibility of the end-to-end production process, EPC basis of design, feedstock supply and logistics strategy, feedstock substitution risks, and other technical and economic aspects. It is also necessary to understand any variables as long-lead time items to be 'fixed' early on in a project development cycle because months of engineering time will be spent designing a project around a product specification, so a product specification change at later project development phases may cost a project substantial development time and expense.

Price defines the unit economic-level agreement between a project and its stakeholders and is fundamental to a project's financial model. Other price-relevant terms include fixed or indexed pricing, escalation terms, caps, and floors. The gold standard for any project financing is a fixed price contract; this is the most dependable and predictable for a project financier. Even the seemingly most economically advantaged or profitable project with a non-fixed price or index-priced contract is not necessarily the most financeable compared to a project with inferior economics that has a predictable fixed price cashflow stream. Thus, projects with predictable cashflow streams will, in most cases, be considered more 'bankable' compared to a non-fixed price or index-priced contract.

Take-or-Pay Contracts: The Importance of Investment-Grade Counterparties

The take-or-pay clause in a product offtake contract may be the gold standard of a project financing. The take-or-pay clause was defined simply by Williams and Meyer in their 1959 text on oil and gas law, "Seller agrees to sell and deliver to Buyer and Buyer agrees to purchase and receive from Seller, or if available and not taken, pay for that quantity of pipeline gas [an agreed amount of gas]…" [57]. In other words, the buyer is obligated to pay regardless of whether they also take the product. While it may seem foolproof, it is not free of risk. There is a chance that either of the parties fail to uphold their obligations. Historic market events, such as the natural gas market crash of the early 1980s and the financial crisis of 2008, created economic circumstances extreme enough to cause buyers to breach contracts.

A 1992 study focused specifically on the mass abandonment and subsequent lack of confidence in natural gas take-or-pay contracts that resulted from the early 1980s natural gas market crash [58]. The study claimed that:

- Take-or-pay contracts do still have commercial merit
- Commodity market decline is a foreseeable risk assumed by the buyer, and does not justify an event of force majeure
- Providing timely notice of force majeure (resulting from either the underperformance of an operating asset, or the inability of the buyers to take or pay) is critical to avoid ambiguity around the genuine intents of being a good actor
- Liquidated damages are a key tool to incent parties to uphold contractual obligations, which allows the courts to judge the good intents of the parties
- Historical performance and creditworthiness of the buyer and seller are strong indicators of likelihood that contracts will be upheld

Rodgers and White note that events (like the 2008 financial crisis, when consumption declined significantly) can boost assumed probability of demand risk for commercial scale energy projects, potentially leaving them unable to sell product. Further, they describe that take or pay can be the optimal contract term, so long as the specifics of what constitutes legitimate force majeure events, the specifics of make-up clauses, and specifics of exact obligations in respect to performance obligation are included. Glossing over these details can lead to many years of financial pains [59].

Term or *tenor* denotes the contract's length. It is critical that contract terms extend to, at a minimum, the weighted average life of project's senior debt. Optimally, contract terms extend past the tenor of the project's senior debt. In some projects with long-tenor debt, contract renewal provisions are customary, but they must include long-dated renewal notice periods (i.e., six to12 months) to minimize contract switching costs.

Termination provisions signal the contract's reliability to perform through its expected tenor with minimum contract cancellation risk. Contracts with subjective 'outs' and high-risk performance triggers are less desirable than contracts with standard termination triggers related to expected performance and/or unethical behavior. Any termination provisions should have cure rights, including cure periods, to rectify any contract underperformance. If a project contract includes termination provisions prior to the term of the debt, a capital provider will likely run default scenarios to assess the likelihood of default given contract non-renewal or renewal with sub-optimal terms.

Payment terms, for example net 30 or net 60 days, including the amount of time allowed for a customer to pay its invoice after product is delivered, factor into project financing. Projects do not ramp up to 100% of nameplate capacity on day one, but perhaps instead over many months. Thus, working capital is required, so payment term clarification allows working capital to be included in project startup costs. These startup costs, like all financial variables, are shown in the financial model sources and uses.

Assignment clauses, which provide a lender with certain project control rights, while not of great economic substance, are important for debt financing as any contract must be assigned to a lender in certain situations such as continued project financial underperformance.

Regarding capital provider perspectives and priorities, pricing terms are the most important and material to the project financial model, closely followed by pricing mechanisms such as caps, floors, or contractual liquidated damages.

3 Financial Model

Project financiers match the terms and definitions in project contracts to the project's financial model. All project financial models include at least two key tabs: the project sources/uses and the pro forma. The project sources define the capital sources contracted to finance the project such as debt, equity, working capital facilities, state and local incentives, reserve funds, etc. Project uses define such funds through a project's commercial operations date. Typical project uses include but are not limited to the EPC contract (always the largest use of funds), project contingency, construction and technology insurance, startup working capital to ramp a plant to its nameplate production capacity, critical spare parts, financing fees, site purchase costs, and interest during construction. The project pro forma includes the projected financial statements including the income statement, balance sheet, and cashflows statement. Some pro formas may include calculations of cashflow available for debt service (CFADS) below the P&L. More sophisticated financial models have a separate tab with these calculations.

All financial models are not equal. The best financial models are typically developed by specialist third-party firms with financing and operational expertise that are skilled in communicating with the financial community. Such models are formatted to Wall Street standards for ease of audit, with separate and organized assumptions tabs, sources and uses, detailed operational and costs-of-goods-sold buildups by process step, pro forma financial statements, investment returns and debt repayment including calculations of CFADS and reserves, analytical scenario tabs, and summary tabs including graphs. While expensive and timely to create and maintain, these worthwhile models elevate a project and management team with financial counterparties, therefore the cost of such a model should be included in any project's development budget.

Developers need to carefully format financial models. It is important to make financial models as easy as possible for others to review and audit. Numerous expert third parties, including model validation firms, review project financial models to verify that model formulas and calculations are correct.

4 Third-Party Reports

A project's vision and its contractual foundations require validation by third-party experts to validate any material assumptions that comprise technical plans and financial models.

Material assumptions are broadly categorized into two main categories: technical and commercial. Technical and commercial market advisors develop individual scopes of work and related budgetary prices early in a project's pre-development process.

The technical scope of work reviews a project's main technical assumptions including underlying technology validity, from technical readiness and demonstration, scale-up strategy and appropriateness, high-level market demand and end product uses, to the technology's heat and mass balance and manufacturing yield assumptions by process step, and bottoms-up cost-of-goods-sold calculations. This process repeats once a project enters into a term sheet with either a debt or equity finance partner. Additional technical assumptions include EPC contract structure, pricing, risk sharing, commissioning, workforce, maintenance, and ramp-up strategies.

The commercial market scope of work reviews and validates key raw material input and end-product markets given these products' specifications. It also reviews, validates, and opines on these variables' price forecasts. A competitive benchmarking exercise may take place along with a competitor analysis and the provision of an industry cost curve and capital expense intensity comparison. The market consultant may also validate any subsidy assumptions and forecasts such as renewable identification numbers or investment tax credit (ITC) qualification. They may also describe any regulatory risks related to these incentives.

Project Risk Profile

A project based on its stakeholder credit profiles, measured contractual strength, financial model, and third-party evaluations culminates in the SACP discussed in Chapter 1. In summary, this credit profile is the result of assessing the aforementioned elements' endpoints within the context of a set of risks. Credit risk profiles range from not creditworthy to highly creditworthy. Creditworthy projects may achieve non-investment grade credit profiles.

The typical risks that collectively form a project's credit risk profile include:

Basis risk – Pricing spread and consequent project cashflow collapse between a supply contract and offtake contract. Tolling, fixed prices, or hedges are typical tools to manage this risk.

Construction risk – If an EPC or construction contractor is unable to complete project construction on time or on budget. This could be due to facility complexity or novelty requiring new construction methodologies or technical applications. Technology risk exposure does not necessarily mean there will be construction risk.

Environmental risk – Environmental damage from a project's direct or indirect environmental footprint may negatively affect project operations. Examples include pollution, utility consumption, and carbon emissions profile versus known comparisons and environmental standards.

Equipment risk – Equipment underperformance or delivery may lead to a fault, downtime, or facility failure. This can result from equipment failure due to either technology risk or a circumstance that puts the equipment outside of design-intended operation such as improper installation, maintenance, or exposure to a natural catastrophe.

Force majeure risk – The risk that the project can claim an extenuating circumstance or 'act of God' for contract non-performance. Contracts such as debt and insurance policies will have very specific terms on what situations or circumstances would be ineligible for making this claim.

Intellectual property risk – Rights to, loss, or illegal distribution of IP could disadvantage the project, or the ability of the project sponsor to build subsequent facilities that utilize this technology.

Interest alignment risk – When project partners have incentives that drive them to act counter to the interests of the project. For example, if an equipment supplier is going to be 100% pre-paid for equipment units, they may not be ultimately driven to supply the equipment at a high-quality standard.

Interest rate risk – Exposure to interest rate movements may negatively affect project cashflows. This is typically higher pre-financial close when a project is most exposed to interest rate movements that can decrease CFADS and resulting debt service coverage ratios (DSCRs).

Interface risk – An EPC contract with multiple contractor or subcontractor relationships may complicate decision making, problem solving, and liability management. The more parties that are present and reporting to the owner/developer, the greater the interface risk that a scope of work is misunderstood, or that parties will judge the other party(ies) to be at fault in the event of contract non-performance or a dispute.

Logistics risk – If facility construction requires acquisition and installation of logistically complex equipment, or if product manufacturing during normal operations requires numerous materials with complex and or instable supply chains, then there is logistics risk that could prevent completion of facility construction or sustained operation. The same goes for product offtake markets if the product involves complex or expensive transportation logistics, such as compressed tube trucks used for hydrogen transport. Logistics risk also relates to logistical or intermodal access via defined rights of way. An example includes the shipment of goods from one country to another's port.

Management risk – Management may not have the skillsets, capabilities, experience, and networks to successfully execute and operate the project.

Market risk – Exposure to adverse feedstock or offtake product price or availability fluctuations.

Offtake risk – Product offtake curtailment, adverse price fluctuation, switching costs, or contract termination may severely affect project cashflows.

Operational risk – The project's ongoing O&M may perform under expectations. This includes lack of workforce, training, experience, knowhow, or maintenance manuals related to the project's successful operation.

Permitting risk – A facility will not be able to be permitted for either industrial zoning, environmental, air quality, construction, and/or operations reasons which may impede a project's ability to achieve FID or normal operations.

Regulatory risk – Regulations/policy is instated or rescinded during the useful life of the facility; compliance incurs reduced revenues or additional costs or fees which could reduce project profitability.

Scaling risk – The difference between technology performance at the PDU or fully-integrated pilot scale and that of the up-scaled facility. This risk is usually the key driver for commercial-scale technology risk; even though a facility may exceed expectations in the integrated pilot, it may severely underperform at full commercial scale. Scaling-up often results from thermodynamic, chemical, and mass-transfer dynamics that are difficult to model. The risk can be further evaluated through volumetric or modular scale-up assessments with the former proving a higher risk.

Sponsor risk – Project ownership, which can have second-order adverse project consequences. This is particularly relevant given existing contractual relationships with the project or implicit financial backstops or guarantees given the sponsor's reputation. A financial sponsor's experience and creditworthiness are important factors when evaluating this risk.

Supply risk – roject raw material supply may be curtailed, in short supply, or difficult to replace in the event of supply contract termination.

Technology risk – A facility or production process may experience a fault, downtime, or failure resulting from the underlying technology underperforming. This risk is usually present for technologies that have not been widely deployed, and thus do not yet have substantial commercial experience. Technology risk is reduced via iterative design improvements over years of operational commercial deployment.

5 Structural Enhancements

Transaction structural enhancements include finance-related elements that can elevate a project's SACP from creditworthy to highly creditworthy. Structural enhancements mitigate gaps within a project risk profile that are not adequately addressed through standard stakeholder operating contracts.

A minimum number of structural enhancements can be expected through equity and debt financing documentation. Example standard enhancements embedded within such documents include management decision and control rights, dividend limitations, and employee incentive compensation approvals. Such documents also require traditional construction- and operational-phase insurance contracts with minimum limits, to manage high-value low-probability risk events. More customized solutions include basis risk hedging arrangements to manage the presence of any floating rate spread between the raw material supply and offtake agreements. Further custom risk management solutions such as technology performance insurance solutions from New Energy Risk may also be necessary to manage debt or equity provider exposure to technology underperformance. Topping off these customized solutions, reserve accounts—either lines of credit, equity reserves, or debt service reserves—are necessary to mitigate unexpected cash demands related to EPC contract change orders; working capital shortfalls due to construction, production ramp-up, and other delays; lower than expected operating margins due to higher expenses and/or lower revenues; and stakeholder switching costs consequent of the aforementioned delays.

A project is ready for development-phase financing assuming that all the above-described elements are adequately structured and provisioned to the highest standard endpoints.

Chapter 5

Options for Technology Project Finance Debt

Project financing purposely structures projects to achieve bankable status with an HC-SACP. A well planned approach to lender selection optimizes a project's development cycle and minimizes time to FID.

Assuming a project has a near-HC or HC-SACP, the debt financing structuring and execution process begins with a bottom-up analysis of the unlevered project financial model pro forma including unlevered free cashflows. These free cashflows, or CFADS, determine the amount of debt (or gearing) and at what price a project can sustain itself.

Notwithstanding a project's cashflow profile, a minimum equity amount to finance a project would range from 25-40% of the total project capital sources depending on the proposed technology and SACP.

A hypothetical, mortgage-style debt amortization schedule is input to the financial model, given a debt amount, interest rate, and tenor. The CFADS, depending on the overall project credit profile, should be in the range of 1.5x to 2.5x of debt service. This multiple of CFADS is the DSCR. The higher a project on the SACP profile, the lower its DSCR may be. Any project with a non-investment-grade SACP likely requires a DSCR in a range above 2.0x.

If CFADS is not within this range, one would increase or decrease the amount of debt or extend or decrease the debt tenor until fitting within the suggested DSCR range. The indicative tenor within the CFADS will be a key indicator of project cashflow and its applicable debt capital markets sub-market.

There are several debt capital markets that bank project finance transactions. The lender-related selection process involves assessing project-lender fit.

Assessing Project-Lender Fit

It is beneficial to understand the project needs and attributes that influence lender selection before exploring lender options. There are generally five factors which identify a project's fit within a given debt market. These include:

1. Tenor: the total length of time that the borrower must repay a debt
2. Quantum: the total amount of capital borrowed
3. Debt to EBITDA: 3. the total amount of capital borrowed divided by earnings before interest, taxes, depreciation, and amortization (EBITDA)
4. Geography: the country or region where the project will be built
5. Risks: the unique risk attributes associated with the project such as technology risk, construction risk, operational risk, market risk, credit risk, etc. Different debt markets may be willing and able to assume some of these risks more than others.

Notwithstanding these factors, a project's scale, scope, risk profile, and reputation may encourage a lender to engage. Additionally, an HC-SACP will likely qualify a project for multiple financing markets. Thus, achieving an HC-SACP financing standard can afford developers the greatest financing optionality within the debt capital markets.

Debt Capital Markets

This list of project finance relevant debt capital markets discusses the individual markets within the context of the project-lender fit attributes.

Municipal Markets: Tax-Exempt Municipal or Governmental Bond Markets

General Characteristics

Although there are many municipal bond markets, the one that is commonly most applicable to project finance is the private activity bond (PAB) market. PABs enable states or cities to issue bonds on behalf of private companies and are issued to attract businesses and labor to a region to derive a public benefit [21]. Municipal bonds are often tax-exempt, contingent on the project meeting a series of requirements, which may include locating within a particular jurisdiction.

Federal and state tax exemptions vary depending on the specific instrument. Municipal markets are only applicable for eligible construction/infrastructure projects deemed to be qualified private activities. Even if the project is an eligible activity, large-scale municipal bonds are typically applicable to projects rated BBB or better. Of the list of bond types, many are subject to a volume cap limiting total bonding capacity of a jurisdiction based on population or as a portion of the jurisdiction's total private activity bonding capacity. For most states, and for bonds issued after 2002, the state volume cap is $277,820,000 or $95 multiplied by the state's population, whichever is greater [22.1].

For more information on the qualified private activities, see Table 2 in *Private Activity Bonds: An Introduction* [23].

Scale of Quantum Accessible

Maximum quantum will vary with the specific state or jurisdiction where the project is built. Although in some jurisdictions PABs may be available in the $10M-$1B range for a specific project [24], this is constrained by state volume caps and PAB oversubscription, such that it may be difficult to acquire more than $150M [25]. Municipal bonds have low fixed interest rates of 2-5%, thus they are an efficient form of capital. They also often allow for lump sum (bullet) repayment, which can be attractive to borrowers [26].

Tenor

Although PABs can be issued with maturities ranging from three months to 30 years, most commonly they range from a few years to 17 years [22.2, 27].

Applicable Geographies

PABs are generally issued on a state basis. The specific issuing agency varies by state. For a list of agencies by state, The Bond Buyer publishes volume caps and issuing agencies [28].

Typical Recourse and Protection Requirements

Recourse and protections will be typical to senior debt in any infrastructure project financing. The lender has recourse to the project cashflows, contracts, and tangible assets [29].

Risks Assumed and Risk Tolerance

These markets will typically assume greater risk than the bank markets, including market and stakeholder credit risks but excluding technology risks.

A project will need to be creditworthy and ideally investment grade [30].

Export Credit Agencies: EXIM Bank is the US ECA

General Characteristics

Export credit agencies (ECAs) support domestic companies conducting business internationally to increase foreign exports and achieve strategic national economic goals. They are ideal for projects that import goods and services from another country. ECAs typically offer loan guarantees (or wraps), which are paired with bank financing. The exporters sponsor projects to their country's respective export-import (EXIM) bank, as the exporter is typically the entity with a long-standing relationship with the home country EXIM bank. The amount of project 'domestic content' or the content coming from the EXIM bank's respective domestic country is a key attribute to gain access to an individual EXIM bank.

ECAs often offer loan guarantees rather than direct loans. The loan guarantees are structured according to publicly available OECD guidelines, which typically include long tenors and low interest rates. The OECD guidelines further define transaction structural parameters within individual industries.

Scale of Quantum Accessible

ECAs will lend approximately $10M-$5B. The US EXIM bank has historically made larger outlays compared to other ECAs [31].

Tenor

ECA funds are typically limited to tenors of seven to 15 years, although they will facilitate financings with longer tenors of up to 20 years for power plant projects [32.1, 33].

Applicable Geographies

Although ECAs are present on every continent, not every country has an active ECA, thus ECA debt is constrained to project sponsors or development entities that will import goods and services from a country with an ECA. See CC-Solutions Finpliance's List, *Export Credit Agencies Around the World* [34].

Typical Recourse and Protection Requirements

ECA loans are typically loan guarantees structured similarly to conventional project finance transactions. Recourse is therefore similar to typical project finance transactions that include all project cashflows, contracts, and tangible property [35].

Risks Assumed and Risk Tolerance

ECAs are dedicated to and familiar with challenging risk environments and will typically assume most project risks excluding technology risk. They are considered reliable partners to mitigate lender country and credit risks [32.2].

US Federal Loan Guarantees (Or Similar Foreign Programs)

1. DOE LPO (Authorized by Title XVII Sections 1703 &1705) [36.1]
2. USDA Business & Industry Loan Guarantee Program (Authorized by Title IX Section 9003) [37.1]

General Characteristics

Loan guarantee programs generally enable projects with poor credit or limited access to traditional debt capital markets. These specific programs enable first commercial-scale facility deployments with elevated technology risk.

The DOE LPO and US Department of Agriculture (USDA) issue loan guarantees that assume all risks up to the full value of the loan, generally with limited recourse to the project entity and are priced to risk. Therefore, the cost of capital varies depending on the credit quality, risk, and loan tenor. The DOE LPO and USDA execution pathways include a two-part application/screening process followed by a due-diligence and underwriting process, which if successful concludes with the offer of a conditional loan commitment (i.e., term sheet). These programs include origination fees of $150K for projects <$150M TIC and $400K for projects >$150M TIC, in addition to general underwriting, third-party IE assessments, and other fees.

Scale of Quantum Accessible

The DOE LPO has $4.5B in loan guarantee authority and manages a $30B portfolio [36.2].

The USDA provides guarantees up to $250M to assist in the development, construction, and retrofitting of new and emerging technologies [37.2].

Tenor

As of 2016, DOE LPO-funded projects had an average tenor of 22 years [38.1].

US Federal Loan Guarantee programs typically have tenors ranging from seven to 30 years.

Applicable Geographies

Applicable for projects within the US and its territories.

Typical Recourse and Protection Requirements

DOE LPO loans have protections and recourse typical of project financings including recourse to project cashflows, contracts, and tangible assets [38.2].

An important note for DOE LPO loans is that the government support is not in the form of proactive project structural enhancement such as credit insurance. Lenders must foreclose on the collateral and workout the loan prior to calling on government support to make whole for any losses.

Risks Assumed and Risk Tolerance

DOE LPO and USDA can assume all project risks including technology risks, although the DOE LPO has historically assumed less market risk than the USDA loan program by way of financing non-PPA or take-or-pay offtake contracts. That said, DOE LPO will consider merchant offtake risks provided projects generate DSCRs in the range of 2.0x or higher.

Corporate Bank Loans

General Characteristics

Corporate bank loans are an ideal source of project finance debt capital given this market's large pools of regularly available capital. This market has the highest standard project credit expectations given bank regulatory capital requirements. Corporate banks may require projects to have a full wrap or be fully insured for the entire loan tenor. They also may explicitly require investment-grade counterparties and/or an investment-grade project credit rating. Thus, capital from this market is the most challenging to secure for first commercial projects.

Corporate banks seek sophisticated project sponsors with existing banking relationships and highly creditworthy project partners. This market's cost of capital is competitive if risk mitigation hurdles are met.

Scale of Quantum Accessible

Loans are available up to billions of dollars to meet the needs of the project, contingent on a bank's internal risk limits.

Tenor

Loans are generally available up to seven years.

Longer tenors are available given wrapped structures.

Applicable Geographies

Applicable in OECD countries with established corporate banking systems.

Typical Recourse and Protection Requirements

Recourse and protections typical of a properly structured project financing including recourse to all project cashflows, contracts, and tangible property.

Risks Assumed and Risk Tolerance

Corporate banks are typically risk averse with low risk tolerance.

Corporate bank loan structures will not accept most market, technology, and project stakeholder risks.

Private Debt
Direct Lending

General Characteristics

Direct lenders are typically large asset managers and PE firms diversifying into alternative credit. Direct lending funds typically have limited partners (LPs) with high return expectations and capital return in 10 years. They are willing to assume more risk than bank lenders and may provide subordinated and senior debt capital. Private debt financing costs are thus typically in the high single-digits or teens of interest due to LP return expectations.

These funds are established by insurance companies, pension funds, private wealth, or sovereign wealth funds. It may be difficult to find direct lenders with funds at a great enough scale to cover a large portion of project finance debt, in particular for transactions with non-investment-grade credit profiles.

Scale of Quantum Accessible

Private loans are typically in the $10M-$350M range due to fund concentration limits [39.1].

Tenor

Loans are available in the five-to-seven-year timeframe due to investment return period expectations [39.2].

Applicable Geographies

Private debt is funded globally where direct lending is considered available, given investment fund investment criteria.

Typical Recourse and Protection Requirements

Recourse is similar to traditional project finance transactions, which includes all project cashflows, contracts, and tangible assets.

Risks Assumed and Risk Tolerance

Direct lenders typically assess and tolerate all risks including market, technology, and stakeholder risk if they are properly understood and mitigated.

Venture Debt

General Characteristics

Venture debt generally compliments venture capital (VC) investments. It is commonly used as growth capital, offered in the form of short-term loans with warrants, used for extending the runway between equity investment rounds, although longer-term debt is available for companies with sales. Venture debt's primary risk is continued equity financing risk at the corporate level. Venture debt prefers to finance companies backed by tier-1 venture funds.

Venture debt is typically not applicable to the project finance market because venture funding is sought by startups earlier in the development timeline. Although this debt can be well suited for first commercial pilot/demonstration facilities that expect to generate revenue on a smaller scale than a typical infrastructure project.

Scale of Quantum Accessible

Loans are generally less than $25M, but higher for syndicated transactions.

Tenor

Venture debt is typically issued with 24 to60-month tenors [40].

Higher tenors are available for important corporate clients.

Applicable Geographies

Venture debt is predominantly issued to US-based companies.

Typical Recourse and Protection Requirements

Recourse can be less than other debt capital markets, but covenants may require a certain amount of capital in the bank.

Less recourse than others, as risks assumed are typically equity-like. Loans have warrants attached equal to 5-15% of the total loan value.

Risks Assumed and Risk Tolerance

Venture debt has a high risk tolerance and assumes all risks including market and technology risks typically associated with early-stage startups [41].

Venture debt risk tolerance generally relies on an early-stage VC investor's willingness and credibility to repay the loan.

Chapter 6

Options for Technology Project Finance Equity

Developers must appreciate key debt and equity market differences prior to approaching equity investors. Equity investors assume all lender risks plus a greater share of market and technology risks. Thus, any equity market outreach must reinforce debt market risk mitigants while concisely emphasizing key market and technology risk mitigants.

Two primary equity markets commonly invest in project finance: strategic investors or financial investors, both with balance sheets capable of financing large infrastructure projects. They primarily assess project compatibility with corporate strategic or equity fund investment criteria and also encompasses what other portfolio investments or capabilities including knowledge, experience, relationships, or assets can they combine with the project investment to enhance its success. In either case, while the investor's internal conversation is out of a developer's control, preparation and the approach to each market is similar and will focus on the project's core substance.

One of the key benefits of achieving the project finance standard of an HC-SACP is that it simultaneously solves two project capital raise frictions. Any debt market term sheet will incentivize equity investors to look closely at a project given a levered investment return opportunity and the consequent risk mitigation standard signal. Thus, the HC-SACP preparation and development also directly supports the equity investment raise.

Emphasizing or reinforcing the above while concisely communicating key equity market risk mitigants and financial return metrics are an effective approach to raising capital.

Assessing Project-Investor Fit

It is beneficial to understand the project needs and attributes that influence equity investor participation before exploring equity investment options. These factors influence a project's fit within a given equity market:

1. Stakeholder strategic fit: Assesses an equity investment via existing business interests. Developers must consider strategic fit with any investor approach.
2. Relative capital intensity efficiency: Measures relative capital efficiency as a ratio of total project dollars or uses required divided by capacity output; this is a signal of technology IRR and long-term scaling potential given inevitable commodity price fluctuations.
3. Relative position on the industry cost curve: Measures relative costs of goods sold versus the industry; this is a key measure of relative staying power and technology comparative advantage within an industry environment given inevitable commodity price fluctuations.
4. Asset returns (project IRR): A measure of unlevered project cashflow returns during the expected project asset useful life. This shows the project's fundamental ability to create investment value, which is comparable across project investment alternatives.
5. Levered equity IRR: A measure of project equity investment cashflow returns during the expected project asset useful life. Levered returns will always be higher relative to an asset return.
6. IP horizon: Concerns questions of what IP is in place, to what level of proof, and in what time horizon will it provide the TechCo with an unfair advantage.
7. Market size: The overall long-term addressable market size of the technology deployment opportunity.
8. Management team: The experience, breadth, capabilities, and network that the team brings to the project.
9. Quantum: The total amount of capital investment required.

10. Geography: The country or region where the project will be built.
11. Risks: The unique risk attributes associated with the project such as technology risk, construction risk, operational risk, market risk, credit risk, etc. Different equity markets may be willing and able to assume some of these risks.

Additionally, project sell-side investment bank representation is a positive indirect and subjective attribute and differentiator. Equity investors know that investment banks will engage with the best projects. Therefore, tier-1 investment banks (not the project developer) introduce projects to tier-1 large fund investors.

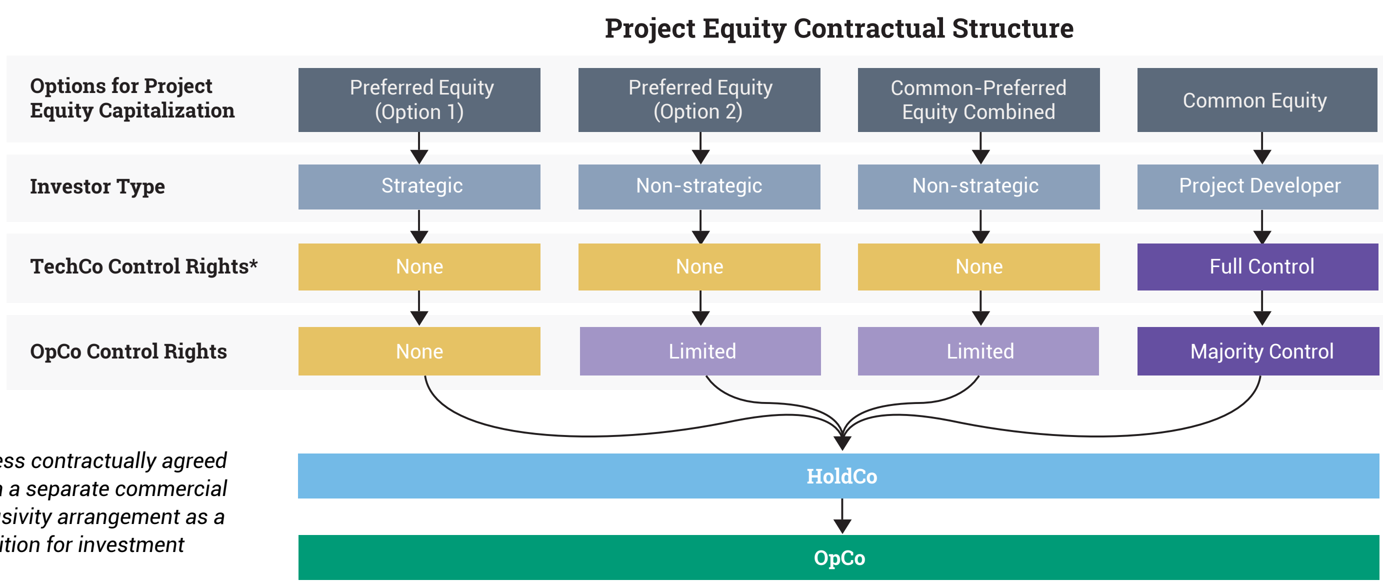
Given the project objective and subjective properties, project equity will be structured to reflect the individual strategic or financial investor risk-adjusted return requirements.

Project Equity Investment and Governance Structures

Project developers typically begin with 100% common equity ownership in the TechCo and HoldCo. Most developers seek to maintain TechCo and project HoldCo governance and decision-making control. However, TechCo and HoldCo control rights dilute due to project investor equity investment. Various equity investment structures can optimize developer governance control and financial returns.

Project equity investors include both strategic and non-strategic financial investors. These investors generally desire varying degrees of project governance control and financial return expectations. Project equity can be uniquely structured to optimize and accommodate these individual investor needs in a mutually beneficial manner for both the project developers and the individual investors. The resulting final structure culminates in a project governance structure with project board of directors-level decision-making control.

The goal is to push as much funding as possible to the project HoldCo level, maintaining for the TechCo as much long-term financial upside and control as possible. Preferred equity issuance(s) can achieve these goals. Preferred equity has a capped financial upside providing the HoldCo with common equity and the TechCo with higher upside returns. Figure 10 depicts the project control-rights distribution for four different equity investor scenarios including: strategic preferred equity with no control rights, strategic or non-strategic preferred equity with limited to no control rights, non-strategic preferred and common equity with limited control rights, and common equity only with full control rights.



*Unless contractually agreed to via a separate commercial exclusivity arrangement as a condition for investment

Figure 10. TechCo Control Rights

Different types of equipment investment have varying implications for control rights of the parent (TechCo) and project (OpCo) based on the project equity contractual structure.

The equity capital markets, similar to the debt capital markets, have various submarkets. Considerations for equity market selections are also like the debt capital markets, but lender quality can provide a point of leverage when approaching equity providers. This table describes common project finance equity markets.

Private Equity Firms

Characteristics

PE firms and LPs typically demand higher returns than the public markets and thus have greater risk appetite. The investments typically have a five to 10-year horizon given capital return expectations. PE firms originate and execute deals and manage portfolios.

Scale of Quantum Accessible

PE finance transactions typically range from $50M to $1B [42].

Expected Returns

PE investors generally target rates of return between 20% and 25%, most commonly 22% [43]. On average, they have earned average annual returns of 10.5% (between 2000 and 2020) [44].

Typical Investors

PE firms often own and manage individual PE funds financed by limited partners (LPs) and general partners (GPs). Investment strategies range from distressed debt investing, leveraged buyouts, real estate investment trusts (REITs), mutual funds, special situations, and later-stage venture or growth capital [45].

Risk Appetite

PE firms are often willing to take on moderate to high risk.

A financial market study evaluated nearly 28,000 PE transactions between 1992 and 2008 and found loss ratios at 35%, 13%, and 14% for VC, growth equity, and leveraged buyouts (LBOs) respectively [46].

Stakeholders Creditworthiness Expectations

PE has mid to high expectations for stakeholder creditworthiness.

PE firms will risk adjust potential returns during their diligence analysis.

Venture Capital (VC) Firms

Characteristics

VC funds invest in new and innovative technologies with large growth potential. These funds, similar to PE firms, have LPs and make investments with five to 10-year horizons.

Scale of Quantum Accessible

Although classified by the financing series round, as of January 2021, the average VC-backed company investment deal size was $29.8M. Typical Seed round initial funding is $0.5-5M, Series A is typically $5-15M, Series B is typically $15-35M, Series C is typically $30-100M [47, 48.1]. Later rounds of VC funding can be in the hundreds of millions of dollars.

Expected Returns

VC firms typically expect returns of 15-30% [49].

Typical Investors

Similar to PE funds, VC firm investors include LP's and GP's.

LP's can also include strategic investors.

Risk Appetite

VC firms have a high risk appetite.

Between 1992 and 2008 had an average loss ratio of ~35% [48.2].

Stakeholders Creditworthiness Expectations

VC firms have low to high expectations for stakeholder creditworthiness.

VC firms at various funding stages will have different perspectives on individual portfolio company market-entry and growth potentials and will thus accept stakeholders with varying financial and credit profiles.

Strategics

Characteristics

Strategic investors are project-related companies that will have a strategic rationale to invest in a project. Thus, strategic investor return expectations are not financial-return motivated.

Strategic investors generally seek to maintain or build market share. They will generally invest for exclusive rights to a project's or series of projects' business, such as the supply or offtake rights.

Scale of Quantum Accessible

Strategic equity investments typically range from single to hundreds of millions of dollars [50].

Expected Returns

Strategics' motives typically align with the investor's long-term vision.

Final returns may vary from a minimum of mid to high single digits.

Strategics returns can include market share retention or development.

Typical Investors

Typical strategic investors include individual corporations.

Risk Appetite

Strategics have varying risk appetite, depending on risk adjusted returns.

Risk appetite is typically correlated with investment size or risk adjusted return.

Strategics are not seeking large returns but rather long-term strategic market goals.

Stakeholders Creditworthiness Expectations

Strategic investors have low to high expectations for stakeholder creditworthiness.

Will correspond with given investment amount and related risk adjusted return expectations

EPC

Characteristics

EPCs will sometimes strategically invest in customer projects. These firms typically have substantial balance sheets and long-term financial incentives past 10 years to secure long-term EPC relationships, as well as to develop a reputation with new and innovative technology markets.

Having an EPC investment aligns interests, providing additional incentive to effectively and efficiently complete the project and uphold contractual obligations. However, in extreme cases there could be interest misalignment, as the EPC could be disincentivized to provide price control if exclusivity is exchanged with the investment.

Scale of Quantum Accessible

EPCs can invest in the hundreds of thousands to single-digit millions of dollars.

Expected Returns

EPCs typically have no general return expectations aside from return of capital [51].

These investments are largely strategic rather than financial.

Typical Investors

EPC investors are typically individual EPC corporations.

Risk Appetite

EPCs' financial stability and reputation are important and thus they have low risk appetite.

Stakeholders Creditworthiness Expectations

EPCs have mid to high expectations for stakeholder creditworthiness.

EPCs seek stability and long-term partner relationships, which is most likely achieved with long-established and highly creditworthy counterparties.

Tax Equity

Characteristics

Tax equity investments involve one party agreeing to assign the rights to claim tax credits generated by a qualifying physical investment to another party in exchange for an equity investment. The exchange is sometimes referred to as monetizing tax credits or benefits.

Examples of tax equity in the US include the ITC, which covers investments in renewable energy infrastructure; the production tax credit (PTC), which generates credits during generation of renewable energy; and Title 26 Section 45Q (45Q), which generates credits for the sequestration of carbon in geological storage or other special applications.

Scale of Quantum Accessible

Available capital usually scales with the capacity or throughput of the renewable energy production facility but can reach the tens or hundreds of millions of dollars for large-scale projects [52, 53].

Expected Returns

Tax equity investors can expect a 5-12% return dependent on the project risk profile [54].

Typical Investors

Tax equity investors typically include tier-1 commercial banks or other corporations seeking tax liability reductions.

Risk Appetite

Strategics have a low risk appetite given their focus on return of capital.

Tax equity investments are typically fixed-rate investments and must maintain stable cashflows

Stakeholders Creditworthiness Expectations

Tax equity investors have high expectations for stakeholder creditworthiness.

Tax equity investors seek long-term stable cashflows with a high confidence in expected revenue and net cashflow.

Concluding Thoughts

Partners Make the Difference

In the race to transition our economy to a zero-carbon one, significant new and improved infrastructure must be built. Although in some instances this transformation is limited by the rate of scientific developments, often the limiting factor today is getting developed technologies deployed. Project finance is a tool to bring technology projects to market more efficiently, especially when the projects are commercial-scale facilities that lack precedent.

Technology project finance is distinct from infrastructure project finance in its elevated technical performance risk. The integrated project finance framework shared in this guide—equally focused on commercial and technical project development—provides a pathway for technology and project developers to overcome both the technological novelty and the project sponsor's lack of credit.

Partnering with creditworthy parties enables the project to receive an SACP, making it more bankable. Separation of the project sponsor from the project entity gives banks greater confidence in repayment, thus enabling a more efficient financing. The FEL process significantly de-risks the technology, building sufficient confidence for an EPC (potentially in combination with technology performance insurance) to wrap its construction and commissioning. The end result of project risk-mitigation achieved through the technical and commercial development process—an HC-SACP—enables the financing of immensely valuable projects whose economics stand on their own.

This guide discussed the numerous contractual relationships and partners required for a successful project financing, drawn from the combined decades of commercial experience of the New Energy Risk team. We hope this guide will help project developers through the technology project finance process, which includes identifying risks, connecting to various forms of capital, and enable their financing by insuring against numerous risks that cannot be mitigated in other ways. Along the way, New Energy Risk stands ready to be one of your most important partners in enabling your financing.

Learn more about New Energy Risk at *newenergyrisk.com*.

Common Technology Project Finance Acronyms

BEP – Basic engineering package

CC – Construction contract

CFADS – Cashflow available for debt service

COD – Commercial operations date

CIM – Confidential information memorandum

CPP – Cost plus pricing

CRA – Credit ratings agency (e.g., Fitch, Moody's, and S&P)

CRL – Commercial readiness level

DoE – Design of experiments

DOE LPO – US Department of Energy Loan Programs Office

DSCR – Debt service coverage ratio

EBITDA – Earnings before interest, taxes, depreciation, and amortization

ECA – Export credit agency

ECM – Equity credit market

EERE – Office of Energy Efficiency and Renewable Energy, US DOE

EPC – Engineering, procurement, and construction firm

EPC-GMAX – EPC-guaranteed maximum price

EPC-LSTK – EPC lump sum turnkey

EPCM – Engineering, procurement, and construction management

EURIBOR – Euro Inter-Bank Offered Rate

FEED – Front-end engineering design

FEL – Front-end loading(FEL-0/1/2/3)

FID – Final investment decision

FMEA – Failure model and effects analysis

FOAK – First of a kind

GP – General partner

HC-SACP – Highly-creditworthy stand-alone credit profile

HoldCo – Holding corporation

IE – Independent engineer

IEA – International Energy Agency

ITC – Investment tax credit

IRR – Internal rate of return

KPI – Key performance indicator

LBO – Leveraged buyout

LIBOR – London Inter-Bank Offered Rate

LLCR – Loan life coverage ratio

LOI – Letter of interest

LP – Limited partner

MOU – Memorandum of understanding

M&A – Mergers and acquisitions

NOAK – Nth of a kind

NTP – Notice to proceed

OECD – Organisation for Economic Co-operation and Development

OpCo – Project operating company

O&M – Operations and maintenance

PDU – Process development unit

PAB – Private activity bond

PE – Private equity

PPP – Public-private partnership

PTC – Production tax credit

REIT – Real estate investment trusts

SACP – Stand-alone credit profile

TIC – Total installed cost of a facility

TRL – Technology readiness level

USDA – US Department of Agriculture

US EXIM – US Export-Import Bank

VC – Venture capital

Appendix

Key Factors that Downgrade SACP

S&P Framework Methodology

Transaction Structure (constraints, legal framework, and protections around a project)

- Lack of clearly defined project entity which will construct and operate the project
- Lack of seniority structure in the capital stack and weakly structured security package (normally designed to limit incentives for third parties to file insolvency)
- Weakly structured covenant package, which would normally limit additional debt, explicitly setting debt service reserve requirements, experience account requirements, and limit the ability to convert, merge, or acquire the project
- Lack of covenants stipulating the waterfall of project cash flows (prioritized order of payout)
- Linkage between the project sponsor/parent company and the project that could allow financial recourse to the sponsor and could allow the sponsor to file for insolvency on behalf of the project. Some of the factors used to identify the degree of linkage include:
    - Presence of separate directors
    - Presence of cross-default provisions
    - Ability for the project to transform, merge, become acquired, or reorganize
    - Ability for the project to amend organizational documents
    - Project's separation from the sponsor
    - Provisions for transfer of project assets in the case of default on debt service
    - Dependencies of the parent with linked liabilities to the project
    - Parent's dependencies (contracts with parents and affiliates, taxes, or insurance)

Construction-Phase Risks

- Presence of risks associated with technology and design including:
    - High project cost
    - High level of construction complexity or novelty
    - Limited applicable contractor experience (with the same technology and/or scale)
    - Poor project management track record

Operations-Phase Risks

- High risk of underperformance due to technical complexity, lack of technical due diligence
- Significant market risk generally resultant from feedstock or offtake contracts that are not fixed price, or are merchant, i.e., bought/sold on the spot market
- Presence of country risk from operating in, supplying feedstock from, or selling product into a country with a governmental or political instability

Counterparty Risks (credit quality of a project's key counterparties)

- Bringing on project counterparties with poor reputation or poor history upholding guarantees and contractual obligations
- If the project is poorly protected by accepting exposure to the project counterparties,
- Linkage of the financial counterparty such that there is a poor balance of power

Key Credit Factors and Assumptions for Energy Projects

- Construction phase, inclusive of detailed design and engineering, construction, and commissioning
    - High level of technology and design risk
    - Poor historical track record of technology
    - Poor alignment of technology performance and contractual obligations
    - Highly complex and novel design and/or construction
    - The EPC has limited relevant experience with the technology at this scale
    - The EPC has a poor track record for effective project management
    - Inadequacy of funding (in the eyes of the rater)
    - Lenders have poor track record (political or otherwise)
- Operations phase
    - Limited rigor and relevance of performance standards
    - Poor operational stability (low-capacity factor) relative to other energy generation assets
    - Material risks associated with supply of feedstock (or other resources)
    - The project has notable exposure to market risk (i.e., resulting from lack of fixed-price feedstock supply or offtake agreements)
    - Poor competitive advantage with limited ability to assume market share
    - Weak counterparty structure with unfavorable (unequal) downside analysis outcomes
    - Limited protections against the project filing insolvency or refinancing

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