Methodology

Rating Solar Power Projects

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All DBRS ratings and research are available in hard-copy format and electronically on Bloomberg and at DBRS.com, our lead delivery tool for organized, Web-based, up-to-the-minute information. We remain committed to continuously refining our expertise in the analysis of credit quality and are dedicated to maintaining objective and credible opinions within the global financial marketplace.
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Scope and Limitations

This methodology represents the current DBRS approach for rating solar power projects. It describes the DBRS approach to credit analysis, which includes consideration of historical and expected business and financial risk factors as well as industry-specific issues, regional nuances and other subjective factors and intangible considerations. Our approach incorporates a combination of both quantitative and qualitative factors. The methods described herein may not be applicable in all cases; the considerations outlined in DBRS methodologies are not exhaustive, and the relative importance of any specific consideration can vary by issuer. In certain cases, a major strength can compensate for a weakness and, conversely, a single weakness can override major strengths of the issuer in other areas. DBRS may use, and appropriately weight, several methodologies when rating issuers that are involved in multiple business lines. Further, this methodology is meant to provide guidance regarding the DBRS methods used in the sector and should not be interpreted with formulaic inflexibility, but understood in the context of the dynamic environment in which it is intended to be applied.

Introduction to DBRS Methodologies

- DBRS publishes rating methodologies to give issuers and investors insight into the rationale behind DBRS’s rating opinions.
- In general terms, DBRS ratings are opinions that reflect the creditworthiness of an issuer, a security or an obligation. DBRS ratings assess an issuer’s ability to make timely payments on outstanding obligations (whether principal, interest, preferred share dividends or distributions) with respect to the terms of an obligation. In some cases (e.g., non-investment grade corporate issuers), DBRS ratings may also address recovery prospects for a specific instrument given the assumption of an issuer default.
- DBRS operates with a stable rating philosophy; in other words, DBRS strives to factor the impact of a cyclical economic environment into its ratings wherever possible, which minimizes rating changes due to economic cycles. Rating revisions do occur, however, when more structural changes, either positive or negative, have occurred, or appear likely to occur in the near future.
- DBRS also publishes criteria that are an important part of the rating process. Criteria typically cover areas that apply to more than one industry. Both methodologies and criteria are publicly available on the DBRS website, and many criteria are listed below under “Rating the Specific Instrument and Other Criteria.”
Solar Project Overview

This methodology outlines key factors considered by DBRS in determining the credit quality of ground-mounted, utility-scale solar projects of more than ten megawatts utilizing photovoltaic (PV) crystalline silicon or thin film panel technologies. DBRS groups these factors into three sections in this methodology as follows: (1) construction period; (2) operating period; and (3) sponsorship, financial, legal and other considerations. Note that for projects that have a construction period, the weaker of either the construction or the operating period generally determines the rating. Solar project risk has many elements in common with other energy project finance transactions, but it also has unique aspects that must be separately considered. It is DBRS’s view that solar projects can potentially achieve investment-grade credit ratings if properly structured. The minimum requirements for an investment-grade rating are outlined below. This methodology should be considered within the general framework of the DBRS methodology Rating Project Finance (August 2014).

Solar Project Structure

Project finance lenders generally only have access to cash flows from project assets for debt servicing with limited or no recourse to the project’s sponsors. This is different from a corporate debtholder who typically benefits from the cash flow of multiple product lines as well as the issuer’s liquidity and other financial resources.

Project finance structures rely on contracts to manage risk during construction and operation. Project assets are typically held in a special-purpose vehicle (SPV), here labeled “ProjectCo.” The engineering, procurement and construction (EPC) contract sets out the terms of construction of the project, usually at a fixed price, thereby passing down completion risk to the contractor. Panel supply contracts should also be on a fixed-price basis and are often separate from the EPC contract. The revenue contract (i.e., a power purchase agreement (PPA)) permits ProjectCo to sell its output (i.e., electricity) to the off-taker or revenue counterparty. The operating and maintenance (O&M) agreement sets out the terms of services provided by the O&M contractor(s) and sub-contractors during the operating period. Finally, a variety of financial agreements (e.g., trust indentures or hedging agreements) and SPV constitution documents address certain financial, legal and other considerations. The terms of the contracts generally transfer, or partially transfer, a variety of risks from ProjectCo to its counterparties in the transaction. Such risks include the timely delivery of panels, construction completion risks, credit risk of various counterparties, operational...
risks, price and inflation risks as well as catastrophic risks, with each risk typically transferred to the entity best able to bear them. These risks and others are discussed in detail in the sections that follow.

A typical ProjectCo is structured with certain limitations and protections, including, among other things, (1) scope of business limited to operation of the project assets, (2) permitted indebtedness and distribution tests, (3) comprehensive insurance to cover perils not within control of the project, (4) limited or no recourse to equity sponsors and (5) bankruptcy remoteness from equity sponsors.

Solar projects are exposed to evolving technology as well as shorter performance history and may be subject to changing market structures. In addition, solar projects are exposed to panel degradation risk and uncertainty with respect to solar resource forecasts (which, while more reliable than wind forecasts, are still a material risk). These characteristics constrain the rating compared with the more mature hydroelectric and natural gas-fired project types that feature long, well-documented performance histories. Accordingly, at this stage in the development of a rated market for utility-scale solar projects, solar project ratings are likely to be capped at the BBB category.

For a project financing to achieve an investment-grade rating, the following must generally be present:

(1) Experienced panel and inverter suppliers that DBRS deems to exhibit characteristics consistent with an investment-grade rating or that benefit from structural enhancements to bring them equivalent to investment grade.

(2) Low to moderate construction risk substantially transferred to an experienced contractor.

(3) A robust PPA with mid- to high-level investment-grade credit quality counterparties. Lower rated PPA counterparties may constrain the project rating.

(4) Moderate operating risk retained by an experienced sponsor or contracted to a qualified third party.

(5) An established and experienced equity sponsor.

(6) Fully amortizing debt with financial metrics that withstand downside scenarios, consistent with the rating.
Construction Period Risk

While PV solar panels have been used in various applications for over 50 years, the advent of utility-scale solar PV projects is relatively recent, and no single business model has emerged among industry players. Some market participants, including panel manufacturers, developers/sponsors, EPC contractors and operators, are vertically integrated. In other cases, companies occupy only one segment of the value chain and may lack scale or have limited performance records. In both cases, market participants may be unrated or non-investment grade. As a result, a standardized project structure has yet to emerge, although two approaches to the construction task are commonly seen: (1) an EPC-anchored model where the EPC contractor takes on most of the construction risks, including panel delivery risk (but usually not future panel performance); and (2) an owner-supplier model where the ProjectCo contracts directly with panel and inverter suppliers and an installation contractor on a fixed-price basis, without the benefit of an EPC fixed-price undertaking over all of the equipment supply and construction.

The construction of a utility-scale PV solar facility is relatively straightforward. The construction task is less complex than for traditional project-financed power assets such as natural gas-fired power plants, which have multiple, highly specified moving components with more complex construction, or hydro assets, which have complex design, excavation and civil construction requirements. Solar projects generally involve low-complexity civil and foundation work and modularity in the work plan, which creates greater scheduling flexibility in the installation and hookup of components manufactured off-site. While the solar panel market has experienced very rapid expansion in recent years, current conditions continue to include excess production capacity, high inventories and underutilized contractors and suppliers. DBRS cautions that the market will likely continue to be prone to fluctuations, although under present conditions, it is expected that a defaulting contractor or panel supplier can be replaced with minimal delay and without a material increase in construction cost. At the same time, weaker manufacturers may produce lesser quality panels that are vulnerable to higher degradation. Assessment of the ability to replace contractors and panel suppliers is also included in the independent engineer’s (IE) scope of engagement.

Solar projects also typically entail construction periods that are much shorter at approximately six to 18 months if the equipment can be sourced with good lead time, versus three- to five-year construction periods for other power projects. The shorter time requirement and low complexity of the work are key rating considerations. However, a shorter construction period can also create greater pressure for the timely replacement of a defaulted contractor or panel manufacturer, which is also a key rating consideration.

The modularity of the construction task allows for much of the build-out to be completed in parallel rather than in sequence. As such, errors in one segment of the project can be quickly isolated before affecting the overall critical path. This generally supports a reasonably high probability of on-time and on-budget completion. Though completion is not necessarily impaired by a defaulting contractor or panel supplier, it can be. Prudent EPC contractual terms include flexibility in the contractor’s schedule commitment, often in the form of three to nine months between substantial completion and final completion. Also, project delays could be caused by regulatory obstacles or changes, and contract terms should provide for adjustments to the schedule to manage regulatory changes—a risk that is normally outside of the contractor’s/supplier’s reasonable control.
CONTRACT FRAMEWORK: EPC-ANCHORED AND OWNER-SUPPLIER APPROACHES

In an EPC-anchored approach, the ProjectCo transfers all construction risk to an EPC contractor by way of a fixed-price, date-certain EPC contract. The strength and quality of the EPC contractor is an important consideration for the construction phase rating. Where the EPC contractor is not publicly rated (as is often the case), DBRS will conduct an internal assessment of the contractor, focusing on track record, technical and financial capability, and expertise. Construction phase ratings may be limited by a weak contractor but may then be enhanced with additional cash reserves, letters of credit (LCs), performance guarantees and other forms of performance security. The limiting effect of weak contractors is more of a factor in tight market conditions where replacement of defaulting contractors would be more difficult and could cause delays and cost increases. In markets characterized by excess capacity and high panel inventories, replacement risk is likely to be low.

In an owner-supplier approach, ProjectCo is the general contractor, and it subcontracts the balance of construction to an installation contractor on a fixed-price basis separate from the equipment supply subcontract. There is still a pass down of risk under fixed-price contracts but with two separate contracts for the separate scopes of work. The credit quality of the panel and inverter suppliers is relatively more important to the rating than if ProjectCo had an EPC to wrap equipment delivery risk, and it can be an important consideration for the construction phase rating.

In the owner-supplier model, the installation contractor is also assessed, but as the cost of panels, inverters and other equipment is typically a high percentage of total construction cost, the installation contractor’s credit quality has less importance in the overall construction phase rating. If the panel/inverter suppliers are not publicly rated, DBRS will develop an internal assessment of the panel and inverter supplier’s credit quality.

Under both approaches, DBRS reviews the contractor, panel and inverter suppliers and equity sponsors’ track records and ability to complete contracts on time and on budget. The most common sources of schedule delay may include (1) late panel deliveries, (2) permitting, (3) transmission interconnection approvals, (4) construction of access roads, (5) severe weather, (6) suboptimal placement of panels and (7) delays in meeting commissioning requirements. Commissioning tests should match or exceed the requirements of the PPA, including power production, uninterrupted operation and cycle-up performance. DBRS will assess the ability to replace non-performing panel or inverter suppliers. This risk is greater for the owner-supplier model but is also relevant to an EPC-anchored model.

DBRS considers construction risk to be a combination of the contractor and supplier credit quality as well as the nature of the construction task: low complexity, modular, fewer critical path constraints and a reasonably good record of on-time, on-budget completion. DBRS expects the IE to opine on the ease and cost of replacement of defaulting contractors-suppliers.

PANEL SUPPLY

An EPC contract transfers responsibility for the delivery and, typically, the initial quality of panels from the ProjectCo to the contractor. Under an owner-supplier approach, this risk is managed directly with the supplier. In both cases, the project is ultimately exposed to the risk of panel delivery delays or default by a panel supplier. Delivery risk increases in periods of excess demand and low inventories but is much less significant in an oversupplied market with excess capacity and unsold inventory. Panel supplier default risk is carefully assessed, as even a smooth supplier replacement scenario can increase costs and delay completion. Replacement supply may also have to comply with local content rules, which can limit the number of suitable providers. The obligations of the panel supplier to the EPC contractor and/or ProjectCo (including warranties of panel performance) should survive a change in control of the panel supplier and must also be assignable to the ProjectCo in the event of an EPC-contractor default.
A project’s exposure to the supplier can be limited by provisions in the panel supply agreement. For example, panel suppliers may charge a premium to pre-build an order and allocate it to inventory. Alternatively, the EPC contractor/ProjectCo can separately schedule early delivery and incur the warehousing cost directly. Both approaches would effectively reduce delivery risk. Penalties for late delivery also encourage the timely provision of panels. The panel supply agreement should also have clear requirements for inspection, certification and testing at the plant site.

The PV panel industry has been characterized by rapid changes in leading competitors, wide swings in demand-supply balance and a sharp decrease in panel prices. These market conditions increase risk related to the supply of panels by pressuring the credit quality of panel suppliers. Investment-grade manufacturers may provide rating strength, but investment-grade solar panel manufacturers are not common. For non-investment grade manufacturers participating in investment grade-rated project financings, external enhancements (described below) may be required, including the transfer of supply risk to an EPC contractor on a fixed-price basis. In any event, the panel supplier’s reliability and credit quality has the potential to materially affect the project rating in both EPC-anchored and owner-supplier project structures.

**EXTERNAL ENHANCEMENTS**
Credit and performance enhancements can be used to provide uplift to a construction phase rating. These may include (1) LCs from a suitably rated issuer, (2) performance bonds, (3) warranties of performance after commissioning and (4) parent guarantees. DBRS notes that LCs are the most direct support for the contractor and supplier credit profile during the construction phase. LCs issued by an acceptable financial institution can lift the construction phase rating. For example, LCs of 5% to 10% can lift the rating by one to two notches, respectively.

In addition, an EPC contract generally provides for liquidated damages (LDs) (typically 20% of contract value) in case of delay in the construction schedule. The LDs, which are covered by parent company guarantees of up to 100% of the contract value, should cover potential costs of delay or performance shortfalls, including debt service to bondholders and penalties owed by the project to the PPA counterparty.

Performance bonds commit a surety to complete construction if the contractor defaults on its EPC obligations. An LC is viewed by DBRS as superior to a performance bond, assuming an equivalent credit rating, since the performance bond relies on the surety’s process of assessing claims and selecting among numerous options for addressing a default rather than providing cash on demand. Given the likelihood that sector participants may be relatively small and likely non-investment grade, DBRS typically considers third-party credit enhancements, such as performance bonds and LCs, superior to LD obligations of the contractor, unless such LD obligations are supported by LCs issued by a suitably rated issuer.

Third-party guarantees, insurance or equipment warranties may be positive for credit quality but require assessment of the credit quality and operational performance of the entities underwriting the risk. These forms of support benefit the project rating only if the entities’ credit quality is superior to the risks assumed under the related warranty or insurance instrument. Parent guarantees for affiliate contractor entities are a customary requirement. To be viewed as effective by DBRS, the guarantee should be irrevocable and not require exhaustion of recourse against the subsidiary. Approximately 60% of total project costs are attributable to the cost of panels and inverters. Accordingly, a liability cap of 20% of the contract price is normally considered sufficient and supportive of an investment-grade rating.

Trapping mechanisms that withhold progress payments to a contractor until delays or overruns are resolved may form part of the financing structure. Contractors can also be subject to a periodic test for value of work performed (as the modular nature of the construction task is convenient for checking progress against specific completion milestones) and not be allowed to front run drawdowns. DBRS notes that trapping mechanisms do not represent surplus funding for the project, and so while such mechanisms can help to focus the EPC contractor on the timely completion of the project, no rating uplift is given.
INDEPENDENT ENGINEER’S REPORT – CONSTRUCTION PERIOD
DBRS carefully assesses the IE’s report and reviews its findings to inform construction risk analysis. As is the case for traditional project financings, and particularly given the early-stage nature of the technology and market, an IE is generally engaged to verify key technical and financial assumptions such as panel supplier and contractor capability, construction design, budget and schedule, technology risk and the ability of the construction plan to meet output specifications and commissioning tests. Equipment warranties and minimum performance thresholds are also reviewed.

The IE scope should also include a review of contractor and panel supplier replacement cost, risks of sourcing labour and materials, the impact of local content rules and any constraints that these may pose for the project. Site preparation, condition and access, regulatory requirements, environmental compliance and satisfaction of all permitting requirements are also reviewed.
Operating Period Risk

During the operating phase of the project, fixed-price contracts that transfer ProjectCo’s O&M risk to the operator are viewed as superior to self-performance with price exposure. However, the O&M budget is generally a small component of the cost structure. The low operating expense of solar projects supports project resilience and lowers the probability that an operating event could cause its termination.

However, the operator’s technical and financial capability, the reasonableness of the pricing and operator obligations under the O&M agreement and the impact of replacing the operator in a default are all assessed by DBRS. Where the operator is an affiliate of the equity sponsor, panel manufacturer and/or the EPC contractor, the O&M agreement is reviewed for the potential for conflicts and the degree to which penalties and incentives are reasonable and promote reliable project performance.

TECHNOLOGY RISK
As operating costs are low, the primary operating period risk (apart from the solar resource risk itself and reliability of the solar resource forecast) is panel underperformance, where panel degradation exceeds the base case assumption. This risk is not usually borne by the operator, unless the operator is also the manufacturer and/or the EPC contractor.

There are two main categories of PV panel technology: (1) crystalline silicon panels and (2) thin film panels. Crystalline panels have a longer performance track record than thin film panels and are more efficient in converting solar energy to electricity per unit of surface area. Thin film panels have lower production costs and lower efficiency loss at high temperatures.

Crystalline silicon panels have decades of operating history, most of which has been in micro applications on residential and commercial rooftops but not in utility-scale applications. The longer dataset indicates lower risk of variance around panel degradation forecasts. Thin film is a more recent technology with operating data of up to 15 years, but less than a decade in utility-scale applications, which are a more recent market development. The shorter dataset indicates higher risk of variance around panel degradation forecasts, particularly later in the life of a project. DBRS will carefully review panel performance datasets from the panel supplier and equity sponsor and will also focus on the IE’s analysis as part of its overall assessment of technology risk.

For both technologies, manufacturers perform accelerated lifecycle testing to forecast performance. The International Electrotechnical Commission provides guidelines for panel testing at the factory for certification purposes, quality assurance and accelerated lifecycle testing. Review of the certification and other quality assurance by the manufacturer should be included in the IE’s scope.

Panel modules are typically designed for a 30-year life. Degradation is caused by three primary factors: (1) an initial light-induced degradation (LID) occurring shortly after panels are first exposed to sunlight, (2) erosion of a module’s moisture protection and (3) breakdown of the protective layer between the module’s front glass and PV cells. Crystalline PV panels degrade approximately 1% to 2% in the first year of operation as a result of light-induced degradation, and then annually at an approximate rate of 0.3% to 1.0%. For thin film panels, the initial degradation can be 4% to 7% over one to three years, and then annually at an approximate rate of 0.3% to 1.0%. Over time, the effect of weather and sunlight causes moisture-protection materials to become more brittle, gradually trapping moisture, corroding electrical connections and reducing operating voltage. Breakdown of a protective layer immediately behind the panel glass gradually reduces the amount of sunlight that hits the PV cell, decreasing output current. Sensitivities around the core project risk from defective panels usually include more severe downside tests for the last half of the project life.
The estimated range for degradation rates for crystalline silicon and thin film panel technologies is between 0.3% and 1.0%. This range is supported by a number of separate sources: (1) actual data from decades of crystalline panel performance (and up to 15 years of data for thin film); (2) protocols for accelerated testing, and factory certification; (3) IE review of certification; and (4) a growing database for performance of different technologies. DBRS notes that there are several factors that affect panel performance, and the data indicating that range of degradation are not homogenous. Differences in technology, suppliers, individual manufacturing facilities, as well as different climates and environments, levels of pollution, correctness of installation, panel configuration and levels of shading can all affect panel performance.

While testing and certification establish the initial power output capability and acceptability of new panels, these tests cannot predict which panels will perform at a 0.3% annual degradation rate for the project life and which will exhibit a 1.0% degradation rate over the same period. Estimates of degradation rate rely on proven performance from operating solar assets and are sometimes supported by long-term studies from independent research and development entities. That may be particularly important in competitive markets where lower prices can pressure some suppliers to cut costs to preserve margins. Accordingly, the experience of the IE and their knowledge of supplier capability and panel performance is critical to the assessment of the technology risk. In order to properly assess panel suppliers and degradation rates, effective IEs typically supplement their own database of panel performance with frequent field surveys of installed solar projects.

DBRS generally considers degradation rates of 0.5% to 1.0% to be a reasonable, conservative assumption for utility-scale solar project panel performance, depending on the type of technology used and subject to specific supplier review as well as the IE’s conclusions. The degradation rate assumption used in the base case project model will also depend on a case-by-case review of the technology, supplier and other relevant factors specific to each project, as well as the IE’s assessment.

In general, most investment-grade solar projects can sustain break-even degradation rate increases (following the initial LID) of roughly 2% each year over a typical project life of 20 years and still service debt (although that break-even resilience might be weaker for projects with higher operating costs and greater leverage). Degradation rates that are at least 100% higher than the already conservative assumption of 1% annual degradation in each year over a typical project life compare well with typical break-even resilience for key variables in the operating phase for other types of project bonds (e.g., 40% to 50% for hydrology risk in hydro projects or operating costs in other investment-grade project types). The risk of degradation rates of more than 100% higher than the conservative assumptions is considered by DBRS to be low. In cases where the degradation assumption is viewed as aggressive, DBRS would adjust the assumption to a level considered reasonable for the purpose of a base case.

**PANEL WARRANTIES**

Most investment-grade solar projects do not retain panel performance risk without some form of structural enhancement. The ProjectCo will generally seek partial risk transfer to the supplier or to a third-party insurer. Warranties, maintenance reserves and specific panel degradation reserves may be used to compensate the ProjectCo for revenue lost as a result of panel underperformance. This structural enhancement may also cover the cost of replacing PV panels and inverters if performance falls below a defined threshold. Typical warranties guarantee a 20% decrease in output over 20 to 25 years or an annual degradation threshold of up to 1%. Panel degradation reserves typically mimic the terms of a panel supplier warranty and are a second layer of protection if the panel supplier becomes insolvent over the life of a project. As the degradation threshold is generally above the actual performance data, both the warranties and panel degradation reserves represent protection that may not ultimately have to be accessed by ProjectCo.

The terms of warranties or reserve mechanisms vary and may be defined in a separate agreement with the panel supplier or within an EPC contract or even the O&M contract. DBRS will assess the quality of the warranty and its relative reliability, including assessment of any technical termination provisions that could weaken the warranty. DBRS also reviews the quality of the warranty provider, as even the most comprehensive warranty cannot confer a credit benefit that exceeds the creditworthiness of its provider.
Where third-party insurance is purchased to enhance a supplier warranty, the insurance coverage is reviewed to determine the degree to which its terms mirror the supplier's coverage. When a panel supplier's rating is non-investment grade, an acceptable form of warranty together with third-party insurance or panel degradation reserve can support the project rating.

Typical supplier warranties include a three- to five-year warranty for panel defects (to cover significant failure of initial panel performance), a power output warranty of 97% of initial rated power in the first year and a specific forecast system average panel output over the 20- to 25-year life of the project. Sensitivity analysis related to project output includes the effect of the panel warranties on the base case and likely effect of warranty failure.

INVERTERS
Inverters convert the direct current produced by solar cells into alternating current. One inverter will usually serve a significant number of solar panels, so whereas one degraded or inoperable panel will have minimal impact on the amount of power produced by the project, failure of an inverter will typically cause a material loss of power. As such, the ProjectCo/O&M provider will need to be attentive to the proper maintenance and timely replacement of inverters. DBRS will consider the stocking of spare parts and the adequacy of the maintenance/replacement plan. Inverters also receive warranties for five to ten years with obligations to replace for premature inverter failure or underperformance. There are only a handful of leading inverter suppliers, including some high credit quality multi-national corporates in the segment. However, this portion of the solar market has also experienced bouts of oversupply and margin pressure from competitive pricing, and includes a number of vulnerable participants and the risk that well-capitalized new entrants could emerge. As inverter performance is a material concern, ProjectCo and debtholders could have some exposure to the inverter supplier’s financial capability, and a careful review of its credit quality is included in the assessment of operating period risk. The ease and cost of replacement of inverters is also an important consideration in determining the creditworthiness of the project.

INDEPENDENT ENGINEER’S REPORT – OPERATING PERIOD
As with the IE’s assessment of construction risk, an IE provides separate verification of project analysis for the operating phase. The IE’s scope provides validation for and informs separate analysis by DBRS. That scope reviews expected panel performance as well as panel supplier and operator capability, including financial and technical capability as well as operational track record.

The report should include an estimate of uncertainty related to newer technologies. The IE also reviews the base case panel degradation assumption and its potential variance. Operating period production and costs, including estimates for maintenance expense, cost of replacement parts and exposure to replacement of distressed suppliers are also reviewed. The IE’s scope typically includes an economic summary that (1) confirms base case economics, including budgeted costs and projected power generation corresponding to the solar energy resource forecast; (2) reviews sensitivity analysis, including the reasonableness of key downside scenarios; and (3) analyzes downside scenario results.

As part of that review, the energy production forecast is verified. Analysis should include estimated losses caused by orientation/shading, temperature, soiling and snowfall. Soiling is a material source of losses, estimated at approximately 5% to 7% for an average rainfall year in a dry climate. The seasonal effect of snowfall in northern climates can cause a reduction in solar energy of between 40% and 70% (depending on location, environment, panel tilt angle and whether a tracking mechanism is used) and should be conservatively estimated in the project's financial model and reviewed by the IE. Based on observations from solar projects in colder, more northern climates, DBRS believes that generation during the winter months is typically between 20% and 30% of that in summer months, and as such has generally applied a discount where estimates have been more optimistic in such climates. Factors affecting soiling include rainfall, panel tilt, traffic, pollution and farming, as well as mining or construction activity nearby. The IE report may also review warranties and maintenance reserves covering panel performance, including assessment of the warranty formula for determining claims under a warranty or sizing of the maintenance reserve.
INDEPENDENT SOLAR RESOURCE REPORT

A comprehensive report from a reputable resource consultant with a proven track record and expertise in estimating solar energy volume is a vital component in rating solar projects and will be considered by DBRS when developing its view on resource variability. The solar resource report should review methodology and measurement equipment for collecting solar data. Its projections inform the base case resource assumptions supporting the financial model revenue forecast. Prior to construction, a minimum of ten years of data relevant to the project site is required to develop the statistical analysis for assessing variance of solar energy and the related variance of power production and project cash flow. Where a rating is assigned after construction, sufficient onsite data from the operating project is required to determine a sufficiently reliable relationship to the applicable long-term reference data and mitigate uncertainty.

The empirical data set is used to generate a long-term distribution for expected project performance. Site-specific data is preferable to nearby data collection locations, which in turn are preferable to even more distant collection locations or datasets based on satellite information. However, as more approximate, non-site-specific datasets tend to introduce only modest forecast variance, they may be acceptable for project assessment, and DBRS notes that this is a relatively standard practice in the industry.

The solar resource consultant assesses resource performance and power output expressed as a stochastic distribution with resource strength and economics of the plant (expected electricity losses, planned operating outage rates, panel degradation assumptions and possible transmission curtailment) at one-year P50 (i.e., the level of annual solar energy that occurs at the 50% percentile), P90 and P99, which are common metrics for estimating expected project performance. Resource forecasts that include all three measures are superior to those with fewer measures. Annual power generation based on a one-year P90 threshold is the underlying revenue assumption used for the DBRS base case. The standard deviation for solar energy is relatively low compared with other renewables (e.g., wind), and variance analysis of the solar resource data should form part of the resource consultant’s report. Annual variance in solar energy over the life of a project is generally about 5% to 10% from the long-term average.

Note: Given the nature of the solar market and technology, the IE report and the solar resource report are especially critical to the rating process. Without these independent assessments, DBRS may not be able to provide a rating.
Sponsorship, Legal, Financial and Other Considerations

SPONSORSHIP

A reputable equity sponsor with previous experience as a solar project investor will bring expertise to new projects and is more likely to closely monitor construction progress, provide guidance to the project’s management and contribute a sense of urgency to early detection of problems and their timely resolution. Project credit is supported by a sponsor with a proven track record, significant volume of solar project completion and/or a portfolio of owned/managed solar assets and experience throughout the solar power value chain (including vendors, developers, financial equity and EPC market participants). Sponsors that have worked closely with a number of suppliers and contractors and have consistently completed solar project assets on time and on budget will be viewed favourably.

A single controlling sponsor with a reputational or strategic stake in a project is also a rating strength and usually superior to multiple sponsor partners with limited and/or passive investment strategies. Somewhat less satisfactory are investment-grade companies with a track record in the power sector but limited experience with solar asset development and ownership. DBRS expects a sponsor to be suitably qualified to manage through the construction, operation and maintenance of a utility-scale solar project. When a sponsor is not qualified or sufficiently experienced (particularly in the context of an owner-supplier model), there may be a negative rating impact. DBRS notes that the project’s rating does not incorporate any expectation of sponsor financial support in excess of contractually obligated amounts.

LEGAL AND REGULATORY

Special Purpose Vehicles

Unlike a traditional securitization transaction where self-liquidating financial receivables are securitized in a true sale to a bankruptcy-remote SPV, obtaining complete isolation from the bankruptcy estate of a parent company is more difficult for SPVs created for project finance assets. These operating asset SPVs typically engage in a wider, although still limited, range of activities, creating the potential for broader credit risks or business liabilities compared with the typical passive securitization trust. Project finance transactions, however, are generally only structured to achieve ratings in the BBB/A range, unlike structured finance ratings, where AAA ratings are commonplace.

In evaluating the merits of an SPV structure for project finance in the BBB/A range, DBRS will usually expect to see the separateness covenants and other transaction features noted below maintained through the life of the transaction:

• Separate legal identity organized for the sole purpose of carrying out the relevant business with restrictions on (1) changes in the business activity of the SPV; (2) commingling of assets with the parent or any other person; (3) disposition of assets; (4) additional assets; (5) additional liabilities; (6) the granting of additional security; and (7) amalgamating, merging or joining with another entity or otherwise reorganizing.
• Bank accounts, financial statements and books, and records separate from the parent or any other person.
• Covenant of the SPV to hold itself out as a separate person from the parent or any other person and to conduct business in its own name.
• Covenant of the SPV to maintain an arm’s-length relationship with its parent or any other person.
• Covenant of the SPV to pay its own expenses and liabilities out of its own funds.
• Restrictions on guarantees to and from the parent or any affiliate.
• Organizational documents that include separateness covenants as well as a covenant to maintain the SPV structural features throughout the term of the transaction.

Project financing relies on contracts with the SPV. Lenders should be informed of any default by the SPV under its contract obligations and should have the ability to cure SPV defaults. Security provisions are an essential feature of a project financing arrangement. Generally, bondholders will have a first-priority, perfected, senior security interest, mortgage, hypothec and/or other appropriate security over the assets of the SPV, including any cash flows and contractual rights of the SPV. In a default by the SPV, bondholders should be able to obtain control of the SPV’s assets and should also have the right to take over any contractual rights and obligations of the SPV, including the assignment of cash flows.

Dispute Resolution

Most projects have a prescribed process for settling commercial disputes between ProjectCo and the revenue counterparty or between ProjectCo and its contractors. When evaluating a dispute resolution process, DBRS looks for an efficient, timely and transparent framework that limits the automatic requirement of legal recourse and supports continued construction or operation while a dispute is ongoing.

Legal Opinions

DBRS will typically expect to see opinions covering, among other things, (1) the creation and legal existence of the SPV; (2) the power, authority and capacity of the SPV to enter into various binding project agreements; and (3) the validity, perfection and enforceability of the security granted to the security holders. DBRS may also require a non-consolidation opinion. DBRS expects to be named as an addressee on all such legal opinions that may be required by DBRS.

Insurance

In general, DBRS evaluates the amount of insurance coverage compared with (1) the force majeure provisions of the key contracts, (2) the replacement cost of the project and (3) the extent of potential business interruption. Bondholders should be an additional insured party and be able to choose whether the notes are paid out or the plant/asset is rebuilt or replaced. If insurance premiums are not paid by the SPV, bondholders should be notified, and no changes to the insurance coverage should be made without the consent of bondholders. Insurance coverage must be from an institution with a reasonable credit rating compared with the project debt rating and may be evaluated by an independent insurance consultant for bondholders. The SPV should be required to provide annual insurance certificates proving continuing adequacy of coverage and compliance with project terms. Insurance renewal risk is present in most projects, although in the normal course, insurance premiums are a small percentage of overall operating costs. Most projects have the ability to absorb a significant multiple of base case insurance premiums, and while shortages in global insurance capacity do occur, they are generally short-lived.

Expert Reports

In most project finance transactions, bondholders retain experts such as IEs, resource consultants, insurance consultants, environmental consultants and market consultants in order to aid in assessing the level of many of the types of risk mentioned above. Issues that require expert evaluation may include (1) environmental assessments of potential liability (such as pre-existing conditions and the risk of lender liability when enforcing security rights); (2) construction process, schedule and costs; (3) O&M costs; (4) operating requirements of the off-take agreements; and (5) various other matters including financial projections, asset quality and the condition of existing projects, adequacy of the insurance package, and, for renewable power generation, a resource study forecasting expected production levels. It is preferable that experts be engaged on behalf of investors to minimize any potential conflicts of interest.

Regulatory Matters

The political commitment to renewable energy subsidies within the jurisdiction is assessed. Growth in solar assets has been most rapid where policy support ensures above-market feed-in-tariff prices. However, even in highly rated economies, some risk exists of future economic and political pressure for revision to subsidized power prices for renewable energy projects.
DBRS reviews the history of the legal jurisdiction to assess the risk of renegotiation of high-tariff PPAs. Where there are cut-off dates for policy subsidies, DBRS evaluates the risk of failing to commission a project within a prescribed deadline. The PPA is carefully reviewed to assess the counterparty’s obligation to pay and the project’s obligation to perform.

**Power Purchase Agreement**

An investment-grade PPA counterparty with a contracted tariff schedule sufficient to generate robust project debt service coverage ratios (DSCRs) is a significant rating strength. Where a PPA includes merchant exposure to market prices, DBRS will apply sensitivity analysis to assess its ratings impact, although DBRS notes that even modest merchant exposure is likely to cause a ratings impact. PPAs are assessed for the reasonableness of availability thresholds or minimum output requirements, if any, and the term of the agreement should be at least one year greater than the project’s debt maturity.

Where a project involves construction risk, the PPA should allow for a construction schedule overrun without immediately terminating. DBRS will consider the amount of time between the target completion/generation date and the point at which the PPA counterparty may terminate the PPA. If this period is too short, the ProjectCo may not be able to replace either the EPC contractor, panel supplier or other subcontractors in a timely enough fashion to avoid a default.

Solar projects that involve the construction of new transmission may be exposed to risk of delays in interconnect approval and commissioning. Where new transmission is outside the project scope, the PPA should provide relief against grid connection delays. A DBRS rating is provisional until approvals have been met and can only be finalized once all required authorizations have been granted.

**FINANCIAL RISK**

Analysis of financial risk includes assessment of certain metrics, scenario and break-even analysis and key financial terms based on a conservative approach to the early-stage solar market. DBRS considers project metrics and related scenario and break-even analysis in the context of all other critical rating factors. That is, the overall profile of debt service coverage is a guide and does not, strictly by itself, determine a specific rating.

**Metrics**

The primary financial metric for solar projects is the one-year P90 minimum DSCR (the annual power production level exceeded for 90% of forecast outcomes). A BBB (low) solar project will generally have a minimum DBRS-adjusted base case P90 DSCR greater than 1.3 times (x), assuming reasonable panel degradation and a panel degradation reserve.

The permitted leverage for a given rating level is driven mainly by a specific jurisdiction’s revenue model, the project cost structure and the desired DSCR threshold. In markets with generous feed-in tariffs, equity contributions may be lower than in jurisdictions that use tax incentives to provide more modest policy support. Where a project can achieve very low construction costs, or for project bonds that fund acquisition of operating assets purchased at a low price, the investment-grade DSCR threshold may also be achieved with lower equity contributions. In some cases, more highly levered transactions can achieve investment-grade ratings, provided other aspects of the project can compensate for the higher gearing, including, but not limited to, a higher DSCR. Equity should be contributed at financial close or be backed by an LC issued by a financial institution acceptable to DBRS.

**Scenario and Break-Even Analyses**

Sensitivity and break-even analysis should include reasonable downside estimates for the following:

- Variance in solar resource.
- Variance in energy produced given the level of solar resource (including panel degradation).
- Construction and operating cost overrun.
- Inflation.
KEY DEBT TERMS
Other critical contractual terms for the project debt assuming a low investment-grade rating include the following:

No Refinancing Risk  Project debt is fully amortizing with at least a one-year tail (between debt maturity and end of the PPA). Higher amortization in the early years of operation when power generation is highest is a strength.

Debt Service Reserve  6- to 12-month debt service reserve. The effect of additional debt service reserve may make a ratings difference, depending on overall credit profile.

Cash Sweep Mechanisms  These support project credit quality and, in addition to increasing project flexibility, can be used to smooth the cash flow impact of seasonal variation in the solar resource.

Distribution Test  Permitted if P90 DSCR > 1.2x (historical and projected).

Additional Indebtedness  Permitted if P90 DSCR > 1.3x (historical and projected).

Sculpting  The amount of power generated from solar energy can be sharply reduced in winter the farther a project is located from the equator. Debt service payments can be sculpted to smooth the projected DSCR to match peak repayments with peak solar energy. Alternatively, some financing structures may make use of a reserving mechanism. In any event, DBRS expects that the financing would incorporate a mechanism to match revenues to cash outflows.

Cash Flow Waterfall  Should be specified in the Trust Indenture and administered by the trustee in the event of a default.

Maintenance Reserve  Equal to 6 to 12 months of O&M costs.

Solar Power Projects – Summary of Primary Rating Drivers

<table>
<thead>
<tr>
<th>Rating Criteria</th>
<th>BBB (low)/BBB</th>
<th>BB Range</th>
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<tbody>
<tr>
<td>Construction Period Risk</td>
<td>• Investment-grade panel supplier and investment-grade contractor with fixed-price contract.</td>
<td>• Non-investment grade supplier and contractor with insufficient enhancements or without fixed-price contract.</td>
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<td>• Non-investment grade supplier and/or contractor but with robust protections against delays, cost overruns and performance defaults.</td>
<td>• Non-supportive or qualified IE report conclusions for design, schedule, budget and debt service coverage.</td>
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<tr>
<td></td>
<td>• Positive IE report conclusions for design, schedule, budget and debt service coverage.</td>
<td>• Negative or qualified solar resource report conclusions confirming solar energy volume estimates and projected power generation.</td>
</tr>
<tr>
<td></td>
<td>• Positive solar resource report conclusions confirming solar energy volume estimates and projected power generation.</td>
<td>• IE may be less experienced, or IE report fails to support conclusions with accurate, relevant data and well-reasoned analysis.</td>
</tr>
<tr>
<td></td>
<td>• Established, experienced IE and an IE report that drives conclusions with accurate, relevant data and well-reasoned analysis.</td>
<td>• Aggressive panel degradation assumption with non-investment grade supplier and weak warranty.</td>
</tr>
<tr>
<td>Operating Period Risk</td>
<td>• Conservative panel degradation assumption with investment-grade supplier and acceptable warranty or suitable reserves, insurance or other credit enhancements.</td>
<td>• Inexperienced O&amp;M operator.</td>
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<tr>
<td></td>
<td>• Experienced and creditworthy O&amp;M operator.</td>
<td>• Cost plus contract with operator not adequately aligned with ProjectCo and bondholder interests.</td>
</tr>
<tr>
<td></td>
<td>• Fixed-price O&amp;M contract with detailed performance criteria.</td>
<td>• Inexperienced O&amp;M operator.</td>
</tr>
<tr>
<td></td>
<td>• High-quality IE and solar resource reports with favourable opinions for expected performance, and each report from providers with established track records.</td>
<td>• Inadequate IE and solar resource reports with qualified opinions for expected performance, and each report from providers with insufficiently established track records.</td>
</tr>
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## Solar Power Projects – Summary of Primary Rating Drivers

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| **Legal and Regulatory Risk** | • Investment-grade PPA counterparty.  
• Strong PPA with all conditions met by closing (e.g., government approvals, permits and transmission access).  
• PPA with reasonable performance criteria and tariff schedule sufficient to generate adequate DSCRs.  
• PPA term at least one year greater than debt maturity.  
• A transparent legal environment with a record of supportive regulation and minimal change-in-law or contract repudiation. | • Non-investment grade PPA counterparty.  
• PPA may leave outstanding exposure to incomplete compliance with regulatory, permitting, and transmission access requirements.  
• PPA with onerous performance criteria and aggressive tariff schedule, likely to lead to weaker DSCRs.  
• No tail at end of PPA term, or PPA expires prior to maturity of long-term debt.  
• A less reliable or opaque legal jurisdiction with precedent for imperfect access to due process and recourse to fair court judgments, inadequate dispute resolution, and an inability of bondholders to enforce their rights, including security interests, in default. |
| **Sponsor**               | • Experienced, creditworthy sponsor(s) with proven track record.  
• Demonstrated sponsor commitment in the project with reasonable equity contribution and support.  
• Single sponsor or consortium with a strong leading sponsor. | • Sponsor(s) with limited or no track record in the type of projects being developed and financed.  
• Sponsor(s) with weak credit quality.  
• Multiple sponsors for which the investment has limited strategic importance. |
| **Country and Political Risk** | • Countries with reasonably stable political, regulatory or economic environments.  
• In cases where potential issues exist, these risks are well mitigated. | • Countries with one or more political risk factors that are difficult to gauge or mitigate because of weakness in the legal framework or uncertainty in political, regulatory or economic environments. |
| **Financial Risk**        | • Minimum one-year P90 DSCR ≥ 1.3x.  
• Leverage is assessed case-by-case and is driven mainly by a specific jurisdiction's revenue model, project cost structure and project DSCR. Feed-in tariff revenue models and low-cost projects may bear lower equity contribution.  
• A minimum debt service reserve of 6 to 12 months.  
• Normal investment-grade standards for key term sheet items have been met. | • Minimum one-year P90 DSCR ≤ 1.3x.  
• Equity contributions that are too low to achieve target DSCR.  
• Minimum debt service reserve is less than 6 months or does not form part of the financing structure.  
• Not all key term sheet items are acceptable to an investment-grade standard. |