ELECTRIC POWER RESEARCH INSTITUTE

PV Plant Decommissioning Salvage Value

Conceptual Cost Estimate

2018 TECHNICAL REPORT

PV Plant Decommissioning Salvage Value

Conceptual Cost Estimate

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Sargent & Lundy LLC

NOTE

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Abstract

This report presents a high-level cost estimate for decommissioning a conceptual ground-mounted crystalline-silicon fixed-tilt solar photovoltaic (PV) plant at the end of its useful life. There are relatively few utility-scale plants that have reached their end-of-life and have been decommissioned. Without direct experience, it is difficult to assess a plant's net salvage value. More research is needed to better estimate and quantify end-of-life considerations, such as the cost of decommissioning, including disposal of PV plant waste and the scrap value of extracted materials. This report includes the methodology performed, all relevant assumptions, explanation of costs, scrap values, indirect costs, contingencies, and other information deemed to be pertinent to the cause of estimating the cost of decommissioning a representative 11 MW_{AC} PV power plant.

Keywords

Decommissioning
Estimate
Scrap
Solar photovoltaics (PV)
End of life

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Product Type: Technical Report

Product Title: PV Plant Decommissioning Salvage Value: Conceptual Cost Estimate

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PRIMARY AUDIENCE: PV plant owners and project financiers interested in end-of-life decommissioning costs for solar photovoltaic (PV) power plants

SECONDARY AUDIENCE: Operation and maintenance providers for PV plants, researchers, and other energy and environment stakeholders

KEY RESEARCH QUESTION

Ninety percent of PV plants operating today have been installed since 2011. With lifetimes of roughly 20 to 30 years, there is little experience with decommissioning PV plants, however, significant increases in PV waste volumes are expected in the 2030 timeframe. High-level estimates of decommissioning costs are needed to improve planning for PV end-of-life and reduce risk in new projects.

RESEARCH OVERVIEW

A decommissioning cost estimate was developed for a conceptual 11 MW_{AC} ground-mounted crystalline-silicon fixed-tilt solar PV plant at the end of its useful life. The estimate relied on assumptions related to foundation sizes, steel and copper quantities, cable quantities, and other equipment considered to be typical for a solar PV plant. The methodology followed by Sargent & Lundy for developing the cost estimate consisted of three elements: 1) prior experience developing plant demolition costs and database of numerous other similar projects, 2) use of unit cost factor methodology for specific tasks, developed from labor and material cost information, and 3) quotes for similar activities for past projects.

KEY FINDINGS

- Decommissioning labor, equipment, and subcontract costs are significant. Only the scrap value of recoverable metals (steel and copper) were considered in the estimate to reduce the overall cost of decommissioning. The negative net salvage value for the conceptual 11 MW_{AC} plant (excluding the salvage value of the inverters and modules) is estimated as \$83/kW_{AC}, or 4.8% (relative to an installed cost of \$1727/kW).
- The net scrap value for recovered metals is relatively low. Scrap metal offsets approximately one quarter of the total cost of plant decommissioning.
- Industry needs to consider end-of-life options for decommissioned PV modules. This study assumed that modules would be landfilled, but reuse or recycling may be viable alternatives.

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EXECUTIVE SUMMARY

WHY THIS MATTERS

PV project cost and schedule can be negatively influenced by uncertainty in decommissioning costs. Lenders and insurers may require costly decommissioning bonds for new projects, the salvage value of materials may not be considered in determining decommissioning costs, and extended project reviews may lead to protracted project development times. Decommissioning studies of representative PV plants are needed to mitigate the perceived risk around end of life project value.

The decommissioning cost estimation study described in this report serves to quantify end-of-life considerations, such as the cost of decommissioning and disposal of a PV plant as well as the scrap value of extracted materials. Together, these values can be used to generate a plant net salvage value.

HOW TO APPLY RESULTS

This report can be used to understand the processes and costs associated with decommissioning a utility-scale PV power plant, as well as the salvage value of recovered materials. It also can be used for estimating the net salvage value of a PV plant at the end of its useful life.

LEARNING AND ENGAGEMENT OPPORTUNITIES

- Related Reports
  - *Solar Photovoltaic Life Cycle Analysis: A Practical Handbook for Solar Photovoltaic Power Plant Owners and Operators.* EPRI, Palo Alto, CA: 2016. 3002008832.
  - *Program on Technology Innovation: Insights on Photovoltaic Recycling Processes in Europe: A Survey-Based Approach*. EPRI, Palo Alto, CA, Alliance for Sustainable Energy, Operator of the National Renewable Energy Laboratory, and Wambach-Consulting: 2017. 3002008846.
  - *Feasibility Study on Photovoltaic Module Recycling in the U.S.* EPRI, Palo Alto, CA: 2018. 3002012461.
- March 14, 2018 Webcast Recording—*Decommissioning Salvage Value of a Solar PV Plant.*

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PROGRAM: Renewables (Solar Project Set, P193C)

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Acronyms and Abbreviations

Term	Definition or Clarification
A/E	Architect/engineering
BOP	Balance of plant
EPRI	Electric Power Research Institute
G&A	General and administrative
GSU	Generator step-up (transformer)
MW_{AC}	Megawatt alternating current
PV	Photovoltaic
Sargent & Lundy	Sargent & Lundy LLC
USD	United States dollars

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Section 1: Introduction

EPRI engaged Sargent & Lundy LLC (Sargent & Lundy) to conduct a decommissioning study for a representative 11-megawatt-alternating-current (MW_{AC}) solar photovoltaic (PV) power plant.

The first utility-scale solar PV power sites in the United States were built in the 1980s. However, most existing utility-scale solar PV power sites were installed in the last 15 years, and the lifecycle of a typical PV solar panel is between 20 and 30 years. Therefore, very few utility-scale solar PV plants have been decommissioned.

According to a report issued by the International Renewable Energy Agency (IRENA) and the International Energy Agency's Photovoltaic Power Systems Programme, (IEA-PVPS), PV panel waste could total nearly 80 tons globally by 2050.[1] The value of this recycled material could exceed $15 billion. In anticipation of this projected volume of solar PV material, comprised mostly of glass, the industry is working to develop industrial-scale methods of waste management. While some manufacturers currently reclaim panels for recycling, the practice is not widespread. In Europe, where PV module recycling is mandated, batches of module waste are typically processed in existing glass and metal recycling facilities.

This decommissioning study includes a conceptual cost estimate for decommissioning a representative 11-MW_{AC} solar PV power plant as of December 2017. This report details the boundaries of the decommission scope, including assumptions, explanation of decommissioning costs, scrap values, indirect costs, contingencies, and other information deemed to be pertinent.

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[1] "End-of-Life Management: Solar Photovoltaic Panels" (2016), http://www.iea-pvps.org/index.php?id=381

Section 2: Basis of Cost Estimate

This decommissioning cost estimate study provides a conceptual estimate to dismantle and remove a representative 11-MW_{AC}, fixed-tilt solar PV power plant with a site area of approximately 70 acres (28 hectares) surrounded by 7,000 linear feet (2134 m) of 6-foot-tall (1.8 m) security fencing. The plant is assumed to be comprised of the following primary components, buildings, and equipment:

- 38,680 modules, ground-supported on steel racks with two support posts (directly embedded in the ground) per rack
- Five inverters supported by a slab on grade foundation
- Generator step-up (GSU) transformer and foundation
- Control building and foundation
- Grounding rods
- Interconnecting wires, conduits, and fittings between inverters, transformers, and combiner boxes
- Miscellaneous electrical equipment located in the control building

Although there have been changes in PV module technologies and general design optimizations over the years, from a decommissioning perspective the selected plant design should be representative of designs from 20 years ago as well as designs today.

The estimate document, "34299A EPRI 11-MW_{AC} Solar Farm Demolition Study Conceptual Cost Estimate," is included as Appendix A. The contracting approach used to develop the estimate was assumed to be multiple lump sums, i.e., payments for each of the multiple contracts or subcontracts shall be made as a single payment (lump sum) as opposed to a series of payments made over time (such as monthly or quarterly payments). The unit of measurement used throughout is United States customary units, and the currency is United States dollars (USD).

Estimate Development

The demolition cost estimate was developed based on Sargent & Lundy's existing estimate for the construction of a new 11-MW_{AC} solar field installation previously prepared for EPRI.[2] Sargent & Lundy leveraged its experience preparing the construction estimate to create the decommissioning estimate for a same size plant.

The cost estimate is based largely on Sargent & Lundy's general decommissioning experience. Detailed engineering has not been performed to confirm project details, and site-specific characteristics have not been fully analyzed due to the general location of the representative site. Allowances were assigned where necessary to cover issues that are likely to arise but that have not been clearly quantified at this time.

Listed below is a summary of decommissioning activities for site facilities and structures included in the estimate:

- Dismantle and remove all mechanical and electrical equipment
  - Fixed-tilt solar modules (labor to place modules in the dumpster is included; pallets are not included)
  - Racking
  - Mounting posts
  - Inverters and foundations, combiner boxes, electrical boxes, above-ground conduits, and wiring
  - Control building and electrical equipment inside
  - Grounding rods
  - Paved roads and gravel areas
  - GSU transformer
- Landscaping (only as noted below)
- Scrap value for metals

Assumptions

The decommissioning cost estimate assumes the following:

- The PV modules are non-hazardous and can be discarded to a non-hazardous landfill.
- Interest is not included.
- All electrical equipment and wiring is de-energized before work begins.

[2] *Solar Energy Technology, Market, Cost and Performance Report*. EPRI, Palo Alto, CA: 2018. 3002008627.

- All items above grade and to a depth of 6 inches (15 cm) will be demolished and removed, unless noted otherwise. Any other items buried more than 6 inches will remain in place.
- Scrap value for recoverable metals is included in the estimate as a credit.
- The resale of equipment or material is not included in the cost estimate.
- Disturbed areas will be covered with topsoil, mulched, and seeded with grass; no other landscaping is included.
- All borrow material (e.g., material, such as soil, gravel, or sand, that is removed from one location to be used at another) needed for ground resurfacing is assumed to be from offsite sources (i.e., a borrow pit).
- No extraordinary environmental costs, such as contaminated soil remediation, are required.
- Decommissioning of overhead transmission towers is not included.
- All scrap steel is considered to be carbon steel.
- Labor work schedule and incentives: work week is five, eight-hour days. Per diem is not included.
- All demolished non-metal materials are considered debris and will be transported to a licensed landfill.
- Hauling (transportation) cost of $13/CY ($17/m^3) is included and based on a 40CY (30.6 m^3) capacity truck making a 65-mile (105 km) one-way trip.[3]
- Plant land is assumed to be leased; therefore, no value is assigned for reclaimed land upon decommissioning.

Due to the lack of readily available recycling programs, this study assumes solar panels are discarded in a landfill. Landfill disposal is the current prevailing approach for end-of-life, utility-scale solar PV power plants. The landfill disposal fee ($18/CY, or $23.5/m^3) is not specific to a particular landfill and was estimated based on Sargent & Lundy's general decommissioning experience. The cost of the subcontract to transport (haul) the PV modules from the solar field to the landfill are included (see Phase 21.18.00 of the cost estimate, included as Appendix A). Although new recycling facilities and methods may be developed over the next several years, this cost estimate is based on decommissioning activities occurring in December 2017.

The study does not consider costs to repower the site with solar PV or decommissioning costs specific to other alternative uses of the plant facility. It is possible that decommissioning activities, and therefore costs, could be reduced substantially if the site were to be reused as a solar facility.

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[3] The entire 11-MW_{AC} plant would require approximately 104 trucks to haul all 38,680 modules to the landfill. This assumes a cubic yard (CY) contains 13 modules with dimensions of roughly 65" x 39" x 1.4" and a 30% container void, due to packing of irregular shaped objects. If module nameplate capacity is 285 W (not accounting for degradation), each 40 CY capacity truck would carry about 148 kW (3.7 kW/CY) of modules.

Labor Wage Rates

Craft labor rates for Oklahoma City, Oklahoma[4] were developed from the publication *Labor Rates for the Construction Industry with RSMeans Data*, 2017 edition. Costs have been added to cover social security, worker's compensation, and federal and state unemployment insurance. The resulting burdened craft rates were then used to develop typical crew rates applicable to the task being performed.

Project Direct/Indirect and Construction Indirect Costs

The estimate is constructed such that most of the direct construction costs are determined directly. Several direct construction cost accounts are determined indirectly by taking a percentage of the directly determined costs. These costs are identified as "variable accounts." These percentages are based on Sargent & Lundy's experience with projects of a similar type and size. Listed below are the variable accounts (items that have not been included in the estimate are indicated as such):

- Additional Labor Indirect Costs:
  - Labor supervision
  - Show-up time (not included)
  - Cost of overtime (not included)
  - Subsistence (per diem) (not included)
  - General liability insurance
- Site Overheads:
  - Construction management (not included)
  - Field office expenses (not included)
  - Start-up craft support (not included)
  - Pre-operational testing (not included)
  - Site services (not included)
  - Safety
  - Temporary facilities
  - Temporary utilities (not included)
  - Mobilization/demobilization
  - Legal expenses/claims

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[4] This location is consistent with Sargent & Lundy's existing estimate for the construction of a new 11-MW_{AC} solar field installation previously prepared for EPRI (see 3002008627). Experience preparing the construction estimate was leveraged to create the decommissioning estimate.

- Other Construction Indirect Costs:
  - Small tools and consumables
  - Scaffolding (not included)
  - Freight on equipment (not applicable)
  - Freight on material
  - Freight on scrap material
  - Contractor's general and administrative (G&A) expense
  - Contractor's profit

Project indirect costs include the following:

- Architect/engineering (A/E) services (included)
- A/E construction management (not included)
- Owner's costs – Included as 4.0% of the total direct labor and material cost. Owner's costs include owner project engineering and planning, administration and construction management, permits and fees, legal expenses, security, taxes, etc.

Scrap Value

The values for scrap metal are based on mill-delivered prices; therefore, a deduction is applied to account for transportation to the processor, process separation, preparation, and shipping to the mill. The resulting net scrap prices are as follows:

- Carbon steel at $166/ton ($183/mT)
- Copper at $3,220/ton ($3527/mT)

Historical data showing scrap value trends over time are presented in Figure 2-1 and Figure 2-2. The scrap values are per gross ton (differs from the net scrap values above) for Zone 3 (consistent with the location of Oklahoma City, Oklahoma used to develop labor rates) and were created based on data obtained from MarketWatch.

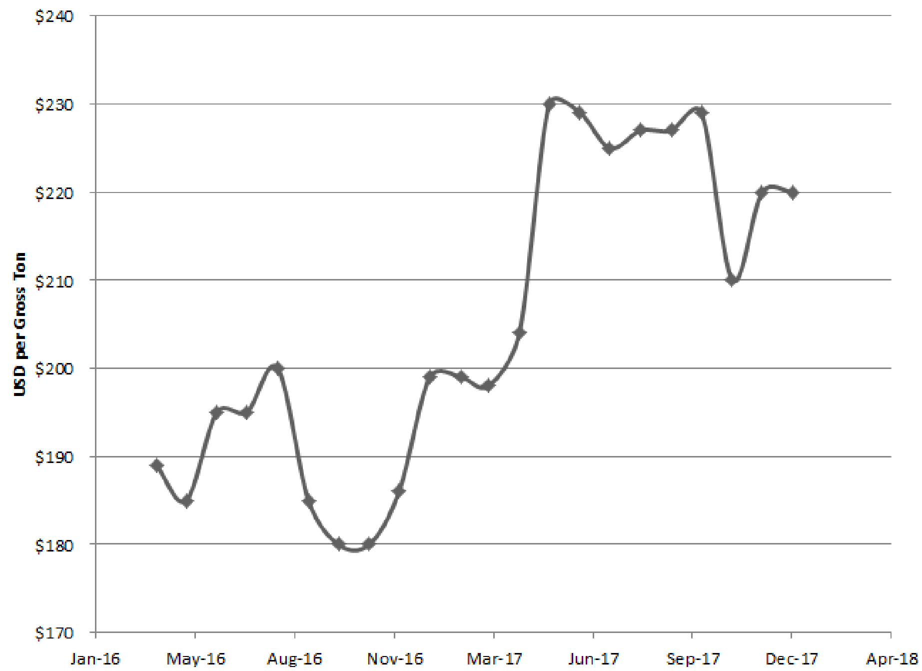

Figure 2-1
Historical Steel Scrap Value

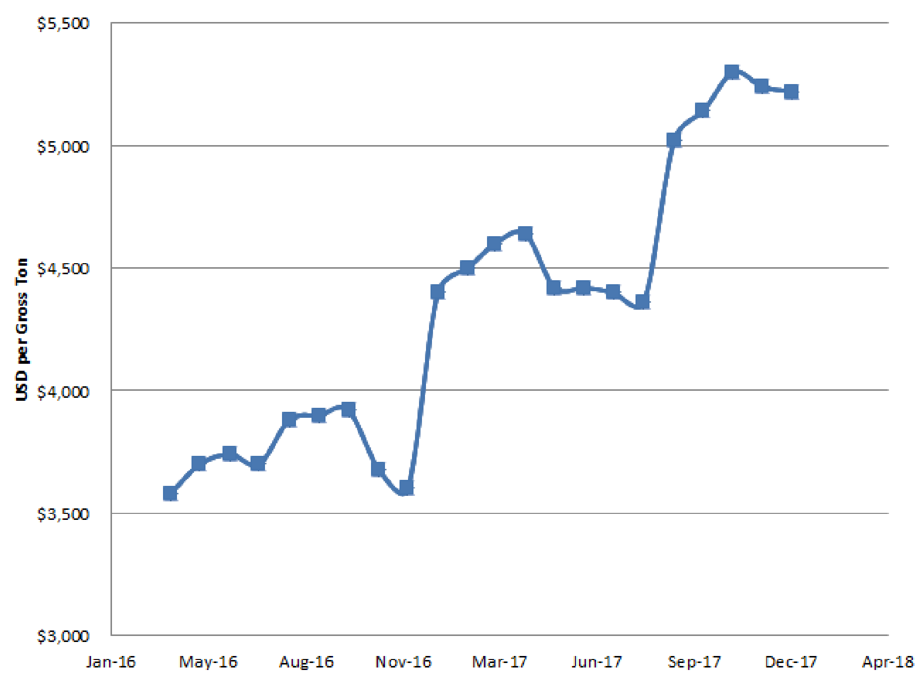

Figure 2-2
Historical Copper Scrap Value

Escalation

Escalation is not included.

Contingency

Based on the level of design effort, a 5.0% contingency is included in the estimate and applied to all cost categories.

Scrap value contingency is included as a 5.0% reduction in the salvage value, resulting in a total net reduction in the salvage value. The contingency assumes a potential drop in salvage value, thus increasing the project cost.

These rates relate to pricing and quantity variation in the specific scope estimated. The contingency does not cover new scope outside of what has been estimated, only the variation in the defined scope. These rates are composite and already take into account expected variations in actual costs. These rates do not represent the high range of all costs, nor is it expected that the project will experience all actual costs at the maximum value of their range of variation.

Excluded Items

All known scope of required physical facilities to encompass a complete project has been included in the estimate. Any known intentional omissions are documented in the assumptions and clarifications.

The cost estimate represents only the costs listed in the estimate. The estimate does not include allowances for any other costs not listed and incurred by the owner. Excluded costs are any that are not listed in the estimate.

Section 3: Cost Estimate

Methodology

The methodology used for developing the cost estimate includes a combination of stochastic and deterministic methods. Stochastic means that which may be statically analyzed but not precisely predicted. Deterministic methods were used based on the quantity and size of equipment (e.g., the number of foundations, linear feet of cable, equipment, and so forth). Stochastic methods were also used if quantity information (e.g., miscellaneous electrical equipment, etc.) was not available.

The cost estimate was developed based on example drawings, documents, and data available to Sargent & Lundy based on previous similar work. These drawings and documents were used to estimate foundation sizes, steel and copper quantities, cable quantities, and other equipment typical for a solar PV power plant.

Sargent & Lundy's methodology for developing the cost estimate consisted of three elements: 1) prior experience developing plant demolition costs and database of numerous other similar projects, 2) use of a unit cost factor methodology developed from labor and material cost information for specific tasks, and 3) quotes for similar activities for past projects.

Cost estimates were created using Sargent & Lundy's cost model and proprietary cost database. The estimates developed include both summaries and details for each type of work performed as well as indirect costs and contingencies. The cost estimate database report lists costs by material, activity, and several other categories.

This information was used with unit cost factors developed by Sargent & Lundy based on industry data and experience. Unit cost factors for concrete removal, steel removal, cutting costs, and other tasks were developed from labor and material cost information. Quantities of recoverable metals that could be sold for scrap were estimated. No salvage value was assumed for any equipment, only the scrap value of metal from equipment.

Cost Estimate Summary

The cost estimate summaries for decommissioning the balance of plant (BOP) of the conceptual ground-mounted, crystalline-silicon, fixed-tilt 11-MW_{AC} solar PV power plant are shown in Table 3-1. All costs are in December 2017 USD.

Table 3-1
Direct Costs Summary

Description	Amount
Demolition	$778,979
Scrap Value	-$371,341
Civil Work	$144,875
Total Direct Costs	$552,513

The demolition amount in the table above includes removal of fencing and the GSU transformer, demolition of the concrete foundations and the control building, and the disconnection and removal of the modules and supporting structures, inverters, wiring, grounding system, and electrical equipment from the control building. The scrap value amount includes credits for carbon steel and copper. The civil work amount includes stripping and stockpiling topsoil, hauling debris (i.e., control building, concrete foundations, crushed stone surfacing, and modules), debris disposal fee, and backfilling and landscaping (i.e., seeding and mulching).

The total of these direct costs summed in Table 3-2 (i.e., demolition, scrap value, and civil work) equates to approximately $50 per kilowatt-alternating-current (kW_{AC})

Table 3-2
Estimate Totals Summary

Description	Amount
Direct Costs	$552,513
General Conditions	$229,338
Project Indirect Costs	$55,668
Contingency	$75,295
Total	$912,814

The direct costs amount in the table above includes labor (16,758 manhours), subcontract cost, construction and process equipment, and scrap value (a credit of $371,341). The general conditions amount includes additional labor costs (i.e., labor supervision), site overheads (i.e., site safety program implementation and management, mobilization and demobilization, legal expenses/claims, and temporary facilities), and other construction indirect costs (i.e., small tools and consumables, general liability insurance, construction equipment mobilization and demobilization, freight on scrap, contractor's G&A costs, and contractor's profit). Project indirect costs include engineering services and owner's costs. Contingency includes costs for contingency on construction equipment, labor and supervision, subcontracts, scrap, and indirect costs.

The total of these costs summed in Table 3-2 (i.e., direct costs, general conditions, project indirect costs, and contingency) equates to approximately $83 per kW_{AC}. Assuming a total capital requirement of $1727 per kW_{AC} (based on EPRI 3002008627) and only the scrap value of the recoverable metals (steel and copper), the net negative salvage value is -4.8%. These results are summarized in Table 3-3. Inclusion of the salvage value of the solar equipment, such as inverters and modules, may change this estimate. It is possible that a material credit would be available for recycling or salvaging solar equipment, though in some cases plant owners are paying high premiums to recycle waste PV modules.[5]

Table 3-3
Summary of Results

Description	Amount
Total Decommissioning Cost	$912,814
Cost per kW_{AC}	$83
Total Capital Requirement	$18,997,000
Net Negative Salvage Value*	4.8%

* Excludes salvage value of solar equipment, such as inverters and modules

The detailed estimate is included in Appendix A. Sage Timberline Office-Estimating Edition 9.7 cost estimating software was used to compile the estimate.

Scaling Decommissioning Estimates

While the scope of this study was confined to estimating decommissioning costs for an 11 MW_{AC} plant, the estimate is scalable based on the MW capacity to be decommissioned. Nearly every line item in the estimate is based on the number of modules. However, there are some potential economies of scale. For example, the cost to mobilize and demobilize construction personnel and equipment, such as cranes, is significant. Spreading those one-time costs over a larger number of modules would make those costs less significant relative to labor and operation costs. Additionally, it is possible that the scrap metal credit could increase for a larger quantity of material, as scrap yards might benefit from economies in sorting, processing, and secondary market sales.

[5] Anecdotally, one utility reported paying the equivalent of $27-30 per module for recycling after a PV plant was damaged by a storm. Because the modules were tested and found to contain levels of hazardous material (lead), landfill disposal was not an option.

Section 4: References

1. Gordian. Labor Rates for the Construction Industry with RSMeans Data. Rockland, MA: Gordian (2017)

Appendix A: Cost Estimate

Estimate 34299A

EPRI 11-MW_{AC} Solar Power Plant Demolition Study

Conceptual Cost Estimate

EPRI
11 MW SOLAR FARM DEMOLITION STUDY
CONCEPTUAL COST ESTIMATE

Estimator	GA
Labor rate table	17OKOKL-B
Project No.	13169-014
Estimate Date	12/1/17
Reviewed By	BA
Approved By	BA
Estimate No.	34299A
Estimate Class	Conceptual
Cost index	OKOKL

EPRI
11 MW SOLAR FARM DEMOLITION STUDY
CONCEPTUAL COST ESTIMATE

Group	Description	Subcontract Cost	Process Equipment Cost	Material Cost	Man Hours	Labor Cost	Equip Amount	Total Cost
11.00.00	DEMOLITION	30,170			16,741	658,147	90,662	778,979
18.00.00	SCRAP VALUE		(371,341)					(371,341)
21.00.00	CIVIL WORK	142,636			17	706	1,534	144,875
	TOTAL DIRECT	172,806	(371,341)		16,758	658,853	92,195	552,514

Estimate Totals

Description	Amount	Totals	Hours
Direct Costs:			
Labor	658,853		16,758
Material			
Subcontract	172,806		
Construction Equipment	92,195		
Scrap Value	(371,341)		
	552,513	**552,513**	
General Conditions			
Additional Labor Costs:			
90-1 Labor Supervision	39,531		
90-2 Show-up Time			
90-3 Cost Due To OT 5-10's			
90-4 Cost Due To OT 6-10's			
90-5 Per Diem			
Site Overheads:			
91-1 Construction CM			
91-2 Field Office Expenses			
91-3 Pre-Operational Testing			
91-4 Site Services			
91-5 Safety	6,984		
91-6 Temporary Facilities	10,497		
91-7 Temporary Utilities			
91-8 Mobilization/Demob.	11,062		
91-9 Legal Expenses/Claims	1,634		
Other Construction Indirects:			
92-1 Small Tools & Consumables	6,984		
92-2 Scaffolding			
92-3 General Liability Insur.	6,984		
92-4 Constr. Equip. Mob/Demob.	922		
92-5 Freight on Material			
92-6 Freight on Scrap	37,134		
92-7 Sales Tax			
92-8 Contractors G&A	24,832		
92-9 Contractors Profit	82,774		
	229,338	**781,851**	
Project Indirect Costs:			
93-1 Engineering Services	23,456		
93-2 CM Support			
93-3 Start-Up/Comm. Support			
93-4 Start-Up/Spare Parts			
93-5 Excess Liability Insur.			
93-6 Sales Tax On Indirects			
93-7 Owner's Cost	32,212		
93-8 EPC Fee			
	55,668	**837,519**	
Contingency:			
94-1 Contingency on Constr. Eq	5,255		
94-2 Contingency on Material			
94-3 Contingency on Labor & SO	41,907		
94-4 Contingency on Subcontr.	8,640		
94-5 Contingency on Scrap	16,710		
94-6 Contingency on Indirects	2,783		
	75,295	**912,814**	
Escalation:			
96-1 Escalation on Constr. Eq.			
96-2 Escalation on Material			
96-3 Escalation on Labor & SO			
96-4 Escalation on Subcontract			
96-5 Escalation on Scrap			
96-6 Escalation on Indirects			
		912,814	
98 Interest During Constr			
		912,814	
Total		***912,814***	

Group	Phase	Description	Notes	Quantity	Subcontract Cost	Process Equipment Cost	Material Cost	Man Hours	Labor Cost	Equip Amount	Total Cost
11.00.00		**DEMOLITION**									
	11.21.00	**CIVIL WORK**									
		REMOVE FENCING		7,000.00 LF	30,170	-					30,170
		CIVIL WORK			**30,170**						**30,170**
	11.22.00	**CONCRETE**									
		CONCRETE FOUNDATION	CONTROL BUILDING, REMOVE ENTIRE FOUNDATION, 42FT X 32FT 2FT	100.00 CY	-	-		96	3,973	1,970	5,943
		CONCRETE FOUNDATION	INVERTER PAD 184FT X 14FT X 1FT	95.40 CY	-	-		91	3,790	1,880	5,670
		CONCRETE FOUNDATION	26FT x 19FT x 1FT GSU TRANSFORMER FOUNDATION	40.00 CY	-	-		38	1,589	788	2,377
		CONCRETE						**225**	**9,353**	**4,638**	**13,991**
	11.24.00	**ARCHITECTURAL**									
		CONTROL BUILDING, 40FT X 30FT X 12FT HIGH		14,400.00 CF		-		58	2,199	2,585	4,784
		ARCHITECTURAL						**58**	**2,199**	**2,585**	**4,784**
	11.41.00	**ELECTRICAL EQUIPMENT**									
		GSU TRANSFORMER		120.00 TN	-	-		240	9,139	5,124	14,263
		DISCONNECT WIRING AND COMPONENTS AT SERVICE RACK		1.00 EA	-	-		40	1,584	69	1,654
		DISCONNECT AND PULL WIRING AT INVERTER AND TRANSFORMER		5.00 EA	-	-		60	2,377	104	2,480
		REMOVE INVERTER		5.00 EA	-	-		240	9,139	5,124	14,263
		DISCONNECT WIRING AND REMOVE COMBINER BOX		38.00 EA	-	-		190	7,526	329	7,855
		PULL WIRE FROM COMBINERS TO INVERTER		38.00 EA	-	-		114	4,516	197	4,713
		DISCONNECT AND REMOVE WIRING AT MODULES		38,680.00 EA	-	-		1,934	76,606		76,606
		DISCONNECT AND REMOVE GROUNDING WIRING AT MODULES AND RACKS		38,680.00 EA	-	-		1,934	76,606		76,606
		REMOVE SOLAR MODULE AND PLACE IN DUMPSTER		38,680.00 EA	-	-		3,868	153,211		153,211
		REMOVE RACK, 20 SOLAR MODULES PER RACK		1,934.00 EA	-	-		4,835	191,514	8,365	199,879
		REMOVE RACK POSTS, W6 X 8.5 X 20FT LONG, 2 POSTS PER RACK	EXTRACT FROM GROUND	3,868.00 EA	-	-		2,901	110,470	61,936	172,406
		REMOVE GROUND RODS	EXTRACT FROM GROUND	13.00 EA	-	-		3	99	56	155
		REMOVE ELECTRICAL EQUIPMENT FROM CONTROL BUILDING		1.00 EA	-	-		100	3,808	2,135	5,943
		ELECTRICAL EQUIPMENT						**16,459**	**646,595**	**83,438**	**730,034**
		DEMOLITION			**30,170**			**16,741**	**658,147**	**90,662**	**778,979**
18.00.00		**SCRAP VALUE**									
	18.10.00	**MIXED STEEL**									
		STEEL	6FT HIGH FENCE	-17.10 TN	-	(2,839)	-				(2,839)
		STEEL	RECOVERED STEEL FROM BUILDING INCL ELECTRICAL	-8.00 TN	-	(1,328)	-				(1,328)
		STEEL	POSTS	-329.00 TN	-	(54,614)	-				(54,614)
		STEEL	RACKS	-580.00 TN	-	(96,280)	-				(96,280)
		STEEL	CONDUIT AND FITTINGS	-4.00 TN	-	(664)	-				(664)
		STEEL	INVERTER	-346.00 TN	-	(57,436)	-				(57,436)
		STEEL	GSU TRANSFORMER	-80.00 TN	-	(13,280)	-				(13,280)
		MIXED STEEL				**(226,441)**					**(226,441)**
	18.30.00	**COPPER**									
		COPPER	GSU TRANSFORMER	-40.00 TN	-	(128,800)	-				(128,800)
		COPPER	WIRE	-5.00 TN	-	(16,100)	-				(16,100)
		COPPER				**(144,900)**					**(144,900)**
		SCRAP VALUE				**(371,341)**					**(371,341)**
21.00.00		**CIVIL WORK**									
	21.14.00	**STRIP & STOCKPILE TOPSOIL**									
		STRIP 6" DEEP, 300 FT HAUL	REMOVE CRUSHED STONE SURFACING	741.00 CY	-	-		17	706	1,534	2,239
		STRIP & STOCKPILE TOPSOIL						**17**	**706**	**1,534**	**2,239**
	21.18.00	**HAULING**									
		40CY DUMPSTER INCLUDING HAULING	CONTROL BUILDING DEBRIS	42.00 CY	525	-					525
		40CY DUMPSTER INCLUDING HAULING	CONCRETE FOUNDATIONS	235.00 CY	2,938	-					2,938
		40CY DUMPSTER INCLUDING HAULING	REMOVE CRUSHED STONE SURFACING	741.00 CY	9,263	-					9,263

Group	Phase	Description	Notes	Quantity	Subcontract Cost	Process Equipment Cost	Material Cost	Man Hours	Labor Cost	Equip Amount	Total Cost
	21.18.00	**HAULING**									
		40CY DUMPSTER INCLUDING HAULING	QUANTITY OF SOLAR MODULE LOADS	104.00 EA	52,000	-					52,000
		HAULING			**64,725**						**64,725**
	21.19.00	**DISPOSAL**									
		DISPOSAL FEE	CONTROL BUILDING DEBRIS	40.00 CY	720	-					720
		DISPOSAL FEE	CONCRETE FOUNDATIONS	235.00 CY	4,230	-					4,230
		DISPOSAL FEE	REMOVE CRUSHED STONE SURFACING	741.00 CY	13,338	-					13,338
		DISPOSAL FEE	SOLAR MODULES	2,894.00 CY	52,092	-					52,092
		REMOVE AND DISPOSE TRANSFORMER OIL		1.00 EA	1,500	-					1,500
		DISPOSAL			**71,880**						**71,880**
	21.20.00	**BACKFILL**									
		FOUNDATION BACKFILL, IMPORTED MATERIAL FILL	BACKFILL FOUNDATIONS	132.00 CY	3,465	-				-	3,465
		BACKFILL			**3,465**						**3,465**
	21.47.00	**LANDSCAPING**									
		SEED AND MULCH	FOUNDATION AND SURFACED AREAS	4,935.00 SY	2,566	-					2,566
		LANDSCAPING			**2,566**						**2,566**
		CIVIL WORK			**142,636**			**17**	**706**	**1,534**	**144,875**

Program:

Renewable Generation

3002013116

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