



Renewable Asset Management Inc.

Solar Facility Reclamation Evaluation



BRIGHT MEADOWS SOLAR PROJECT

Edmonton, Alberta

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Canadian Renewable
Energy Association
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de l'énergie renouvelable
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1. EXECUTIVE SUMMARY

This report details the expected cost to reclaim the Bright Meadows Solar Project, 15.7MWac / 20.3MWdc facility south of Edmonton, Alberta. The expected cost to reclaim the site after decommissioning costs and recycling revenue is **\$350,786.00** based on a class 3 estimate (-20%/+30%). Below is a breakdown of the cost (red) and the associated recyclable value (green). The math proves this out to be \$17.28 /KWdc based on all factors described in this evaluation.

This cost estimate is before Provincial & Federal taxation and does not account for inflation which is estimated at 2% as per the Future Canada Inflation Calculator.

With variables of commodity pricing, and technological developments such as mobile onsite deconstruction units, hub facility infrastructure and the build out of additional downstream supply chains and revenue sources, the current breakdown is based on today's available prices, costs, and technologies. SUNSET recommends a Typical view while identifying any likely Conservative or Optimistic metrics.

For the purpose of providing bonding/surety to satisfy AUC Rule 007 towards the reclamation of the site, a Typical case model should be applied. By pro-actively conducting this reclamation evaluation, the asset developer has taken the first step towards the responsible and sustainable development of critical renewable energy infrastructure.

Breakdown of Typical Case by Costs and Revenue

Scope	Costs	Revenue	Net
Electrical Shut Down & Removal	\$137,830.00	-\$127,050.00	\$10,780.00
Hardware Removal	\$93,990.00	-\$1,689.00	\$92,301.00
Module Reuse	\$306,060.00	-\$245,720.00	\$60,340.00
Module Recycling	\$212,750.00	\$0	\$212,750.00
Racking Deconstruction	\$210,310.00	-\$295,642.00	-\$85,332.00
Fencing Removal	\$77,300.00	-\$61,913.00	\$15,387.00
Foundation Extraction	\$234,650.00	-\$504,350.00	-\$269,700.00
Gravel Removal	\$240,210.00	-\$182,700.00	\$57,510.00
Substation Removal	\$46,750.00	-\$110,000.00	-\$63,250.00
Logistics	\$320,000.00	\$0	\$320,000.00
Total	\$1,879,850.00	-\$1,529,064.00	\$350,786.00



2. INTRODUCTION

The rapid expansion of solar energy projects in Alberta has highlighted the need for effective reclamation strategies to restore land post-decommissioning. This report examines current best practices in solar reclamation and outlines the processes to be applied to the sustainable management of this specific and unique project; determines the calculated costs associated with the end-of-life or end-of-financed life reclamation; and provides recommendations for sustainable land management in Alberta's unique environmental context while providing an outlet for the recycling of otherwise waste materials in order to capture and reuse critical natural resources for a circular economy.

Alberta has seen significant growth in solar energy installations due to its favourable sunlight conditions, open electricity market, closure of high-carbon power generation facilities, and supportive government policies. As these projects mature, it becomes crucial to address their environmental impacts and ensure that lands used for renewable energy facilities can be reclaimed to their natural or economically productive states.

Objectives

- Provide a clear summary of the processes to be applied to sustainably manage any early-loss, end-of-life, and end-of-financed-life materials.
- Determine the calculated costs associated with the reclamation of the project and return the land to its original condition prior to development.
- Identify any risks associated with the proposed reclamation plan.
- Provide recommendations to improve the reclamation outcomes and ensure long-term land sustainability.

Effective reclamation is essential for minimizing the environmental footprint of renewable energy projects in Alberta. By adopting standardized practices, ensuring financial readiness, and engaging stakeholders, Alberta can lead the way in sustainable solar energy development while preserving its natural landscapes for future generations. By addressing the current challenges and leveraging opportunities for improvement, Alberta can enhance its solar reclamation outcomes, ensuring a responsible and balanced approach to energy development and environmental stewardship.

Recycling Summary¹

Item	Quantity	T CO ₂ e Saved Per	CO ₂ Reduction
Modules Reused	24,572	5	122,860
Modules Recycled	6,144	3	18,432
Metal recycled 50% Aluminum and Steel (T)	1,001	5	5,005
Total			146,297

¹ CO₂ reduction calculations performed by McMaster University



3. QUALIFICATIONS

SUNSET is a sustainability solutions company that focuses on implementing circular economy principles within the renewable energy sector. A federally registered company since 2020, SUNSET is headquartered in (WEST) Taber, Alberta, and (EAST) Hamilton, Ontario, and operates both domestically and internationally. We are developing Canada's first Renewable Energy Circular Centre in Brooks, Alberta.



SUNSET has developed and employed cutting-edge technologies and innovative processes to handle waste materials from renewable energy systems. This includes decommissioning, transporting, and recycling solar panels, wind turbine components, and industrial batteries. Our approach ensures landfill waste will be diverted and that materials will be repurposed in a way that contributes to the circular economy based on current technological capacity and supply chain demand.

SUNSET has established partnerships with prominent academic institutions and a diverse network of industry experts. These collaborations enable us to develop and commercialize the technologies and processes for effective waste management.



MISSION: To provide the renewable energy industry with advanced solutions to manage End-of-First-Life, Early Loss, and End-of-Life material back into a circular economy.



VISION: Facilitate a clean, healthy, and well protected environment supporting a sustainable society and resilient economy by mitigating the ecological footprint of renewable energy systems through environmental stewardship.



LEADERSHIP: A commitment to promote sustainable development goals wherever possible to educate, innovate, partner, and implement sustainable solutions specific to the renewable energy industry (Solar, Wind, Energy Storage).



STAKEHOLDERS: Asset Owners, Developers, Manufacturers, Operations and Maintenance Contractors, Engineering Procurement Contractors, Installers, Insurance, Academia, Government, and Industry Associations.



Dan Carrocci is the President of SUNSET Renewables and an industry sustainability leader with 15+ years of experience in the renewable energy industry. He has constructed projects in every province and territory in Canada as well as abroad. In addition to his experience, he has continued to develop his knowledge and skills through post-secondary institutions:

- Resources Drilling & Blasting Program and the Geological Technologist Program at Sir Sandford Fleming College (School of Environmental and Natural Resource Sciences)
- Total Quality Management and Six Sigma at the University of Waterloo
- Sustainability Leadership at the Rotman School of Management, University of Toronto
- Circular Economy, Carbon Mitigation, and Transitional Leadership at McMaster University
- Introduction to Climate Change and Sustainability at Mohawk College
- Indigenous Canada at the University of Alberta.
- 21st Century Energy Transition at University of Alberta
- Renewable Energy Essentials, Technologies, and Design at University of Alberta

The team at SUNSET are passionate about the benefits of renewable energy and understands that its long-term success is directly related to the effort and resources we apply to further circular economy principles through infrastructure, innovation, and determination.

Notable Sunset Team Members include:

- **Greg Zilberbrant** – P.Eng, PhD – Sustainability Officer
- **Jeff Dodgson** – P.Eng – Innovation Officer
- **David Bruce** – P.Eng, PhD – Intellectual Property Officer
- **Chris Davies** – CSC – Safety Officer
- **Shane Powell** – PMP – Projects Officer
- **Meaghan Niewland** – MCOM – Communication/Media



4. CONDITIONS

The intent of this evaluation report is to determine the processes and associated costs required to decommission and reclaim the proposed ground-mounted photovoltaic solar facility within the Province of Alberta, Canada.

Our objective is to apply sustainable solutions to recycle or repurpose all materials into a circular economy and divert waste from landfills. The cost values contained in this report are based on 2024 rates and may fluctuate with inflation and the market value of goods and services as the facility reaches early loss or end of life. The information in this report is to be used as a benchmark for indicative costing and methodology.

SUNSET recommends re-evaluating the processes and economics for this Project upon commissioning as well as throughout its lifespan at intervals of 5 years up to the 20th year and then every year thereafter, leading into decommissioning & reclamation to ensure decommissioning funding is in alignment with current industry costs and processes are in alignment with current industry standards.

SUNSET does not assume liability for omissions, misinterpretations, monetary costs, or deficiencies that may occur as a result of the information contained in this reclamation evaluation. This report is intended for speculative informational purposes only based on existing technologies and infrastructure and is not to be distributed to anyone other than the client and the authority requesting this information (Alberta Utilities Commission).

It is not to be redistributed or revised unless expressly agreed in writing by an authorized signatory of the company.

The information contained in this report is prepared to the best of our knowledge and expertise and determined with the singular intention of providing available data to assist in protecting the environment through foresight and preparation using current best practices in renewable energy reclamation.



5. PROJECT

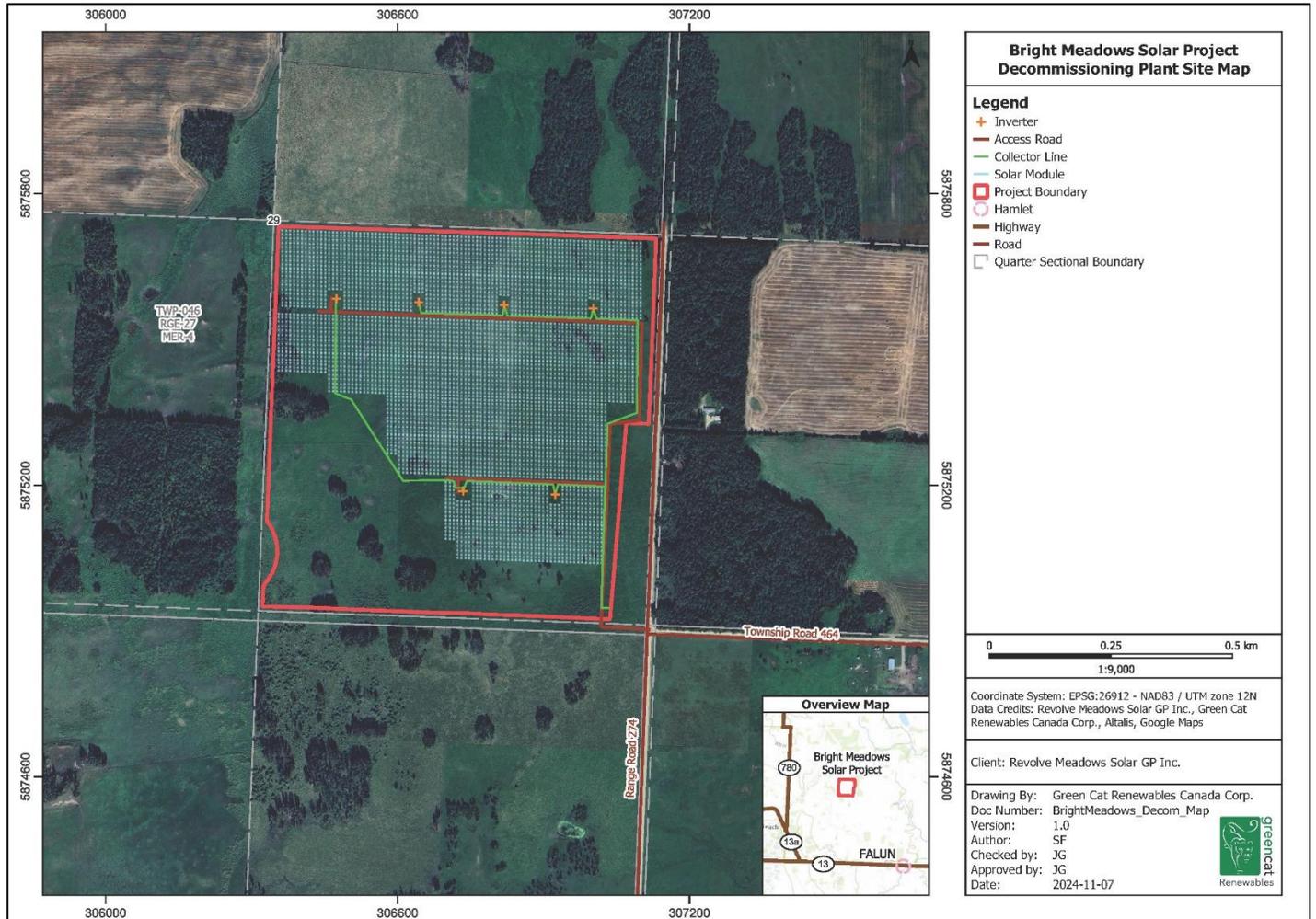
5.1. PROJECT DETAILS²

Client Name	Revolve Meadows Solar GP Inc.
Client Address	2200-700 W. Georgia Street Vancouver, BC, V7Y 1K8
Client Representative Name	Tania Ontiveros
Client Representative Position	Chief Financial Officer
Client Representative Email	Tania@revolve-renewablepower.com
Client Representative Phone Number	778-840-9156
Project Name	Bright Meadows Solar
(Google Maps Pin Location)	https://maps.app.goo.gl/b8XnSwDFBxMoiUYi9
Size AC (kW)	15,700.0
Size DC (kW)	20,300.0
Racking Type	Single Axis Tracker
Module Make	TRINA
Module Model	TSM--DEG21C.20
Module Size (Wp)	660
Module Quantity	30,716
Foundation Type	Ibeam
Foundation Quantity	5,240
Inverter Type	SUNGROW SG3150UD-MV
Inverter Size (kVA)	3,150
Inverter Quantity	6
Fencing Distance (M)	2,860
Internal Road Type	gravel, 4.5m wide
Internal Road Area (Square Meters)	9135
Site Commissioning Date	12-31-2026
Site Decommissioning Date	12-31-2056
TRANSFORMER	3150KVA, 0.6/25kV, 3-Phase Oil-immersed, KNAN,
CIRCUIT BREAKER	600A, 25kV, 125kV BIL
SWITCHGEAR	25kV outdoor padmounted switchgear, 600A BUS, 12.5KAIC, 125kV BIL
BUSBARS	600A, 25kV, 125kV BIL
DISCONNECTORS (ISOLATORS)	600A, 25 kV, 150kV BIL, 12.5KAIC, Pole Mounted Load Break Switch
SURGE ARRESTORS	25kV Nominal, 15.3kV MCOV
RELAYS	SEL-751, SEL-3555,
GROUNDING SYSTEM	1000 KVA, 24.9/14.4 kV, ONAN
COMMUNICATIONS TOWER	TBD; typical communication tower; assume 30m

² Details provided are based on the preliminary layout for permitting and standard assumptions. Details may change based on the results of geotechnical surveys and detailed design.



5.2. PROJECT LAYOUT





6. METHODOLOGY & ASSUMPTIONS

The following is a summary of the methodology used to break down a site into its base components for the secondary market, recycling, and landfill. The objective is to divert as much material as possible away from landfills through reuse and recycling and the development of downstream revenues generated from base components. The costs estimated in this evaluation are based on a project's size in peak kilowatts (kWp). SUNSET applies a realistic estimate of labour, food and lodging, vehicle rentals, and transportation to provide inclusive costs based on experience and current technologies. The cost values do not account for inflation and are based on 2024 rates.

6.1.1. ELECTRICAL SHUT DOWN & REMOVAL

Much of the balance of plant equipment such as inverters, switchgear, substation, and communications tower reclamation pricing is located within this item.

6.1.2. HARDWARE REMOVAL

The hardware (fasteners, clamps, connectors) to attach modules to racking are similar across vendors and therefore SUNSET expects little variance across suppliers.

6.1.3. MODULE REUSE

Modules have been shown to achieve over 85% of their performance by the 30-year point. SUNSET expects 80% of modules to be fit for reuse in the secondary market as Grade B modules. Grade B modules are to be tested, re-certified, and used for low risk applications such as agriculture, recreational, remote telemetry, etc.

6.1.4. MODULE RECYCLING

SUNSET expects 20% of modules to require full recycling. We have developed the technology to break down the solar modules into their base components with the constituent parts to be repurposed or recycled.

6.1.5. RACKING DECONSTRUCTION

Racking designs vary significantly across manufacturers and will result in the largest variance of cost. Based on the quantity of metal being recycled it is currently shown a revenue source to offset costs of reclamation. This Project has a single-axis tracking design.

6.1.6. FENCING REMOVAL

Fencing for high-voltage solar facilities - anything greater than 750 volts - requires a typical 6-foot tall chain-link fence with potential barbed wire. Depending on the terrain, it is expected each post is driven into the ground as per standard installation methods, and there are minimal footings for the facility except in key locations such as gates and entryways.

6.1.7. FOUNDATION EXTRACTION

Foundations costs focus mostly on steel piles given the large quantity expected in any large solar facility. Other foundations have been considered including concrete pads for transformers, switchgear, e-house, and other balance of plant. It is assumed that the pads do not go further than 4 feet below grade and can be broken up and hauled away. The estimated weights of foundations are based on standard helical pile



foundations required to support a structure of this nature and may change after geotechnical investigations and foundation load testing programs confirm that the design is conducive to the geology.

6.1.8.GRAVEL REMOVAL

This includes the stripping of gravel using a dozer, loading it into a screening plant using a loader, and then loading it into trucks to be removed off of the site. The area will be covered with topsoil and seeded as per the line item in the logistics table.

6.1.9.SUBSTATION REMOVAL

The substation equipment is to be removed in its entirety. Foundations, fencing and gravel removal calculations are accounted for and incorporated into their respective tables.

Assumptions Table^{3,4}

Category	Quantity	Unit
All	10	Hours/Shift
All	9	Crew Size excluding Foreman
Electrical Shut Down & Removal	17500	kg/Inverter
Electrical Shut Down & Removal	2	min/module
Hardware Removal	0.1	lbs/module
Hardware Removal	2	min/module
Module Reuse	25	Modules per pallet
Module Reuse	80%	Module to Reuse
Module Reuse	5	Minutes/Module
Module Reuse	100	km from site to metal recycler
Module Reuse	100	km/h
Module Recycling	25	Modules per pallet
Module Recycling	20%	Modules to Recycle
Module Recycling	5	Minutes/Module
Racking Deconstruction	17.5	lbs/module
Racking Deconstruction	1	Minutes/Modules
Racking Deconstruction	100	km to local metal recycler
Fencing Removal	1.25	Minutes/linear foot
Foundation Extraction	175	lbs/pile
Foundation Extraction	5	Min/Pile
Foundation Extraction	50	km distance to landfill
Fencing Removal	10%	Hours required for skid steer

³ Assumptions are based on references and appendices provided as well as the industry field experience of the SUNSET team as outlined in the qualifications section of this report.

⁴ Scrap values are estimated based on local metal recycling facilities.



6.1. OFF-SITE RECYCLING

Materials requiring offsite recycling or further processing will be transported to our 380-acre hub facility in Brooks, AB. This includes black mass (silicon, EVA sheeting, busbars), glass, motors, inverters, junction boxes, as well as any solar modules that are physically damaged, deformed, or deteriorated.

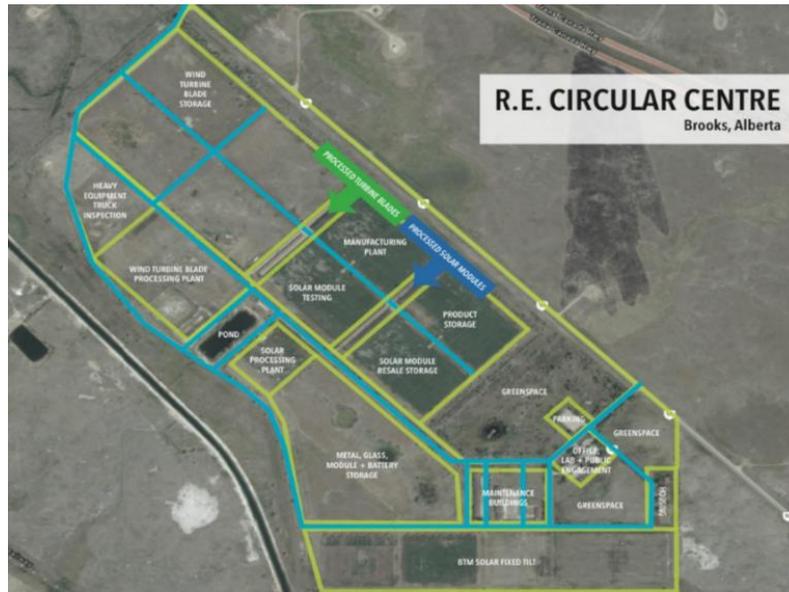


Fig 1 : SUNSET HUB

Brooks, Alberta

6.2. LOCAL METAL RECYCLERS

All metal parts which do not require further deconstructing or processing including fasteners and related hardware, racking and piles will be brought to facilities equipped for metal recycling.

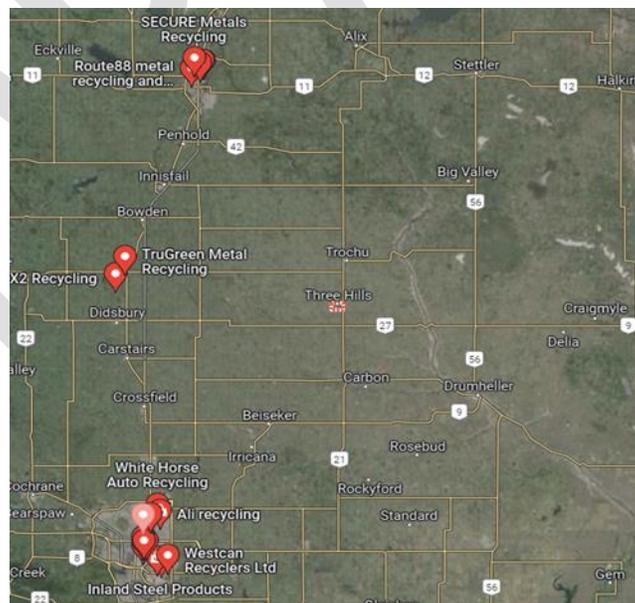


Fig 2: Map of Metal Recyclers

Local to Project



7. DECONSTRUCTION PROCESS

7.1.1. Overall Assumptions

- The site is free and with clear access to the project area.
- Does not include any substations, transmission lines, or communications towers.

7.1.2. Overall Risks

- Inclement weather.

7.2. ELECTRICAL DISASSEMBLY

7.2.1. Scope

- De-energize and isolate full system.
- Unplug each module, wrap in a knot, and secure to backing sheet with tape.
- Cut Inverter Cables.

Electrical Shut Down & Removal

Item	Rates	Unit	Quantity	Total
Food & Lodging	\$250.00	Night	135	\$33,750.00
Resale: Inverters	-\$0.55	unit	231,000	-\$127,050.00
Crane	\$5,000.00	Crane per day	2	\$10,000.00
Role: Technician Apprentice	\$70.00	Hour	1,344	\$94,080.00
Total				\$10,780.00

7.2.2. Assumptions

- Concrete pads to be broken using rock hammer attachment, loaded into dump truck and sent to landfill.
- Underground cable removal is not factored into this report as design is preliminary, however based on the cost to remove vs. recyclable value of material this will not have a material effect on the overall project price. Typical lease agreement is to remove anything 1m below ground surface with the majority of cabling being below this depth.

7.2.3. Risks

- Hardware could be corroded or stripped beyond expectations and requires cutting which will result in additional labour.
- DC strings continue to be energized.



7.3. HARDWARE REMOVAL

7.3.1.Scope

- Undo fasteners holding modules to the purlins,
- Put hardware into storage containers to be reused or recycled.

Hardware Removal

Item	Rates	Unit	Quantity	Total
Food & Lodging	\$250.00	Night	111	\$27,750.00
Resale: Metal	-\$0.55	lb	3,071	-\$1,689.00
Role: Labourer	\$60.00	Hour	1,104	\$66,240.00
Total				\$92,301.00

7.3.2.Assumptions

- Four (4) Bolts and nuts per module.

7.3.3.Risks

- Hardware corroded, rustiest, or stripped beyond expectations,
- Weather could limit tasks and speeds of tasks.



7.4. MODULE REUSE

7.4.1.Scope

- Record module specifications or serial numbers off of the backside label.
- Remove modules and stack them on wooden pallets.
- Wrap with shrink wrap to secure the bundle.
- Wrap the serial number identification sheet into the last wrap so it's visible.

Module Reuse

Item	Rates	Unit	Quantity	Total
Food & Lodging	\$250.00	Night	205	\$51,250.00
Material: Custom Vertical Pallet	\$20.00	Pallet	983	\$19,660.00
Material: Shrink Wrap	\$20.00	Pallet	492	\$9,840.00
Resale: Modules Used	-\$10.00	Module	24,572	-\$245,720.00
Role: Technician Apprentice	\$70.00	Hour	1,366	\$95,620.00
Role: Equipment Operator	\$70.00	Hour	683	\$47,810.00
Vehicle: Skid Steer	\$250.00	Day	69	\$17,250.00
Vehicle: Truck 53 foot flatbed	\$230.00	Hour	281	\$64,630.00
Total				\$60,340.00

7.4.2.Assumptions

- Modules have been checked regularly over the life of project therefore reducing the likelihood of non-reusable modules,
- Assuming 80% of modules will be in safe and useful working conditions to be reused for other applications,
- Resale value estimated at \$0.02/watt at full 25 year end of life

7.4.3.Risks

- Microfractures may not become visible until transported back to SUNSET facilities,
- Technology advancement renders panels obsolete,
- Project experiences early loss due to catastrophic weather event.



7.5. MODULE RECYCLING

7.5.1.Scope

- Record the module serial number on the backside label.
- Remove modules and place them into the transport bins.

Module Recycling

Item	Rates	Unit	Quantity	Total
Food & Lodging	\$250.00	Night	52	\$13,000.00
Material: Custom Vertical Pallet	\$20.00	Pallet	246	\$4,920.00
Material: Shrink Wrap	\$20.00	Pallet	123	\$2,460.00
Module Processing	\$20.00	Module	6,144	\$122,880.00
Role: Technician Apprentice	\$70.00	Hour	342	\$23,940.00
Role: Equipment Operator	\$70.00	Hour	171	\$11,970.00
Vehicle: Skid Steer	\$250.00	Day	69	\$17,250.00
Vehicle: Truck 53 foot flatbed	\$230.00	Hour	71	\$16,330.00
Total				\$212,750.00

7.5.2.Assumptions

- Handling and care with the same attention to detail as reuse modules,
- Assuming 20% of panels will experience early loss or become damaged in the deconstruction/transportation process,
- Module processing cost estimated based on current technologies & economics of SUNSET processes

7.5.3.Risks

- Any panels significantly damaged will be difficult to place into bins.



7.6. RACKING DECONSTRUCTION

7.6.1.Scope

- Secure table with excavator's thumb,
- Using cutting torches or cut saw, slice top brackets/lower brackets,
- Cut to length for bins,
- Put racking into transport bins for recycling.

Racking Deconstruction

Item	Rates	Unit	Quantity	Total
Food & Lodging	\$250.00	Night	103	\$25,750.00
Resale: Metal	-\$0.55	lb	537,530	-\$295,642.00
Role: Labourer	\$60.00	Hour	512	\$30,720.00
Role: Equipment Operator	\$70.00	Hour	512	\$35,840.00
Vehicle: Truck Bin Rolloff 40 cubic foot	\$250.00	Hour	160	\$40,000.00
Vehicle: Excavator with Thumb	\$1,500.00	Day	52	\$78,000.00
Total				-\$85,332.00

7.6.2.Assumptions

- The racking is not damaged and is in its original installation form,
- This is a fixed tilt racking design,

7.6.3.Risks

- Racking is under compression before final connections are released resulting in additional care required.



7.7. FENCING REMOVAL

7.7.1.Scope

- Remove the barbed wire,
- Remove the chain link fence,
- Remove the wooden foundations.

Fencing Removal

Item	Rates	Unit	Quantity	Total
Food & Lodging	\$250.00	Night	64	\$16,000.00
Resale: Fence @12lbs/linear ft	-\$6.60	linear ft	9,381	-\$61,913.00
Role: Equipment Operator	\$70.00	Hour	640	\$44,800.00
Vehicle: Truck Bin Rolloff 40 cubic foot	\$250.00	Hour	17	\$4,250.00
Vehicle: Skid Steer	\$250.00	Day	7	\$1,750.00
Vehicle: Excavator with Thumb	\$1,500.00	Day	7	\$10,500.00
Total				\$15,387.00

7.7.2.Assumptions

- All materials are made of metal (no wooden posts),
- Includes interior fencing around substation,
- The majority of footings are not concreted in place,

7.7.3.Risks

- Site security is compromised once fencing is removed.



7.8. FOUNDATION EXTRACTION

7.8.1.Scope

- Using an excavator secure connection adaptor on top of the pile.
- Apply upward pressure to raise pile out of the ground.
- Lay the pile onto the ground.
- Remove the connector pins and uncouple the adaptor.
- Load piles into bins for removal to be recycled into raw material.
- Includes foundations for substation & communications tower.
- If piles do not pull then dig beside to expose pile and reduce friction

Foundation Extraction

Item	Rates	Unit	Quantity	Total
Food & Lodging	\$250.00	Night	132	\$33,000.00
Resale: Piles @ 175lbs/pile	-\$96.25	pile	5,240	-\$504,350.00
Role: Equipment Operator	\$70.00	Hour	874	\$61,180.00
Role: Labourer	\$60.00	Hour	437	\$26,220.00
Vehicle: Truck Bin Rolloff 40 cubic foot	\$250.00	Hour	105	\$26,250.00
Vehicle: Excavator with Rotary Head	\$1,750.00	Day	44	\$77,000.00
Vehicle: Skid Steer	\$250.00	Day	44	\$11,000.00
Total				-\$269,700.00

7.8.2.Assumptions

- Piling design parameters including length, pipe diameter, metal gauge, estimated to be 175lbs/pile. This value may vary with geotechnical considerations,
- Foundation design is conducive to the geology through data collected throughout geotechnical investigations, foundation load testing programs, and pile quality control data recorded for each foundation installed,

7.8.3.Risks

- Design may change due to geological data collected throughout a geotechnical investigations and foundation load testing program.



7.9. GRAVEL REMOVAL (ROADS & PADS)

7.9.1.Scope

- Using heavy equipment (dozer, loader, excavator & skid steer),
- Scrape granular material off of soil, and load into trucks for offsite removal and resale.

Gravel Removal

Item	Rates	Unit	Quantity	Total
Food & Lodging	\$250.00	Night	45	\$11,250.00
Resale: Gravel	-\$20.00	Cubic Meter	9135	-\$182,700.00
Role: Equipment Operator	\$70.00	Hour	290	\$20,300.00
Role: Labourer	\$60.00	Hour	156	\$9,360.00
Vehicle: Dozer	\$1,500.00	Day	10	\$15,000.00
Vehicle: Excavator with Bucket	\$1,500.00	Day	10	\$15,000.00
Vehicle: Loader with Bucket	\$1,500.00	Day	10	\$15,000.00
Vehicle: Skid Steer with Bucket	\$250.00	Day	10	\$2,500.00
Vehicle: Screening Plant	\$3,000.00	Day	3	\$9,000.00
Vehicle: Truck Bin Rolloff 10 cubic meter	\$150.00	Hour	952	\$142,800.00
Total				\$57,510.00

7.9.2.Assumptions

- Granular Material is being shipped to a resale location within 1 hour of site location,
- Topsoil and seeding costs are included in Line Item 5 of Logistics,

7.9.3.Risks

- Soil Contamination into gravel material.



7.10. SUBSTATION REMOVAL

7.10.1. Scope

- Remove all substation components using Excavator, Crane, & Skid Steer.

Fencing Removal

Item	Rates	Unit	Quantity	Total
Food & Lodging	\$250.00	Night	25	\$6,250.00
Resale: Substation Metal Components	-\$0.55	Lb	200,000	-\$110,000.00
Role: Operator	\$70.00	Hour	100	\$7,000.00
Role: Technician Apprentice	\$60.00	Hour	150	\$9,000.00
Vehicle: 53ft Flatbed Truck	\$250.00	Hour	15	\$3,750.00
Vehicle: Truck Bin Rolloff 40 cubic foot	\$250.00	Hour	8	\$2,000.00
Vehicle: Crane	\$5,000.00	Day	2	\$10,000.00
Vehicle: Skid Steer	\$250.00	Day	5	\$1,250.00
Vehicle: Excavator with Thumb	\$1,500.00	Day	5	\$7,500.00
Total				-\$63,250.00

7.10.2. Assumptions

- Foundations, fencing, and gravel pads are accounted for in respective tables,

7.10.3. Risks

- Site security is compromised once fencing is removed.
- Inclement weather



7.11. LOGISTICS

7.11.1. Scope

- Organization of hiring, safety, and daily work,
- Coordination of recycling, transportation and equipment rentals/purchases.

Logistics

Item	Rates	Unit	Quantity	Total
Role: Journeyman Foreman	\$100.00	Hour	1,000	\$100,000.00
Mobilization/Demobilization	\$10,000.00	project	2	\$20,000.00
Logistics	\$75,000.00	Project	1	\$75,000.00
Facilities	\$1,000.00	Per Crew Person	50	\$50,000.00
Soil Testing, Seeding, Topsoil & Minor Grading	\$25,000.00	Over 3 years	3	\$75,000.00
Total				\$320,000.00

7.11.2. Assumptions

- One (1) foreman for a nine (9) person crew.
- One mobilization and demobilization.
- Project total length with simultaneous operations is 4-6 months.

7.11.3. Risks

- Inclement weather leads to extended loss of productivity resulting in additional costs such as facilities not being used.



8. TOTAL DECOMMISSIONING COSTS

The costs of decommissioning this solar facility are significantly impacted by the ability to offset those costs through recycling metals and the reuse of models. This is a class 3 AACE estimate with a range of -20% to +30%.

Cost Summary

Scope	Cost	\$/kWp
Electrical Shut Down & Removal	\$10,780.00	\$0.53
Hardware Removal	\$92,301.00	\$4.55
Module Reuse	\$60,340.00	\$2.97
Module Recycling	\$212,750.00	\$10.48
Racking Deconstruction	-\$85,332.00	-\$4.20
Fencing Removal	\$15,387.00	\$0.76
Foundation Extraction	-\$269,700.00	-\$13.29
Gravel Removal	\$57,510.00	\$2.83
Substation Removal	-\$63,250.00	-\$3.12
Logistics	\$320,000.00	\$15.76
Total	\$350,786.00	\$17.28

9. IMPACT SUMMARY

The overall reduction in CO₂ emissions is estimated below:

Recycling Summary⁵

Item	Quantity	T CO ₂ e Saved Per	CO ₂ Reduction
Modules Reused	24,572	5	122,860
Modules Recycled	6,144	3	18,432
Metal recycled 50% Aluminum and Steel (T)	1,001	5	5,005
Total			146,297

⁵ CO₂ reduction calculation performed by McMaster University



10. CASE COMPARISON

A comparison to a Conservative and Optimistic case was completed and includes the higher costs for operational costs, consumable costs, and capital costs. The Conservative and Optimistic cases represent the +30% and -20% cost estimates, respectively.

The Conservative case accounts for the higher costs for items such as labour, equipment, fuel, and transportation as well as lower reimbursement for recycled materials and module reuse.

In the Optimistic case, there are many opportunities to save costs, such as reducing overhead by increasing crew size among shared facilities, hiring locally to reduce logistical costs, and developing downstream markets, which is currently underway by SUNSET and to be considered upon the next scheduled reclamation review. Commodity prices are also considered which fluctuate daily.

For approval of surety requirements to satisfy the Alberta Utilities Commission Rule 007, the Typical value calculation should be applied as it represents a fair evaluation of costs vs. recyclable value of materials. Factors influencing Conservative and Optimistic values will be evaluated at each scheduled review period throughout the project life.

Case Comparison

Scope	Conservative (+30%)	Typical	Optimistic (-20%)
Electrical Shut Down & Removal	\$14,014.00	\$10,780.00	\$8,624.00
Hardware Removal	\$119,991.30	\$92,301.00	\$73,840.80
Module Reuse	\$78,442.00	\$60,340.00	\$48,272.00
Module Recycling	\$276,575.00	\$212,750.00	\$170,200.00
Racking Deconstruction	-\$59,732.40	-\$85,332.00	-\$102,398.40
Fencing Removal	\$20,003.10	\$15,387.00	\$12,309.60
Foundation Extraction	-\$188,790.00	-\$269,700.00	-\$323,640.00
Gravel Removal	\$74,763.00	\$57,510.00	\$46,008.00
Substation Removal	-\$44,275.00	-\$63,250.00	-\$75,900.00
Logistics	\$416,000.00	\$320,000.00	\$256,000.00
Total	\$706,991.00	\$350,786.00	\$113,316.00
\$/kWp	\$34.83	\$17.28	\$5.58



SUNSET Renewable Asset Management Inc.

2493 Hendershot Road, Hamilton, Ontario L0R 1C0

6002 58 Street, Taber, Alberta T1G 2B8

info@sunsetrenewables.com

sunsetrenewables.com

11. APPENDIX A – SINGLE AXIS TRACKER

OVER 3.2 GW SOLD

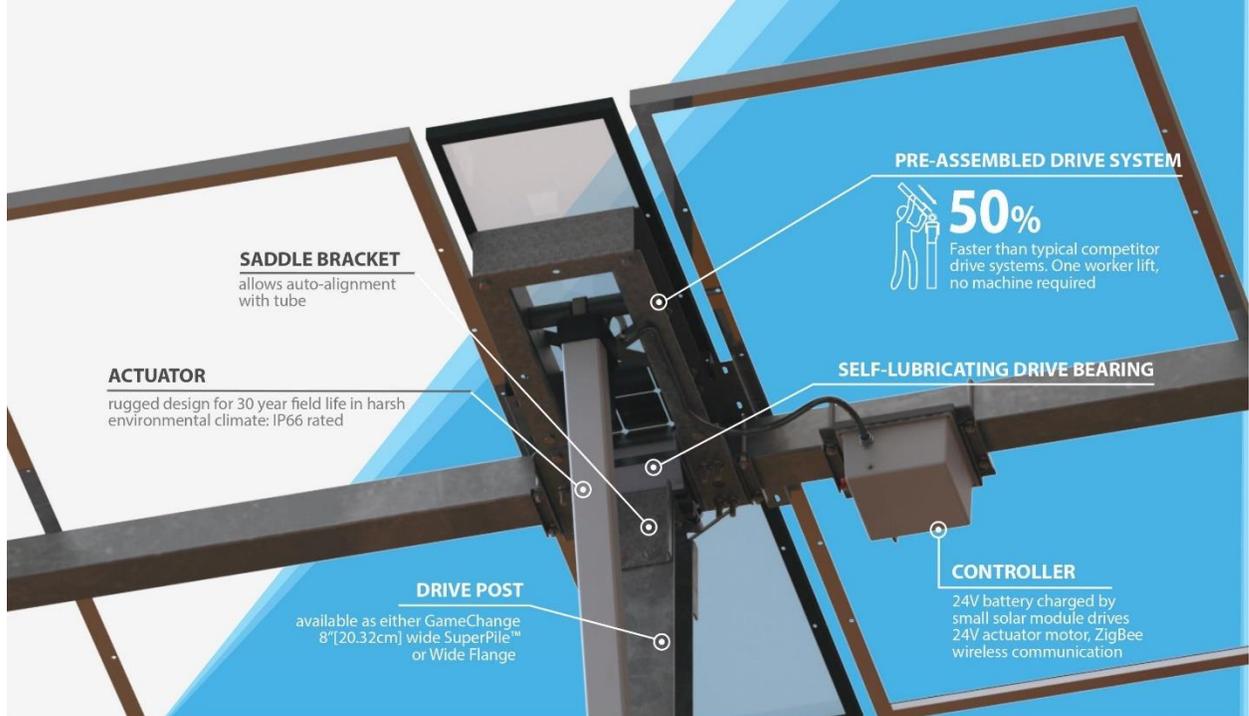
Every System For Your Every Need



GENIUS TRACKER™

WORLD'S HIGHEST POWER PRODUCING AND FASTEST INSTALLING SOLAR TRACKER

TECHNICAL DATASHEET



SADDLE BRACKET

allows auto-alignment with tube

ACTUATOR

rugged design for 30 year field life in harsh environmental climate: IP66 rated

DRIVE POST

available as either GameChange 8" [20.32cm] wide SuperPile™ or Wide Flange

PRE-ASSEMBLED DRIVE SYSTEM



50%

Faster than typical competitor drive systems. One worker lift, no machine required

SELF-LUBRICATING DRIVE BEARING

CONTROLLER

24V battery charged by small solar module drives 24V actuator motor, ZigBee wireless communication

OWNERS BENEFITS

UP TO

6.75% MORE POWER PRODUCTION

RESULTS IN HIGHER KWH OUTPUT & UP TO 40% HIGHER ROE

Varies based on project specifics

INSTALLERS BENEFITS

FASTEST INSTALLING SYSTEM

ADVANCED DESIGN INNOVATIONS AND PRE-ASSEMBLED COMPONENTS

SpeedClamp™



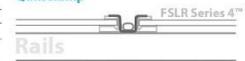
Row Tube

No Mounting Hardware

Speeds Module Installation Up To:

40%

QuikClamp™



Rails

FSLR Series 4 Module

Installation Speeds Up To:

30%



OVER 3.2 GW SOLD

Every System For Your Every Need



GENIUS TRACKER™

OWNERS BENEFITS

UP TO 40% HIGHER ROE

Combine to increase owner cash flow of sample project to \$17MM cash flow vs \$13MM & \$15MM for competitors

Higher Module Density - increased row spacing means more time facing the sun and less time running from the shade, adds up to 5% more power production than competitors

WeatherSmart™ - AI technology optimizes tilt angle based on weather data to maximize power production, adds up to 1.25% additional power production

PowerBoost™ - Smart optimization allows table rows to respond individually based on topography to prevent shading, adds up to 0.5% additional power production. Available in Q4 2018

LOWEST O & M COST

Lowest grass cutting & module washing cost

Zero maintenance drive system

INSTALLERS BENEFITS

FASTEST INSTALLING SYSTEM

Advanced design innovations & pre-assembled components

Pre-assembled Drive Arm - can be lifted by one worker, no machine required. 50% faster than typical competitors

SpeedClamp™ - Mounts modules with no mounting hardware, speeds module installation up to 40%

QuikClamp™ - Speeds install for FSLR Series 4 modules up to 30%

GameChange Solar

152 W 57 Street 17FL

New York, NY 10019

Phone: 212-388-5160

Fax: 646-607-2223

Email: info@gamechangesolar.com

***Disclaimer:** GameChange Solar provides this documentation without warranty in any form either expressed or implied. GameChange Solar may revise this document at any time without notice.

Modules	Supporting Type	Most commercially available, including frameless crystalline and thin film		
Civil	Slope Tolerance (H-S)	7% standard, can go to 15% special order		
	Slope Tolerance (E-W)	15%	Tracker follows slope (V/N) Yes	
Structural	Drive Type	Robust linear actuator stainless steel & aluminum		
	Piles per MW	450/MW typical		
	Operating Wind Load	105mph(Std) / 130mph(Premium 1) / 150mph(Premium 2) / 175mph(Premium 3)		
	Snow Load	5psf(Std) / 20psf(Premium 1) / 40psf(Premium 2) / 60 psf(Premium 3)		
	Tracking Range (Std)	45° - 52°	Tracking Range (Premium)	60°
	Pile Sections	G235 galvanized steel (or HDG option) roll formed standard posts, HDG wide flange option also available		
	Pile Size (Interior) & (Exterior)	6" X 6" roll form shape or W6x7 or W6x9 or W6x15 wide flange		
	Motor Foundation	6.5" x 8" roll form hat or W6x15 or larger wide flange		
	Standard Embedment	5 - 7 ft	Flood Plain Allowance	Up to 6 feet
	Design	Module Configuration	1 up in portrait for crystalline, FSLR Series 6, 2 up landscape for Bifacial, 3 to 4 up landscape FSLR Series 4	
Modules per Table		Up to 340 ft. (for example 102.72 cell crystalline)		
Module Attachment		SpeedClamp™ or Bolts available for bottom mount frame modules or clamps for glass on glass modules		
Ground Coverage Ratio		0.25 to 0.65		
Rows per Drive		1 drive per tracker(table), distributed drive system		
Powering System		Onboard solar module with battery or wireline power		
Compliance		UL 2703 / 3703		
Ground Clearance To Module		2 ft		
Min / Max Ground to Top of Pier		51" typical / ground clearance + 51" + 9" adjustment range		
Backtracking		Yes, although can be turned off as requested (i.e. for FSLR modules)		
Temperature Range		-20° C + 48° C		
FCC 3rd party design verified		Compliant with FCC guidelines		
Self Perform		Specialty Tools Required	No	
	Mechanical Installation	Available		
	Max offload for deliveries	As per customer requirement		
Electrical	Tracking Method	Time and location based algorithm		
	String Design	Compatible with any string size		
	Cable Supports	Free hole punching as per customer requirement		
	Linear Actuator Motor	24 volt DC		
	Controller Box	Zigbee® wireless communications, 24v solar panel and battery or wireline power		
	Control System	Master to Node: Zigbee® wireless communications Master to SCADA/DAS: MODBUS communications		
	# of Motors	28 to 52 / MW depending on panel wattage and loading conditions (35 for typical conditions)		
	1000V System or 1500V System	Both		
	Grounding Method	Tracker structure is part of grounding path per UL 2703		
	UL Listed Assembly	UL 2703 / UL3703		
	NEMA Ratings	IP66 stroke tube end /67 waterproof motor end (NEMA 3x/4 equivalent)		
	# Weather Station	1 per 6 MW typical		
	Monitoring System	Web portal interface available Compatible with all standard third party monitoring vendors		
Snow & Flood Sensors	Move panels to optimum location for weather events			
Backup Power	Solar module and battery providing integrated backup - 3 days			
O & M	Warranty	5 year drive & control, 10 year structural standard, 10 / 20 also available		
Shipping	Max load	45,000 lbs. per truckload 5,000 lbs. maximum bundle size 2,900 lbs. or other maximum as requested by customers		
	Shipping Containers or flatbeds	Flat beds for structure, dry vans for hardware		
	# Trucks per MWdc	2.76 typical		
Commissioning	Backfeed required?	No, Generator for power to master as alternative		



12. APPENDIX B – PV MODULES

Mono Multi Solutions



BIFACIAL DUAL GLASS MONOCRYSTALLINE MODULE

PRODUCT: TSM-DEG21C.20

POWER RANGE: 640-665W

665W

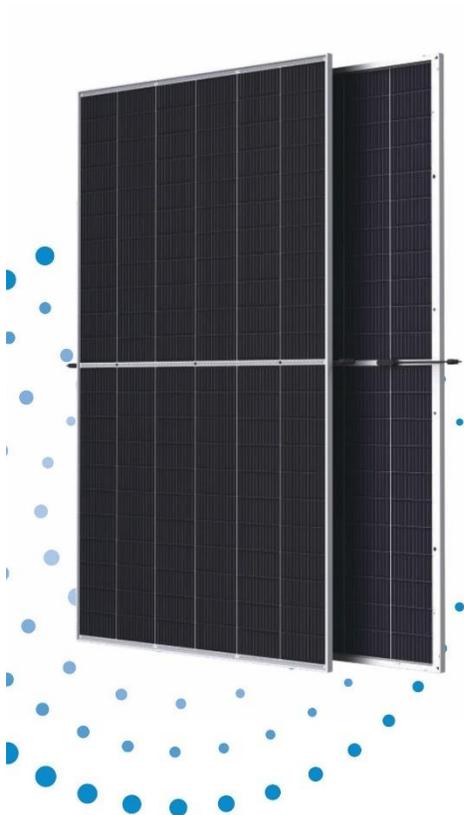
MAXIMUM POWER OUTPUT

0~+5W

POSITIVE POWER TOLERANCE

21.4%

MAXIMUM EFFICIENCY



High customer value

- Lower LCOE (Levelized Cost Of Energy), reduced BOS (Balance of System) cost, shorter payback time
- Lowest guaranteed first year and annual degradation;
- Designed for compatibility with existing mainstream system components



High power up to 665W

- Up to 21.4% module efficiency with high density interconnect technology
- Multi-busbar technology for better light trapping effect, lower series resistance and improved current collection



High reliability

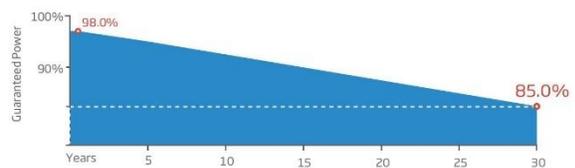
- Minimized micro-cracks with innovative non-destructive cutting technology
- Ensured PID resistance through cell process and module material control
- Resistant to harsh environments such as salt, ammonia, sand, high temperature and high humidity areas
- Mechanical performance up to 5400 Pa positive load and 2400 Pa negative load



High energy yield

- Excellent IAM (Incident Angle Modifier) and low irradiation performance, validated by 3rd party certifications
- The unique design provides optimized energy production under inter-row shading conditions
- Lower temperature coefficient (-0.34%) and operating temperature
- Up to 25% additional power gain from back side depending on albedo

Trina Solar's Vertex Bifacial Dual Glass Performance Warranty



Comprehensive Products and System Certificates

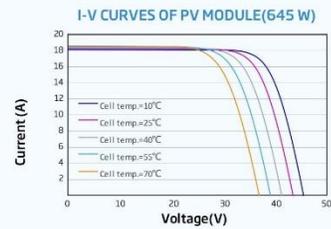
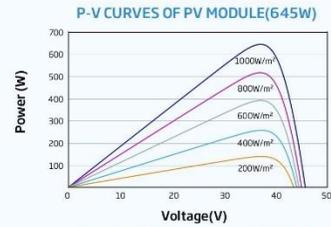
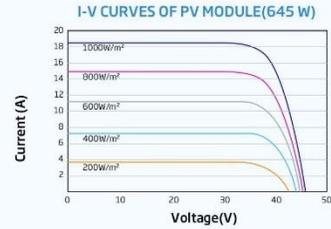
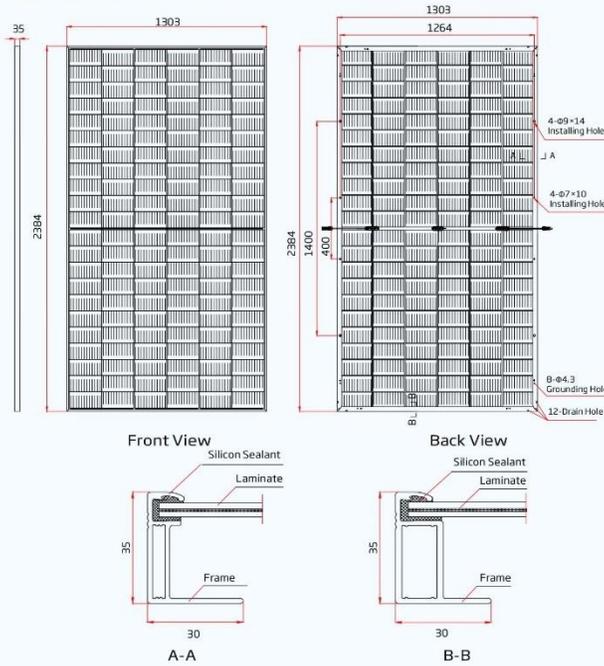


IEC61215/IEC61730/IEC61701/IEC62716/UL61730
 ISO 9001: Quality Management System
 ISO 14001: Environmental Management System
 ISO14064: Greenhouse Gases Emissions Verification
 ISO45001: Occupational Health and Safety Management System





DIMENSIONS OF PV MODULE(mm)



ELECTRICAL DATA (STC)

Peak Power Watts-P _{MAX} (Wp)*	640	645	650	655	660	665
Power Tolerance-P _{MAX} (W)	0 ~ +5					
Maximum Power Voltage-V _{MPP} (V)	37.3	37.5	37.7	37.9	38.1	38.3
Maximum Power Current-I _{MPP} (A)	17.19	17.23	17.27	17.31	17.35	17.39
Open Circuit Voltage-V _{OC} (V)	45.1	45.3	45.5	45.7	45.9	46.1
Short Circuit Current-I _{SC} (A)	18.26	18.31	18.35	18.40	18.45	18.50
Module Efficiency η _m (%)	20.6	20.8	20.9	21.1	21.2	21.4

STC Irradiance 1000W/m², Cell Temperature 25°C, Air Mass AM1.5. *Measuring tolerance: ±3%.

Electrical characteristics with different power bin (reference to 10% Irradiance ratio)

Total Equivalent power -P _{MAX} (Wp)	685	690	696	701	706	712
Maximum Power Voltage-V _{MPP} (V)	37.3	37.5	37.7	37.9	38.1	38.3
Maximum Power Current-I _{MPP} (A)	18.39	18.44	18.48	18.52	18.56	18.60
Open Circuit Voltage-V _{OC} (V)	45.1	45.3	45.5	45.7	45.9	46.1
Short Circuit Current-I _{SC} (A)	19.54	19.59	19.63	19.69	19.74	19.79
Irradiance ratio (rear/front)	10%					

Power Bifaciality: 70±5%.

ELECTRICAL DATA (NOCT)

Maximum Power-P _{MAX} (Wp)	484	488	492	495	499	504
Maximum Power Voltage-V _{MPP} (V)	34.7	34.9	35.1	35.2	35.4	35.6
Maximum Power Current-I _{MPP} (A)	13.94	13.98	14.01	14.05	14.10	14.16
Open Circuit Voltage-V _{OC} (V)	42.5	42.7	42.9	43.0	43.2	43.4
Short Circuit Current-I _{SC} (A)	14.71	14.75	14.79	14.83	14.87	14.91

NOCT: Irradiance at 800W/m², Ambient Temperature 20°C, Wind Speed 1m/s.

MECHANICAL DATA

Solar Cells	Monocrystalline
No. of cells	132 cells
Module Dimensions	2384×1303×35 mm (93.86×51.30×1.38 inches)
Weight	38.7 kg (85.3 lb)
Front Glass	2.0 mm (0.08 inches), High Transmission, AR Coated Heat Strengthened Glass
Encapsulant material	POE/EVA
Back Glass	2.0 mm (0.08 inches), Heat Strengthened Glass (White Grid Glass)
Frame	35mm(1.38 inches) Anodized Aluminium Alloy
J-Box	IP 68 rated
Cables	Photovoltaic Technology Cable 4.0mm ² (0.006 inches ²), Portrait: 280/280 mm(11.02/11.02 inches) Length can be customized
Connector	MC4 EVO2 / TS4*

*Please refer to regional datasheet for specified connector.

TEMPERATURE RATINGS

NOCT (Nominal Operating Cell Temperature)	43°C (±2°C)
Temperature Coefficient of P _{MAX}	-0.34%/°C
Temperature Coefficient of V _{OC}	-0.25%/°C
Temperature Coefficient of I _{SC}	0.04%/°C

MAXIMUM RATINGS

Operational Temperature	-40 ~ +85°C
Maximum System Voltage	1500V DC (IEC) 1500V DC (UL)
Max Series Fuse Rating	35A

WARRANTY

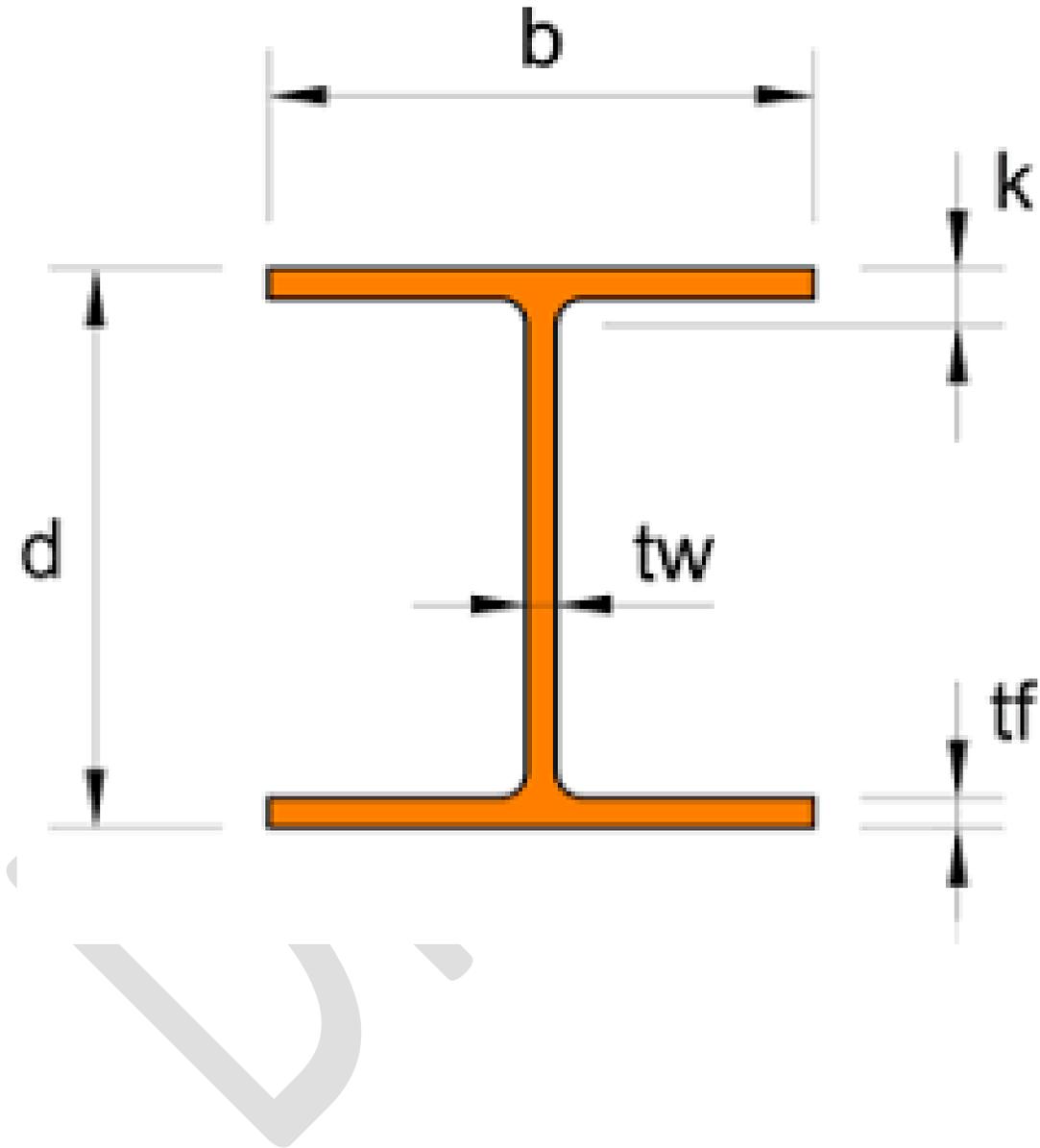
12 year Product Workmanship Warranty
30 year Power Warranty
2% first year degradation
0.45% Annual Power Attenuation
(Please refer to product warranty for details)

PACKAGING CONFIGURATION

Modules per box: 31 pieces
Modules per 40' container: 558 pieces



13. APPENDIX C – DRIVEN H PILES





14. APPENDIX D – INVERTER

SG3150UD-MV-US

Turnkey Station for 1500 Vdc System MV Transformer Integrated



HIGH YIELD

- Advanced three-level technology, max. inverter efficiency 99%
- Full power operation at 40 °C (104 °F)
- Effective cooling, wide operation temperature



EASY O&M

- Integrated current, voltage and MV parameters monitoring function for online analysis and trouble shooting
- Modular design, easy for maintenance



SAVED INVESTMENT

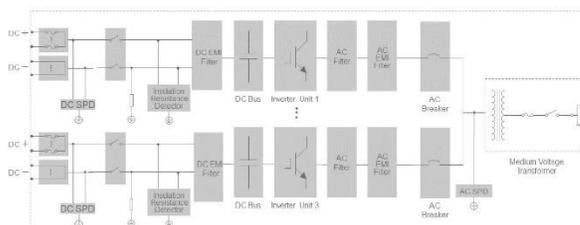
- Low transportation and installation cost due to 20-foot container size design
- DC 1500V system, low system cost
- Integrated MV transformer and LV auxiliary power supply
- Q at night optional



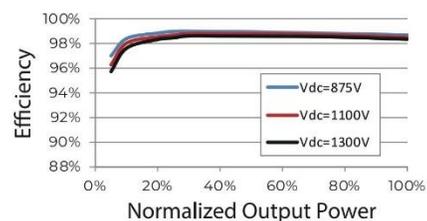
GRID SUPPORT

- Compliance with standards:UL 1741, UL 1741 SA / SB, IEEE 1547, Rule 21 and NEC code
- Low / High voltage ride through (L / HVRT), L / HFRT, soft start / stop
- Active & reactive power control and power ramp rate control

CIRCUIT DIAGRAM



EFFICIENCY CURVE





Type designation	SG3150UD-MV-US
Input (DC)	
Max. PV input voltage	1500 V
Min. PV input voltage / Start-up input voltage	875 V / 915 V
Available DC fuse sizes	250 A - 630 A
MPP voltage range	875 V - 1500 V
Full power MPP voltage range @ 40 °C	875 V - 1300 V *
No. of independent MPP inputs	3
No. of DC inputs	21 inputs negative grounding (optional: 18 inputs floating)
Max. PV input current	3 * 1226 A
Max. DC short-circuit current	3 * 3528 A
PV array configuration	Negative grounding or floating
Output (AC)	
AC output power	3150 kVA @ 40 °C (104 °F)
Nominal grid frequency / Grid frequency range	60 Hz / 57 Hz - 63 Hz
Harmonic (THD)	< 3 % (at nominal power)
Power factor at nominal power / Adjustable power factor	> 0.99 / 0.8 leading - 0.8 lagging
Efficiency	
Inverter Max. efficiency	98.9 %
Inverter CEC efficiency	98.5 %
Transformer	
Transformer rated power	3150 kVA
Transformer max. power	3150 kVA
LV / MV voltage	0.6 kV / (12 - 35) kV
Transformer vector	Dy1 (Optional: Dy11, Yny0)
Transformer cooling methods	KNAN (Optional: ONAN)
Protection	
DC input protection	Load switch + fuse
Inverter output protection	Circuit breaker
AC MV output protection	Load switch + fuse
Surge protection	DC Type II / AC Type II
Grid monitoring / Ground fault monitoring	Yes / Yes
Insulation monitoring	Yes
Overheat protection	Yes
General data	
Dimensions (W*H*D)	6058 mm * 2896 mm * 2438 mm 238.5" * 114.0" * 96.0"
Weight	≤ 31967 lbs
Degree of protection	NEMA 4X (Electronic for Inverter) / NEMA 3R (Others)
Auxiliary power supply	5 kVA, 120 Vac; Optional: 35 kVA 480 Vac + 5 kVA 120 Vac
Operating ambient temperature range (It refers to the ambient temperature of 1m around the inverter)	-35 °C - 60 °C (> 40 °C derating) / optional: -40 °C - 60 °C (> 40 °C derating) -31 °F - 140 °F (> 104 °F derating) / optional: -40 °F - 140 °F (> 104 °F derating)
Allowable relative humidity range	0 % - 100 %
Cooling method	Temperature controlled forced air cooling
Max. operating altitude	1000 m (Standard) / > 1000 m (Customized) (3280.8 ft (Standard) / > 3280.8 ft (Customized))
Display	LED Indicators, WLAN+WebHMI
Night reactive power function	Optional
DC-coupled storage interface	Optional
Charging power from the grid	Optional
Communication	Standard: RS485, Ethernet
Compliance	UL 1741, UL 62109-1, CSA C22.2 No.107.1-16, IEEE 1547-2018, IEEE 1547.1-2020, UL 1741 SA/SB, California Rule21, HECO SRD V2.0, NEC 2023,PRC-024
Grid support	Q at night function (optional), L/HVRT, L/HFRT, Active & reactive power control and power ramp rate control, Volt-var, Frequency-watt

*Full power MPP range is temperature dependent, check the characteristic curve of the inverter for more information.

15. APPENDIX E – FENCE DESIGN (Example)

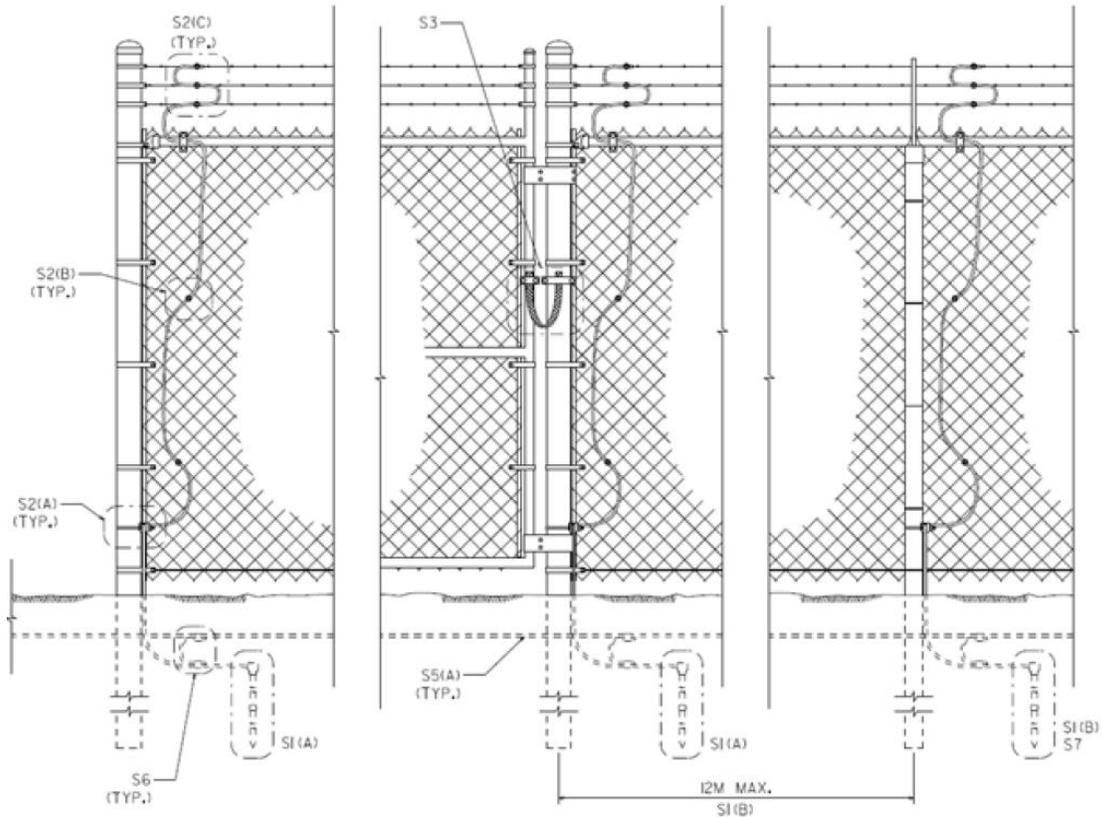


Figure 8 ~ Typical Substation Chain Link Fence Grounding Application
(See Rule 6-116.)



16. APPENDIX F – CANREA : SOLAR RECYCLING IN CANADA

Sustainable Energy: Recycling Renewables

Just as sustainability is at the heart of our industry, circular-economy principles are central to the Canadian Renewable Energy Association (CanREA). This series of factsheets on Recycling and Renewables examines the current recycling options for wind energy, solar energy and energy-storage technologies in Canada, and points the way for the future.



Recycling Solar Panels in Canada

Recycling and renewables go hand in hand. But what happens to renewable-energy components when they reach the end of their life span? This CanREA fact sheet examines the current recycling options for solar panels in Canada.

Powering up solar

In just about every corner of the world, solar photovoltaic (PV) energy is emerging as a reliable, sustainable and scalable solution for low-cost electricity, powering everything from single-family dwellings in remote communities to massive power plants serving the world's largest cities.

Canada's solar-power industry is developing a full life-cycle approach, aiming not only to eliminate the carbon emissions of fossil-fuel electricity generation, but also to reduce waste in solar panel manufacturing, and in their end-of-life processes as well.

Giving panels new life

Solar power systems are typically designed with a life span of 25 years. Performance often outshines these expectations, and there are also significant re-powering opportunities thanks to accelerating technological advances.

But eventually, older panels may need to be replaced with new, higher-performing modules. In many cases, used solar panels can be sold for a significant portion of their initial value.

Likewise, solar panels that are damaged during shipping, installation and service, or by extreme weather events such as hailstorms or tornados, can be repaired, and re-sold after a proper safety inspection. This second-hand market serves an important purpose, as they are useful for sites that aren't necessarily looking for the newest technology.

Solar panels are 90% recyclable by mass

A solar-power plant is comprised of several key components:

- Power-management equipment, such as transformers, power inverters and power-collection systems (wiring, control panels, conduits, etc.)

- Mounting system for the panels
- Solar modules ("panels") grouped into arrays
- An energy-storage device, such as lithium-ion batteries, may also be part of the system.

These components can be reused, refurbished or upcycled at the end of their life, and eventually, they can be recycled.

Solar power systems consist of recyclable materials, including copper (cabling), aluminum (racking), steel (posts), glass and electronic components. There are also precious metals, such as silver, but the proportion of these materials has been greatly reduced over the past few years, contributing to solar's significant cost-reduction.

Once the glass and metal have been channelled into well established recycling processes, there is very little mass remaining that requires special treatment.

There are several recycling methods for the solar panels themselves, including disassembly and shredding.

Canadian ingenuity

As popular support grows for circular-economy principles, there is an increased focus on ways to divert all forms of waste from landfills, and the renewable energy sector is no exception.

Canada's transition to non-emitting energy is expected to greatly increase the need for solar panels and other renewable energy technologies.

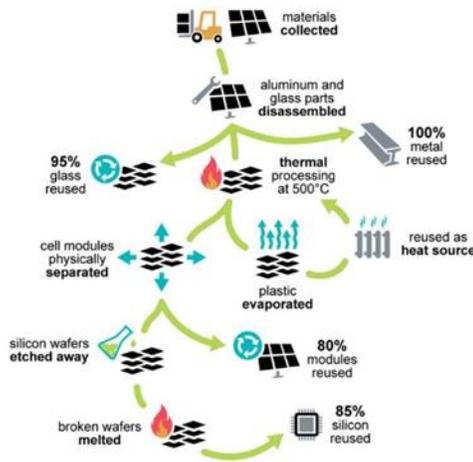
The disposal of solar panels is at a low volume today, but this will ramp up in the future, providing greater feed stocks for recycling processes. Plans are already being put into place to handle the increase.

Innovators are rapidly developing solutions to the sustainability challenges being faced across many sectors. They are stepping up today to manage our future needs.



Delivering these solutions will require a collaborative effort between the solar-power industry, the recycling sector, manufacturing, clean-tech, and governments at every level. Logistics and transportation will also play a significant role, given Canada's vast landmass.

Recycling process for solar panels (silicon based)



Think globally

To put solar waste into perspective, the United Nations Environment Programme estimates that 50 million metric tons of electronic waste (such as computers, televisions and cell phones) are produced annually around the globe. Of this, solar PV represents only 0.5%, or about 250,000 tons annually, according to a [2016 IEA report](#).

As this stream keeps growing, the industry is anticipating the need and ramping up its capability to recover waste materials for re-use, not just for sustainability reasons but for the economic opportunity presented by each decommissioned component.

Canada is by no means alone in the adoption of solar PV and the eventual need to recycle its materials. Many countries and regions are well ahead of North America on this front and present various solutions from which the emerging Canadian industry can learn.

The International Energy Agency (IEA) has produced numerous resources quantifying the problem with a scientific approach, including [Canada's expert input](#).

Likewise, the European Commission has established a directive on "[Waste from Electrical and Electronic Equipment \(WEEE\)](#)," guiding end-of-life strategies for solar panels in the European Union.

In North America, similar considerations are being developed with notable progress in California and Washington State.

Next steps

In Canada today, end-use electricity consumers, as well as manufacturing facilities with strong Environmental, Social, and Governance (ESG) goals, are fueling new interest in working with CanREA to eliminate carbon emissions and improve sustainability throughout the supply chain.

As Canada's solar PV capacity grows, CanREA members are examining new ways to innovate and close the circular economy loop. From the sourcing of raw materials to the final disposal and reuse of components, the opportunities to push further into sustainability over the full life cycle of our technologies continue to expand.

For more information

Learn more about recycling and renewables in the "Life Cycle" section of the CanREA website: [Repowering and Decommissioning](#).





17. APPENDIX G – REFERENCES

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