WHITE PAPER

Solar PV Project Repowering

Best Practices and Insights

Jake Silhavy (Sargent & Lundy)
Eric DeCristofaro (Sargent & Lundy) | **Eric Soderlund** (Sargent & Lundy)
Megan La Tronica (Sheppard Mullin)
Darian Hackney (Sheppard Mullin) | **Julie Marion** (Sheppard Mullin)

55 East Monroe | Chicago, Illinois 60603-5780 | 312.269.2000 | www.sargentlundy.com

Contents

Introduction

In August 2022, the United States (U.S.) Congress passed the Inflation Reduction Act of 2022 (the "IRA"), landmark legislation that modified and extended the longstanding 30% investment tax credit (ITC) for solar photovoltaic (PV) projects and added solar PV projects to the list of qualified facilities eligible for production tax credits (PTCs). In addition to imposing new requirements to qualify for the full amount of the credit available under prior law, the IRA also introduced the domestic content bonus and energy community bonus for projects placed in service after December 31, 2022, which provide for incremental credit amounts above and beyond the credit amounts available under prior law for projects that satisfy the bonus criteria. As amended by the IRA, the PTC and ITC regimes under Internal Revenue Code (the "Code") Sections 45 and 48 are phased out for projects that begin construction after December 31, 2024, after which a new "technology neutral" credit regime under new Code Sections 45Y and 48E are phased in for projects that are placed in service after January 1, 2025. Projects that begin construction on or before December 31, 2024, and that are placed in service after December 31, 2024, effectively have a choice between the two regimes. PTCs and ITCs available under the new credit regime are calculated the same as under the current regime and will begin to phase down at the later of (i) 2033 or (ii) after electricity generation-caused greenhouse gas emissions in the U.S. fall by at least 75% from 2022 levels.

Against this backdrop, a key trend in the industry is the emerging need for inverter replacement at aging PV facilities. It is estimated that the next five years will see roughly 10–20% of the U.S. solar PV industry's 163-GW deployed capacity approach or surpass the 15-year "benchmark" at which older inverters have begun to need replacement. In addition, an average of 4.5 GW of solar PV projects are projected to need new inverters every year for the next five years.[1]

The aging contingent of the solar PV market and imminent need for major component replacement in a large number of existing projects—in addition to the currently active incentives (e.g., the IRA tax credits)—creates an environment in which there is strong technical and financial motivation for renewed solar PV project investment. By extension, the current environment provides owners with an opportunity and incentive to evaluate and extend their projects' operating life while maximizing the potential for additional or renewed tax credit eligibility. One major challenge to new solar PV project development is completing the interconnection process and avoiding the risk of potentially high interconnection upgrade costs. A partial repower effort—in which some components (e.g. modules or inverters) are replaced while others (e.g. the electrical balance of plant) are reused—presents an opportunity to avoid this challenge and risk while improving the project's performance by replacing older modules with newer and more efficient ones.

This whitepaper highlights some of Sargent & Lundy's key considerations during solar PV repowering projects to aid owners, investors, lenders, and engineers in planning capital deployments to aging solar PV infrastructure. It also offers insights from Sheppard Mullin's expert energy tax attorneys regarding the tax credit implications and how to maximize available incentives when replacing solar PV major components.

---

[1] Utility Dive, "*US solar farms are aging. Is it time to begin repowering?,*" published October 6, 2023, authored by Emma Penrod.

Lastly, we explore relevant permitting (e.g., land use permits) and decommissioning considerations in a repowering effort.

These findings are based on Sargent & Lundy's experience providing design, owner's, and independent engineering services—including detailed civil, structural, and electrical engineering—for a large number of solar PV projects. This experience includes independent engineering services for over 100 solar projects totaling over 10 GW of capacity, and ongoing owner's engineering support for over 5 GW of solar PV projects. Sargent & Lundy's past and ongoing independent engineering due diligence engagements with major tax equity investors comprise some of the largest financial institutions as well as nearly 200 debt lenders. Sargent & Lundy has additionally supported the financing of nearly 100 wind repower projects since 2017, which share common considerations that can be applied when deciding to repower a solar PV project.

Tax Credit Implications

Tax Credit Eligibility

Since the passage of the IRA, taxpayers are permitted to claim either the ITC or PTCs with respect to solar projects that are originally placed in service after December 31, 2021. The ITC is a one-time credit equal to a percentage of the cost basis of the eligible property claimed in the year the property is originally placed in service.[2] In contrast, PTCs are claimed over a ten-year period beginning on a facility's placed-in-service date, with each annual credit amount determined based on the production and sale of electricity generated by the facility during the year.[3] In either case, only projects that meet the criteria to be considered "originally placed in service" after December 31, 2021, qualify for the credit.

As developers consider the prospect of significant capital expenditures for aging solar projects, consideration should be given to whether those expenditures qualify a project for additional tax credits. This determination will hinge on whether they want to qualify for PTCs or additional ITCs based on the new capital expenditures, as well as potential changes in the tax law regarding the ITC eligibility of additional capital expenditures for modifications to existing solar projects.

Repowering for PTCs and the 80/20 Test

For a repowered solar project for which a 10-year PTC would be more advantageous than an additional ITC based on the associated capital expenditures, the repowered project must satisfy the so-called "80/20 test" to re-qualify as "originally placed in service" (the original use requirement) as a result of the repowering.

The Internal Revenue Service (IRS) has provided guidance on how taxpayers may successfully repower a wind facility and satisfy the original use requirement for purposes of re-qualifying a facility for PTCs for an additional 10-year period.[4] Generally, in order for a repowered facility to satisfy the original use requirement and re-qualify for PTCs as a "new" facility, the fair market value (FMV) of the facility's used property cannot exceed more than 20% of the sum total of the cost of the new property added to the facility plus the value of the facility's used property.[5] This typically involves an expert appraisal of the facility. Partial repowering of wind projects that Sargent & Lundy has been or is currently involved with were able to meet, or plan to meet, the criteria set forth by the IRS to claim the PTC while using, at a minimum, existing wind turbine foundations, wind turbine towers, and electrical balance of plant (BOP). Sargent & Lundy sees parallel avenues for solar projects to meet the IRS criteria through a strategic partial replacement of components rather than a full replacement of all project infrastructure.

What is a "Facility" for Purposes of a Solar PV Project?

The IRS has clearly defined what property constitutes a "facility" for wind projects. In the wind context, a "facility" consists of each separate wind turbine, together with the tower on which the turbine is mounted

[2] Code § 48(a)(1).
[3] Code § 45(b)(2)(A)(ii).
[4] Revenue Ruling 94-31 and CCA 2003474024.
[5] Rev. Rul. 94-31, 1994-1 CB 16 (5/23/1994).

and the supporting pad on which the tower is situated.[6] Therefore, each turbine must pass the 80/20 test independently, even if the wind project as a whole is otherwise treated as a single project (including, for example, for purposes of beginning construction).[7] The IRS noted that each turbine can be separately metered, operated, and placed in service.

Although solar projects that are originally placed in service after December 31, 2021, are now eligible for the PTC, the IRS has yet to provide any guidance on what constitutes a "facility" for solar PV projects. Absent direct guidance, it is reasonable to reference how the IRS has defined a "qualified facility" in the context of a wind project.

Proposed U.S. Department of the Treasury (Treasury) regulations under Code section 45Y may provide insight on how the IRS intends to apply the 80/20 test for the "technology neutral" PTC.[8] The proposed regulations state that when applying the 80/20 test for purposes of the PTC, the test is performed on a "unit of qualified facility," which is defined as "all functionally interdependent components of property owned by the taxpayer that are operated together and that can operate apart from other property to produce… electricity."[9] Likewise, proposed Treasury regulations under Code Section 48 (the "Section 48 Proposed Regulations")[10] apply the 80/20 test to a "unit of energy property," which is defined similar to a "unit of qualified facility."[11] In each case, in order for components to be considered "functionally interdependent," the placing in service of each component is dependent upon the placing in service of each other component.

The IRS has yet to provide any guidance on what constitutes a "facility" for solar PV projects. Absent direct guidance, it is reasonable to reference how the IRS has defined a "qualified facility" in the context of a wind project.

For a solar project, practically speaking, components should be considered functionally interdependent if they are able to generate electricity independently from the rest of the project and can be separately metered. Project configurations may vary, but generally, a string of panels connected to an inverter may satisfy the functional interdependence standard if they are separately metered.

Developers seeking to qualify a repowered solar project for PTCs should carefully consider how the functional interdependence concept would apply to their project, as the 80/20 test must be met independently for each separate "facility" included in the project, in the same way that the test must be met for each individual wind turbine in a wind project. Additionally, because the PTC is calculated based on the production and sale of electricity, when repowering only portions of a solar project, it is important to consider what portions of the project are capable of being metered separately so as to accurately measure the actual PTCs generated from the repowered project. It is reasonable to expect a single repowered inverter block

---

[6] *Id.*
[7] Notice 2016-31 § 6.01.
[8] Section 45Y Clean Energy Production Credit and Section 48E Electricity Investment Credit, 89 FR 47792 (June 2024) (to be codified at 26 C.F.R. pt. 1), [Federal Register :: Section 45Y Clean Electricity Production Credit and Section 48E Clean Electricity Investment Credit].
[9] Prop. Reg. § 1.45Y-1(a)(2)(iii).
[10] Definition of Energy Property and Rules Applicable to the Energy Credit, 88 Fed. Reg. 82188 (proposed Nov. 22, 2023) (to be codified at 26 C.F.R. pt. 1), [Federal Register :: Definition of Energy Property and Rules Applicable to the Energy Credit].
[11] Prop. Reg. § 1.48-14.

to be eligible for PTCs as long as the 80/20 test is met with respect to that block if the electricity produced from that block can be separately metered.

> It is reasonable to expect a single repowered inverter block to be eligible for PTCs as long as the 80/20 test is met with respect to that block if the electricity produced from that block can be separately metered.

Repowering for Additional ITC & Code Section 48 Proposed Regulations

Historically, capital expenditures for modifications or improvements to ITC-eligible property were ITC-eligible regardless of whether the 80/20 test was met.[12] However, the Section 48 Proposed Regulations, released by the IRS in November 2023, would require that the 80/20 test be met in order for repowered projects to qualify for the ITC with respect to capital expenditures in connection with the repowering. The Section 48 Proposed Regulations would apply the 80/20 test to each "unit of energy property," and allow an additional ITC only if the FMV of the used property does not exceed 20% of the sum total of the value of the used property plus the capitalized costs of the modifications/improvements to the applicable unit of energy property.[13]

There has been significant opposition to the application of the 80/20 test to ITC property.[14] If the proposed regulations are finalized in their current form, it will create significant return on investment considerations for solar repowerings that cannot satisfy the 80/20 test. In such cases, neither the PTC nor the ITC would be available. It is worth noting that even if the 80/20 test is met, any additional ITC would be limited to the applicable percentage of the capital expenditures incurred in connection with the repowering because the ITC is a function of cost basis and the basis in the used property will likely have been fully depreciated by the time of the repowering.[15]

Bonus "Adders" under the IRA

In addition to requiring projects to satisfy the prevailing wage and apprenticeship (PW&A) requirements to receive the full credit amount, the IRA also introduced two new "bonus" adders that can increase the value of the ITC and PTCs for certain projects. These include the domestic content bonus credit and the energy community bonus credit.

Prevailing Wage and Apprenticeship Requirements

Post-IRA, the value of the PTC and the ITC depends on whether a project is eligible for the "base" credit amounts or the "increased credit amount." The increased credit amount equal to five times the base incentive is available if a project is (1) less than 1 MW, (2) began construction before January 29, 2023, or (3) met the new PW&A requirements enacted by the IRA. The "base" credit for the PTC is 0.3 cents per

---

[12] Treas. Reg. § 1.48-2, examples 2, 4, and 5; Notice 2018-59 § 7.01(1) (parenthetical exception to the definition of energy property comprising all functional interdependent parts).
[13] Prop. Reg. § 1.48-14.
[14] Tim Shaw, *Energy Sector Pushes Back Against Investment Tax Credit '80/20 Rule'*, Thomson Reuters (Feb. 23, 2024).
[15] Presumably the repowering would occur after the original ITC recapture period, at which time the used property would be expected to have $0 basis because the basis of ITC property is generally written off over six years.

kWh (subject to an annual inflation adjustment), and is increased to 1.5 cents per kWh if the PW&A requirements are met.[16] Thus, with this increased base rate, the PTC rate for 2024 is 2.9 cents per kWh.[17] For the ITC, the base rate is six percent (6%) and the increased rate is thirty percent (30%).[18] If the PW&A requirements are not satisfied, the project may still be eligible for the base credit rate, but an 80% haircut applies in respect of the available credit.

Generally, in order to satisfy the PW&A requirements, a taxpayer must pay any laborers or mechanics employed by the taxpayer, or any contractor or subcontractor, the prevailing wage rates as most recently determined by the Secretary of Labor in accordance with the Davis-Bacon Act[19] for construction, alteration, or repair of the facility. In order to comply with the apprenticeship requirements, a taxpayer must ensure that the applicable percentage of the total labor hours of the construction, alteration, or repair of the facility is performed by qualified apprentices.[20] The applicable percentage varied based on when the facility began construction but is 15% for all projects that began construction after December 31, 2023.[21] The apprenticeship requirements also include a participation requirement and a ratio requirement. The participation requirement instructs each taxpayer, contractor, or subcontractor who employs four or more individuals to perform construction, alteration, or repair on the facility to also employ one or more qualified apprentice.[22] In order to satisfy the ratio requirement, the number of journeyworkers to qualified apprentices must comply with the applicable apprentice-to-journeyworker ratio of the registered apprenticeship program.[23]

[16] The PTC is subject to phase-out if the annual average contract price per kilowatt hour of electricity generated from the same qualified energy resource and sold in the previous year in the United States exceeds 8 cents, which is also subject to annual adjustment by an inflation adjustment factor. Further, to the extent the inflation adjustment result is not a multiple of 0.05 cents, the Section 45 Tax Credit will be rounded to the nearest multiple of 0.05. Then, if such increased amount is not a multiple of 0.1 cent, the Section 45 Tax Credit will be rounded to the nearest multiple of 0.1. Section 45(b)(1)-(2).
[17] On June 20, 2023, Treasury released the 2023 inflation adjustment factor in the federal register. 2023-13191.pdf (govinfo.gov). Treasury has not yet released the 2024 inflation adjustment factor.
[18] Code §§ 48(a)(5)(A)(ii), 48(a)(9)(A)(i).
[19] Davis-Bacon Act of 1931, 40 U.S.C. §§ 3141–3148 (2020).
[20] A qualified apprentice means an individual who is employed by the taxpayer or by any contractor or subcontractor and who is participating in a registered apprenticeship program, as defined in Code § 3131(e)(3)(B). Code § 45(b)(8)(E)(ii).
[21] Under Code § 45(b)(8)(A)(ii), for purposes of Code § 45(b)(8)(A)(i), the applicable percentage is: (i) in the case of a qualified facility that begins construction on or before December 31, 2022, 10 percent, (ii) in the case of a qualified facility that begins construction during 2023, 12.5 percent, and (iii) in the case of a qualified facility that begins construction after 2023, 15 percent.
[22] Code § 45(b)(8)(C).
[23] Code § 45(b)(8)(B).

Domestic Content

The domestic content adder increases the value of the PTC by ten percent (10%) (calculated on the rate otherwise allowable before any increase/adder for satisfying the energy community adder, described in the next section) and the value of the ITC by ten percentage points (for example, from 30% to 40%) for projects that meet the domestic content requirements.[24] The requirements to capitalize on the domestic content benefits are two-fold:

- 100% of the structural steel and iron included in the project must be manufactured in the United States.
- A specified percentage of all manufactured products included in the project must be manufactured in the United States.

The IRS has issued limited guidance to date on the domestic content adder, Notice 2023-38 and Notice 2024-41.

Notice 2023-38 provides guidance on how to compute the applicable percentage of domestically manufactured products. It requires taxpayers to identify each manufactured product and its first-tier components (manufactured product components). A manufactured product will be considered manufactured in the U.S. only if each of its manufactured product components is of U.S. origin. Each manufactured product component[25] directly incorporated into a manufactured product is considered to be of U.S. origin if its manufacturing location is within the U.S., regardless of where its subcomponents are produced. Section 4 of Notice 2023-38 provides that the eligibility of a repowered project for the domestic content adder is determined by looking solely at the direct costs and county of origin of new property.[26]

Notice 2024-41 establishes a new elective safe harbor intended to eliminate the need for obtaining direct cost information from suppliers. Under the new elective safe harbor, the IRS has established an exclusive list of manufactured products and manufactured product components for certain technologies and assigned a domestic content percentage to each manufactured product component on the list. Taxpayers electing into the safe harbor are required to identify which manufactured product components are included in the manufactured products incorporated into their project, and whether they are manufactured in the U.S., and then add up the assigned percentages of the U.S. manufactured components. If the total of the percentage satisfies the required percentage for U.S. manufactured products, the domestic content requirements are deemed satisfied.

---

[24] The domestic content adder is set forth in Code § 45(b)(9) for the PTC. With respect to the ITC, the domestic content adder is available for projects claiming the ITC under Code § 48(a)(12) which cross-references § 45(b)(9). For the technology neutral ITC, Code § 48E(a)(3)(B) cross-references Code § 48(a)(12) for the domestic content adder. For the technology neutral PTC, Code § 45Y(g)(11) sets forth the domestic content adder. The value of the adder for the PTC is calculated excluding any other adders that may apply to the project.

[25] Notice 2023-38, 2023-22 I.R.B. 872 (5/12/2023). Section 3.01(2)(d) of Notice 2023-38 defines manufactured product component as "any article, material, or supply, whether manufactured or unmanufactured, that is directly incorporated into an Applicable Project Component that is a Manufactured Product."

[26] Notice 2023-38, 2023-22 I.R.B. 872 (5/12/2023).

Table 1 shows the exclusive list of manufactured products and manufactured product components for solar PV projects, as well as their assigned domestic content percentage, for purposes of the new elective safe harbor.

Table 1 — New Elective Safe Harbor per IRS Notice 2024-41[27]

Solar PV Table					
Applicable Project Component	**Manufactured Product Components**	**Ground-Mount (Tracking)**	**Ground-Mount (Fixed)**	**Rooftop (MLPE)**	**Rooftop String**
PV Module	Cells	36.9	49.2	21.5	30.8
	Frame/Backrail	5.3	7.0	3.1	4.4
	Front Glass	3.7	4.9	2.2	3.1
	Encapsulant	2.2	3.0	1.3	1.8
	Backsheet/Backglass	3.7	4.9	2.1	3.1
	Junction Box	1.6	2.2	1.0	1.4
	Edge Seals	0.2	0.2	0.1	0.2
	Pottants	0.2	0.2	0.1	0.2
	Adhesives	0.2	0.2	0.1	0.2
	Bus Ribbons	0.4	0.5	0.2	0.3
	Bypass Diodes	0.4	0.5	0.2	0.3
	Production	**11.5**	**15.3**	**6.7**	**9.6**
Inverter	Printed Circuit Board Assemblies	3.0	4.0	16.0	2.5
	Electrical Parts	1.0	1.3	1.6	1.1
	Climate Control	0.7	0.9	-	0.3
	Enclosure	1.0	1.3	1.6	0.8
	Production	**3.3**	**4.4**	**16.4**	**2.9**
PV Tracker or Non-Steel Roof Racking	Trackers	9.7	-	-	-
	Fasteners	0.4	-	11.1	16.0
	Slew Drive	2.0	-	-	-
	Dampers	0.4	-	-	-
	Motor	3.1	-	-	-
	Controller	0.9	-	-	-

[27] Notice 2024-41, 2024-24 IRB 1615 (5/16/2024).

Solar PV Table					
	Rails	2.0	-	8.6	12.3
	Production	**6.2**	**-**	**6.1**	**8.7**
Steel photovoltaic module racking	-	-	Steel/Iron Product	-	-
Pile or ground screw	-	Steel/Iron Product	Steel/Iron Product	-	-
Steel or iron rebar in foundation	-	Steel/Iron Product	Steel/Iron Product	-	-
	TOTAL	**100**	**100**	**100**	**100**

Although helpful for the development of new solar projects, the new elective safe harbor poses some challenges for repowered projects. Under the new elective safe harbor, if a listed manufactured product or manufactured product component is not part of the project, it is assigned a zero value. In a repowering context where only the new property is taken into account, the assigned new elective safe harbor percentages may fall well short of the required domestic content percentage. A helpful modification of the new elective safe harbor for repowered projects would be if taxpayers were permitted to calculate their domestic content percentage based on the *relative* percentages of the new components included in the repowering, versus the *absolute* percentages of the new domestic components. Unless and until any such modified guidance is issued, developers seeking to qualify for the domestic content adder in connection with a solar PV repowering will likely need to obtain and rely on their supplier's direct cost information.

The 80/20 test may be of particular importance when considering projects that must replace their pile foundations (as discussed later herein). Projects seeking to replace their PV modules (and possibly their racking systems) may also reap the benefit of the domestic content bonus. While most PV module manufacturing takes place in China, some tier 1 manufacturers (such as First Solar, Canadian Solar, and Hanwha Qcells, among others) either have well-established domestic manufacturing operations or are in the process of expanding their domestic manufacturing capacity. Some racking vendors have also begun to announce significant expansion efforts to their domestic manufacturing capacity, such as GameChange Solar's February 2024 announcement to expand its domestic annual manufacturing capacity to 35 GW in 2024.[28] Considering the strong financial incentives including the domestic content bonus, Sargent & Lundy considers it reasonable to expect other manufacturers to follow suit in this regard.

Energy Communities

The IRA stipulates that certain locations in the U.S. may be eligible for higher tax credit benefits and designates these areas in specific but relatively expansive terms. These locations are referred to as "energy

[28] GameChange Solar, "*GameChange Solar Announces Expansion to 35 GW Annual U.S. Domestic Manufacturing Capacity,*" dated February 20, 2024.

communities," and must fit into at least one of the three categories in the list below.[29] The energy community adder is intended to encourage the development of renewable energy and energy storage projects on contaminated sites, and to bring economic development to areas which have been historically reliant on fossil fuel-related industries.[30]

- **Brownfields**[31]**:** small, distinct tracts of land that have been polluted and subsequently designated by the U.S. Environmental Protection Agency (EPA) for redevelopment efforts. There are 25,000 brownfield sites throughout the U.S.
- **Coal communities**[32]**:** census tracts in which, or which are adjacent to tracts in which, either (i) a coal-fired power plant has closed since 2010 or (ii) a coal mine has closed since 2000.
- **Locations with fossil fuel-related employment or tax revenue**[33]**:** a metropolitan or non-metropolitan statistical area where 0.17% or greater direct employment or at least 25% of local tax revenues are related to extraction, processing, transport, or storage of coal, oil, or natural gas, and unemployment is at or above the national average in the previous year.

Qualifying projects located in energy communities are eligible for incremental U.S. federal income tax credits, above and beyond the "base" credit available to all qualifying projects, and the "base + 5x bonus" credit available to qualifying projects that satisfy the PW&A requirements. For projects claiming the PTC, the energy community bonus credit is 10% of the PTC otherwise allowable before any increase/adder for satisfying domestic content requirements.[34] For projects claiming the ITC, the energy community bonus credit is a 10% increase in the base + 5x bonus credit rate (30%) for projects that satisfy the PW&A requirements (i.e., a 40% total credit rate) or a 2% increase in the base credit rate (6%) for projects that do not satisfy such requirements (i.e., an 8% total credit rate).[35]

> To ensure no bonus incentives are missed, Sargent & Lundy recommends determining whether the census tract or statistical area in which a project is located can be considered an energy community, as designated by the IRA.

Of the three categories, the third has the most expansive definition—due not only to its relatively low employment rate (0.17%) necessary for eligibility, but also the massive size of some statistical areas. As a result, the third category

[29] Resources.org, *"What is an 'Energy Community'?,"* dated September 7, 2022, published in Resources Magazine January 11, 2024, authored by Daniel Raimi and Sophie Pesek.

[30] *See* White House, *Fact Sheet: One Year In, President Biden's Inflation Reduction Act is Driving Historic Climate Action and Investing in America to Create Good Paying Jobs and Reduce Costs* (August 16, 2023) ("The law is driving investment to places too often left out and left behind through bonus tax credits for building clean energy projects in traditional energy communities…."). *See also*, *House Budget Committee Report on Build Back Better Act (H.R. 5376)*, Report No. 117-130, Book 2, pages 1696-7 (Section 1706. Energy Community Reinvestment Financing Program) (September 27, 2021).

[31] I.R.C. § 45(b)(11)(B)(i) (defining brownfield site by reference to Section 101(39)(A), (B) and D(ii)(III) of the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) (42 U.S.C. 9601(39), which generally includes "real property, the expansion, redevelopment, or reuse of which may be complicated by the presence or potential presence of a hazardous substance, pollutant, or contaminant," subject to certain exclusions, and including mine-scarred).

[32] Code § 45(b)(11)(B)(ii).

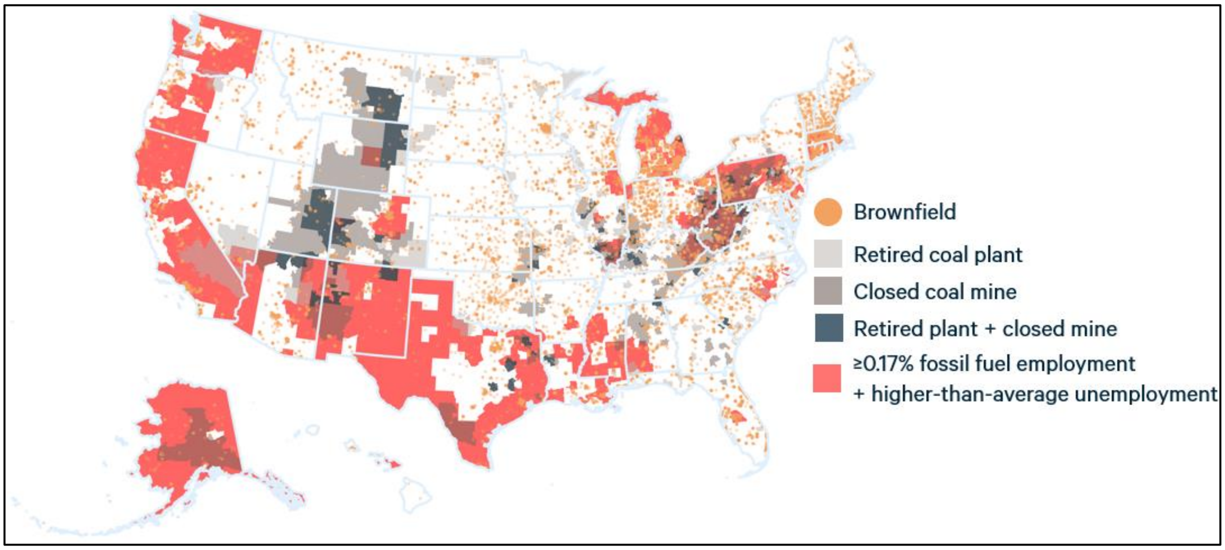
[33] Code § 45(b)(11)(B)(iii).

[34] Code §§ 45(b)(11)(A), 45Y(g)(7).

[35] Code §§ 48(a)(14)(A), 48E(a)(3)(A)(i)

designates nearly 40% of the U.S. land area as energy communities. As a whole, approximately 50% of the total U.S. land area qualifies as an energy community, as illustrated in Figure 1.

Figure 1 — Estimate of IRA-Designated Energy Communities[29]



The expansiveness of the “energy community” designation, particularly in parts of the U.S. in which there are many existing and aging projects (e.g., parts of the Southwest, Texas, and California), increases the number of projects that may be eligible for tax credit bonuses if they were to begin repowering efforts that qualify for the ITC or PTCs. To ensure no bonus incentives are missed, Sargent & Lundy recommends determining whether the census tract or statistical area in which a project is located can be considered an energy community, as designated by the IRA.

Repower Strategy for Major Components

A key aspect of planning the optimal repowering strategy for an aging solar asset is understanding which major components should remain and which should be replaced. In a repower scenario, components that are not replaced will be expected to serve operating lives commensurate with the new equipment, which will likely be beyond the project's initially envisioned operating life. The major component replacement strategy will also be impacted by the ability to re-qualify for tax incentives, which is explained in the previous section.

Sargent & Lundy has evaluated the major components of solar PV projects that we consider to be most sensitive to operating life. The following subsections list those major components, and describe their ability to support an extended, post-repower operating life. Sargent & Lundy's experience and capabilities make us well suited for these evaluations. We have significant experience providing independent and owner's engineering services—including detailed civil, structural, and electrical design reviews—for solar PV projects and the broader renewable industry. In the last five years, we have provided independent engineering services in support of financing for over 250 renewable power projects and are currently supporting over 5 GW of solar PV projects as owner's engineer.

PV Modules

One key consideration for repowering a solar PV project is to determine whether to replace the project's PV modules. If PV modules are not replaced, their ability to support an extended, post-repower project life must be evaluated. The primary consideration for life extension of the PV modules is the performance degradation during the additional years from the end of the project's stated design life (e.g., 25 years following the achievement of commercial operation) until the end of the repower design life. Sargent & Lundy considers there to be a variety of well-established PV module manufacturers that can be considered "tier 1" suppliers whose long-term[36] power warranties provide some assurance of the manufacturer's long-term performance expectations. It should be expected that some modules will need to be repaired or replaced throughout the life of the project. These repairs/replacements should be accounted for in the Project's operations and maintenance (O&M) budget, but Sargent & Lundy does not consider them to impact the ability of the modules to support a significant post-repower operating life. While Sargent & Lundy considers it reasonable to expect that tier 1 suppliers' PV modules will continue to operate and degrade approximately linearly beyond the power warranty period, newer PV modules exhibit markedly higher efficiency relative to older panels. As such, replacing a project's modules as part of the repower effort allows for improved performance while avoiding the risk of having to navigate the interconnection process again.

[36] Sargent & Lundy typically sees suppliers' power warranties last for at least 25 or 30 years.

The degradation in a project's peak power rating can be mitigated by replacing some portion of a project with new modules. While there are clear benefits to using new modules to replace older, degraded ones (e.g., increases in capacity and efficiency), there are also key challenges, namely:

- Newer modules almost always have larger physical dimensions and thus impart higher structural loads, which may necessitate the replacement of racking structures and/or components.
- Newer modules typically operate at higher voltages relative to older modules and relative to older inverters' maximum voltage limits, which may necessitate different string sizing or inverter replacements, depending on the results of an updated ampacity study.

These challenges are discussed further herein. Sargent & Lundy generally recommends detailed structural and electrical design reviews to determine the extent to which each challenge is applicable. A review of the old and new module design specifications, as well as an energy yield assessment with the project's new capacity, may also be warranted to evaluate the benefit that can reasonably be expected when using newer replacement modules with higher efficiency and nameplate capacity. Replacement of a project's PV modules during a repower will likely be driven by the need to satisfy the 80/20 test to qualify for tax credits, as discussed in the previous section.

Racking Systems

Sargent & Lundy considers there to be a variety of well-established racking manufacturers that can be considered tier 1 suppliers, the product offerings from whom are mature products that have evolved from years of product development. In the case of single-axis tracking systems, the system's primary structural requirement is to support the PV modules without significant deformation under the forces of wind, snow, rain, or earthquakes for the project's pre- and post-repower design life. Tier 1 suppliers typically offer products that have undergone comprehensive wind tunnel and destructive wind testing. While such testing provides a reasonable level of confidence that the key components of the tracker are suitable for the project's intended post-repower operating life (as long as they are maintained in accordance with original equipment manufacturer [OEM] guidance), Sargent & Lundy considers a project's racking system to go hand-in-hand with the project's modules that the racking system supports. If the modules are replaced, there is no guarantee that the racking system will continue to be compatible with the replacement modules. To ensure tracker-module compatibility, Sargent & Lundy typically recommends procuring a compatibility letter that has been signed by the tracker OEM and countersigned by the module vendor. Sargent & Lundy also typically verifies UL 2703 or 3703 standard compliance, which ensures electrical safety, mechanical strength, and material suitability for mounting systems, clamping devices, and purlins for PV modules. Alternatively, a report summarizing the results of field testing and evaluation of the mounting system to the requirements of the applicable UL standard might be reviewed.

While new module clamps and purlins can often be applied to address challenges from having larger and heavier replacement modules, some instances may require the racking system to be replaced to handle the larger structural loads. As mentioned in previous sections, Sargent & Lundy recommends performing a detailed review of a project's structural design drawings and calculations to determine whether such a replacement is necessary. If a project's racking system is replaced, there is an opportunity to capitalize on the IRA's tax incentives if the 80/20 test is satisfied.

Pile Foundations

Sargent & Lundy considers a project's pile foundations to be the among the most critical components to assess when formulating a repower strategy. The assessment of a project's piles can be divided into (1) an evaluation of the suitability of the original pile design and (2) a determination of the extent to which the pile design has held up in the actual site conditions. A key part of pile design involves determining a design corrosion rate based on prevailing soil and atmospheric conditions, and designing the protection applied to the pile (e.g., galvanizing and "sacrificial steel thickness") to meet the intended design life. An accurate prediction of the corrosion rate is therefore essential to designing a pile such that it will remain serviceable throughout the project's pre- and post-repower operating life.

At a minimum, a corrosion study is typically performed to measure the electrical resistivity and pH at a variety of boring locations to determine the apparent resistance and acidity of the in-situ soil conditions throughout the project site. Electrical resistivity and acidity test results are used to characterize the soil's corrosivity potential, and corrosion rates are then used to calculate a sacrificial steel thickness in pile design.

The first evaluation should be whether and to what extent any available margin may be available beyond the project's initially planned design life. In some instances, margin in some design parameters (e.g., utilization ratio) may vary throughout the site. In addition, the site topography may impact the height at which the project's piles are installed relative to its maximum design height. A shorter reveal height reduces bending stress in a pile under the same design loads, allowing it to tolerate greater corrosion (i.e., over an extended life) and still meet design requirements.

Belowground corrosion rate prediction is also an evolving science, and considerable variability between predicted and actual rates has been found in published field studies carried out by numerous academic and government institutions. Measured corrosion rates over the life of the project can be used to compare to the predicted corrosion rate in order to determine whether any margin likely exists, and the project's galvanizing certificates can be analyzed to determine whether any galvanizing thickness in excess of the design requirement was applied originally.

In some cases, the project may have little to no design margin, and/or the actual corrosion rate may be worse than predicted. In such instances, some or all of the project's piles may require replacement. Pile replacement may also be needed if the PV module size or weight has increased. Pile replacement is a large and costly undertaking, but projects have an opportunity to defray some of the expense by capitalizing on the IRA's tax benefits and domestic content bonuses, which are elaborated on in the previous section. Sargent & Lundy recommends performing a detailed review of the pile foundation structural design drawings and calculations in consideration of the actual corrosion rate that has occurred. In a scenario where pile foundation replacement is needed to support a life extension under a repower scenario, Sargent & Lundy would expect that developers would also elect to replace racking and modules as well.

Civil Aspects

Sargent & Lundy does not typically consider there to be significant concerns regarding the civil works of a project that would impact its ability to achieve its intended post-repower operating life. A repowering effort may be an opportunity to address civil concerns such as flooding, scour, or erosion if any such concerns have been exhibited. In the event that the site experiences extreme flooding events, the site should be monitored and inspected to assess the scour and other erosion effects to the site. Evaluation and monitoring should also be performed to determine whether regrading or recompacting is necessary. In general, Sargent & Lundy expects civil maintenance at the site to continue at roughly the same pace beyond the project's pre-repower design life.

Power Conversion Systems

As the U.S. solar PV market continues aging, more operational power conversion systems (PCSs)—comprised of an inverter (or multiple inverters) and a medium-voltage (MV) transformer—are beginning to approach or surpass the 15-year mark at which older inverters have begun to need replacement. According to recent projections, up to 20% of the 163-GW U.S. solar PV industry's deployed inverter capacity will reach this 15-year milestone in the next 5 years, and an average of 4.5-GW of solar PV projects will need new inverters every year for the next five years. To complicate matters, many manufacturers of first- and second-generation inverters that are reaching this milestone have gone out of business.

There are technical challenges involved with replacing an inverter with a new and distinct unit in instances when the original product line has been discontinued. For example, there are voltage mismatch considerations: older sites typically have modules with a maximum direct current (DC) voltage rating of 600 V_{dc} and an operating, maximum-power string voltage (V_{mp}) of 300–450 V_{dc}, whereas newer inverters operate at a much higher DC voltage (typically as high as 1000–1500 V_{dc}). Additionally, in smaller community-scale projects (i.e., <5 MW), central inverters were often originally used, but the industry has shifted to using string inverters for such systems. String inverters have different configurations and grounding requirements relative to older inverters, and these differences must be appropriately accounted for. Codes and interconnection requirements have also changed in some cases, which may impact wiring methods, grounding, and bus interconnections for inverter replacements.

These challenges must be overcome or mitigated to ensure a successful repower effort in instances in which inverters are one of the components being replaced. For the voltage compatibility challenge, a DC:DC converter can be used to boost the DC-side voltage prior to the input of the inverter. Such an approach avoids derating the inverter (which can occur if the string voltage is much lower than the inverter's optimal input voltage) and maximizes efficiency. In some instances, another reasonable approach might be to use an inverter with an operating V_{mp} window that is wide enough (i.e., that has a sufficiently low minimum) to match the existing PV module operating voltage without derating. This approach avoids the added cost and efficiency losses of introducing a DC:DC converter to the system. Sargent & Lundy recommends performing a thorough review of the project's PV array and MV collection system electrical design to determine the current module- and string-level operating voltage setpoints (i.e. V_{dc} and V_{mp})—as well as a review of the design specifications for both the original and the new, proposed inverters—to determine the optimal approach in this regard. A review of the authority having jurisdiction (AHJ) requirements may also be appropriate, as some AHJs may require aspects of the system to be brought up to compliance with the current codes. AHJ requirements and other potential permitting constraints are discussed in a subsequent section.

Electrical Balance of Plant

Reusing the electrical BOP (MV collection system and project substation) can provide substantial cost savings but is not without risk to the project. To assess such risk, an independent engineering evaluation should be performed to assess the suitability of the existing electrical BOP for the repowered configuration and the impact of additional years of operating life on the equipment. Evaluations should include a detailed analysis of site drawings, calculations, and reports, along with a site visit to assess the condition of project equipment, and whether the substation, collection system, control systems, and transmission lines are suitable for repowering and life extension. Certain repowering variations, including ones that involve changes to PV array's maximum output, inverter reactive capability, or transformer ratings, may require new engineering studies to support the repowering. For example, the following studies may need to be completed: ampacity, transformer loading, reactive capability, short circuit, grounding, relay coordination, harmonics, and supervisory control and data acquisition (SCADA) coordination. The results of these studies may require new capital upgrades or replacements to ensure reliable operation and compliance of the electrical BOP post-repowering.

Based on experience designing electrical BOP systems, as well as our own independent reviews of over 300 renewable project electrical BOP designs in the last five years, Sargent & Lundy typically considers it reasonable to expect the electrical BOP operating life not to be a limiting factor in a project's suitability for repower if regular maintenance is adhered to. However, the suitability of electrical BOP is directly dependent on other major components. For example, if the inverter is replaced, there may be a need for replacement of DC trenching and conduit, as well as alternating current (AC) cabling replacement. In addition, the new collection system voltage level may impact the compatibility of the main power transformer (MPT). Specifically, if there is no low-side MPT voltage tap setting that matches the new collection system-level voltage rating, there may be a need to replace the MPT. As such, particularly in instances of inverter replacement, Sargent & Lundy recommends performing a detailed electrical design review, including a review of the single-line diagrams for the project's MV collection system and substation. We also recommend reviewing the MPT specifications to determine its compatibility with new inverter replacements.

Additional Considerations

Interconnection

Understanding how repowering will impact compliance with an existing interconnection agreement (IA) is a critical element when considering whether to repower a project. Initially, a project needs to determine if its existing IA and interconnection studies will remain valid post-repowering. Depending on the repowering scope, the entire IA and all its associated studies may need to be redone, potentially leading to a delay while the project progresses through the interconnection queue with the independent system operator (ISO). This scenario can also expose the project to the possibility of updated and potentially more stringent interconnection requirements, as well as the possibility of additional payments to the interconnection utility for system upgrade costs. If it is determined that the existing IA and interconnection studies are valid, the project must still confirm that all IA technical requirements are being met and submit updated documentation of the planned upgrades to the ISO and/or interconnecting utility. In Sargent & Lundy's experience on over 100 wind repower projects, for cases where the repower does not increase the point of interconnection capacity, existing IAs and interconnection studies have been found to be applicable and valid by the appropriate stakeholders post-repowering. We expect the outcome of solar repowering efforts with regards to interconnection to follow a similar precedent.

Commercial and Permitting

Prior to repowering, a review of commercial agreements and permitting requirements should determine that operating and technical requirements of applicable agreements and contracts will be met post-repowering. The review should include existing approvals, permits, and licenses to confirm that a repowered plant can operate in full compliance and that there are no limiting restrictions after the commercial operation date (COD). Extending the life of a solar project through repowering typically pushes the anticipated project life past the expiration dates of important contracts, such as power purchase agreements (PPAs), as well as site control contracts (e.g., leases and easements). Sargent & Lundy recommends that appropriate sensitivities be considered in any financial models when projecting revenue beyond the expiration date of such contracts. In addition, the repowering effort itself will temporarily impact production and availability, which could impact PPA performance guarantees. To understand the appropriate sensitivities and risks, it is important to rely on experienced industry professionals. To reduce the risk of noncompliance, the IA should be reviewed in detail, particularly if a generating capacity increase is planned. Several federal legal authorities, including the Federal Aviation Administration (FAA), U.S. Army Corps of Engineers (USACE), U.S. Fish and Wildlife Service, EPA, and state and county legal authorities may impose additional permitting requirements that need to be considered. To avoid unexpected delays and/or fines, a permitting specialist with relevant experience should be consulted.

Operations and Maintenance

Repowering a solar project is expected to positively impact project O&M costs in the years following the repower. Projected O&M costs following repowering through the end of a project's life should be assessed for agreement with its financial model to evaluate the level of risk to project stakeholders. This assessment should include a review of existing operations, maintenance, and management agreements in place; a review of historical operating costs for a project; and an assessment of O&M cost escalation for similar operating solar projects. The review should also include assessments of unplanned maintenance costs relative to historical major component failure rates. A buildup of anticipated annual project costs can be calculated based on a review of operating cost data gathered from similar projects. For this, Sargent & Lundy relies on our internal O&M project cost and performance database, which includes cataloged capital cost, operating cost, and performance data from our experience on over 100 solar projects.

Decommissioning

A solar project repowering effort is expected to include some level of decommissioning of older equipment. Sargent & Lundy recommends that a decommissioning cost assessment be performed to inform stakeholders of the costs associated with removal of existing equipment for the development of an optimal repowering strategy. Sargent & Lundy has a dedicated cost estimating group that routinely performs decommissioning cost estimates for solar projects. In addition, when considering decommissioning, it is important to validate applicable conditions for existing permits and approvals, as well as to identify and secure necessary permits and approvals for decommissioning construction activities. Sargent & Lundy has expertise to support these tasks.

Conclusions

The current U.S. PV market has strong incentives, from both a policy and technical standpoint, for solar PV project investment. On the policy side, the IRA has created financial incentives in the form of investment and production tax credits—for which bonus incentives are available—for project investment. The technical impetus is the industry's aging operational fleet, which has begun to exhibit the need for at least partial major component replacement and will continue to at an increased rate over the next five years.

In evaluating solar PV project's suitability for repower and operating life extension, as well as the tax credit implications for such a repower effort, Sargent & Lundy has distilled the following list of key takeaways and recommendations:

- Since the passage of the IRA, taxpayers are permitted to claim either the ITC or PTCs with respect to solar projects that are originally placed in service after December 31, 2021. For a repowered solar project attempting to claim PTCs, the project must satisfy the "80/20 test" to re-qualify as "originally placed in service" (the original use requirement) as a result of the repowering. The Section 48 Proposed Regulations, released by the IRS in November 2023, would require that the same test be met for repowered projects to qualify for the ITC as well, with respect to capital expenditures in connection with the repowering.
- In addition to requiring projects to satisfy the prevailing wage and apprenticeship requirements in order to receive the full credit amount, the IRA also introduced two new "bonus" adders that can increase the value of the ITC and PTCs for certain projects. These include the domestic content bonus credit and the energy community bonus credit.
    - Unless taxpayers are permitted to calculate their domestic content percentage based on the relative percentages of the new components included in the repowering versus the absolute percentages of the new domestic components, developers seeking to qualify for the domestic content adder in connection with a solar PV repowering likely will need to obtain and rely on their supplier's direct cost information.
    - Sargent & Lundy recommends determining whether the census tract or statistical area in which a project is located can be considered an energy community, as designated by the IRA.
- Degradation of operational projects' DC nameplate rating can be mitigated by replacing some or all of the project's PV modules. Such a replacement effort comes with challenges, for instance, newer modules being heavier and operating at higher voltages, which can impact the suitability of the project's existing racking system and inverters. Sargent & Lundy generally recommends detailed structural and electrical design reviews to determine the extent to which each challenge is applicable. A review of the old and new module design specifications, as well as an energy yield assessment with the project's new and increased capacity, may also be warranted to evaluate the benefit that can reasonably be expected when repowering with newer PV modules.

- A project's pile foundations are among the most critical components to its ability to undergo repower. Sargent & Lundy recommends evaluating whether and to what extent any margin exists in the project's pile design. Such margin may stem from in-situ corrosivity being lower than expected (for some or all of the project), pile reveal heights being smaller than the maximum design height, or utilization ratios being designed to the worst-case (i.e., exterior row) conditions, causing interior piles that constitute the majority to have margin. Sargent & Lundy recommends performing a detailed review of the project's structural design drawings and calculations to evaluate the extent to which any margin exists and to determine whether the racking system must be replaced as part of a repower effort. Such considerations are of particular importance when the project's PV modules are being replaced. While new module clamps can often be applied to address challenges that stem from having larger and heavier replacement modules, the racking system may sometimes need to be replaced to handle these larger structural loads.
- Voltage mismatch and grounding requirements must be taken into consideration when evaluating the need for and suitability of an inverter replacement. For the former challenge (i.e., voltage mismatch concerns), a DC:DC converter can sometimes be used to boost the DC-side voltage prior to the input of the inverter. Sargent & Lundy recommends performing a thorough review of the project's PV array and MV collection system electrical design drawings (including a review of applicable single-line diagrams) to determine the current module- and string-level operating voltages. A review of the design specifications for both the original and the new, post-repower inverters is also appropriate to determine the optimal approach for PCS replacement.

About Sargent & Lundy

Sargent & Lundy is one of the world's longest-standing full-service architect engineering firms. Founded in 1891, the firm is a global leader in power, energy, and decarbonization with expertise in grid modernization, renewable energy, energy storage, nuclear power, fossil power, carbon capture, and hydrogen. Sargent & Lundy delivers comprehensive project services – from consulting, design, and implementation to construction management, commissioning, and operations/maintenance – with an emphasis on quality and safety. The firm serves public and private clients in the power, energy, gas distribution, industrial, and government sectors.

Sargent & Lundy's roles on electric power generation projects include full-design architect-engineer, owner's engineer, lender's independent engineer/technical advisor, and consultant. Our services include specialized technical advisory and consulting services to complete engineering and program management, encompassing procurement, construction management, technology transfer, and assistance with construction. Sargent & Lundy is at the forefront of new solar technologies and applications, from bifacial PV modules to the integration of solar and battery energy storage. Our clients are some of the biggest names in the industry and include project owners and operators as well as financial institutions and investors. We support projects of all sizes—including residential, rooftop, carport, distributed generation, and utility scale—in the United States and internationally. We have evolved alongside the solar market to support hundreds of clean energy projects every year.

About Sheppard Mullin's Energy, Infrastructure and Project Finance Team

Sheppard Mullin's Energy, Infrastructure and Project Finance team, which includes more than 100 attorneys nationwide, is consistently recognized as one of the leading renewable energy and regulatory practices in the U.S. by The American Lawyer, which selected the firm as a finalist for 2024 Energy Corporate Practice Group of the Year, Chambers USA, Legal 500 and Best Lawyers. The team is comprised of highly specialized attorneys with the requisite experience in electrical power, oil and natural gas, renewables, and biofuels to understand its clients' objectives. The largest and most innovative energy industry players—including leading utilities, pipeline operators, municipalities, independent power producers, commercial banks, equity and tax investors, EPC contractors, and energy technology companies—look to the team for assistance on their most important energy-related legal matters. The team is recognized for its work on record-setting deals, including the $1.5 billion purchase of American Electric Power's unregulated renewables portfolio, which was named IJ Investor's 2023 North America Renewables M&A Deal of the Year.

For more information, please contact:

Jake Silhavy | Senior Consultant
+1-248-318-3041 | jake.t.silhavy@sargentlundy.com

Eric DeCristofaro | Vice President
+1-312-269-7261 | eric.r.decristofaro@sargentlundy.com