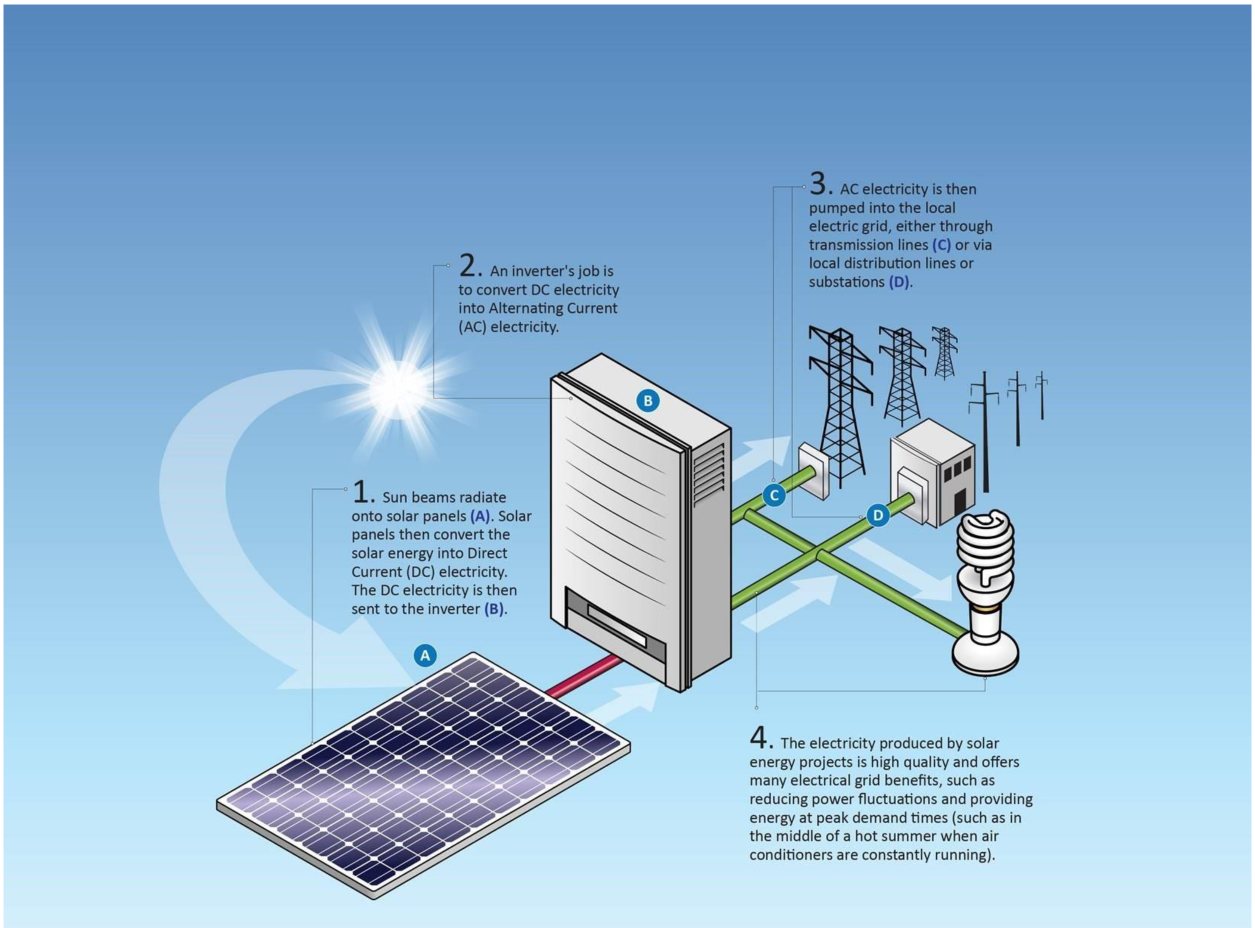
3.0 ENGINEERING AND OPERATIONAL DESIGN

Image 1 below outlines the process of converting solar energy and connecting it to the transmission grid. The process begins with solar panels converting energy from sun into direct current (DC) electrical power. Sets of panels will be electrically connected in series and terminated at an inverter. The inverters will convert the DC power (approximately 1,500 volts) from the panels to AC power (650-950 volts depending on the inverter specifications). Next, a transformer will step up the AC voltage of generated electricity from the inverter output voltage to 34.5 kV. From the transformers, electrical cable will be buried below-ground, or pole mounted above-ground for routing to the Project substation where the electricity will be stepped up from 34.5 kV to 115 kV to interconnect to the existing transmission infrastructure.

Image 1: Harvesting Solar Energy



Source: Geronimo Energy

3.1 Design

The Project will utilize photovoltaic (PV) panels with tempered glass varying in size approximately 4 to 6.5 feet long by 2 to 3.5 feet wide, and 1 to 2 inches thick. The panels will be installed on a tracking rack system that utilizes galvanized steel and aluminum for the foundations and frame with a motor that allows the racking to rotate from east to west throughout the day. Each tracking rack will contain multiple panels. On the tracking rack system, panels will be approximately 15 feet in height from the ground to the top of the panels when at a 45-degree angle (refer to Image 2 below). Height may vary due to manufacturer, topography and vegetation constraints and could reach a height of approximately 20 feet from the ground. Depending on the technology selected, the PV panels may have an aluminum frame, silicon, and weatherized plastic backing or a side-mount or under-mount aluminum frame, heat strengthened front glass, and laminate material encapsulation for weather protection.

To limit reflection, solar PV panels are constructed of dark, light-absorbing materials. Today's panels reflect as little as two percent of the incoming sunlight depending on the angle of the sun and assuming use of anti-reflective coatings. The solar array will occupy most of the Project site for the solar facilities.

3.1.1 Linear Axis Tracking Rack System

A linear axis tracking rack system allows the PV panels to track the solar resource throughout the day. The panels and tracking rack system are generally aligned in rows north and south with the PV panels facing east toward the rising sun in the morning, perpendicular to the ground during mid-day, and then west toward the setting in the afternoon. The panels are rotated by a small motor connected to the tracking rack system to slowly track with the sun throughout the day. The tracking rack system allows the Project to optimize the angle of the panels in relation to the sun throughout the day thereby maximizing production of electricity and the capacity value of the Project.

The tracking rack system is mounted on top of steel piers that are typically driven into the ground, without a need for excavation or concrete to install the piers.

The footprint of the arrays is the same for the below-ground and hybrid below-ground / above-ground collection systems, but is slightly different for the above-ground collection systems (see Figures 3-6). The difference is a result of above-ground poles potentially casting shadows on the arrays. To avoid shadows on the arrays, for the above-ground electrical system, there is approximately 100 feet between the arrays and the access road located to the south of the arrays, and the above-ground collection line with poles is located on the south side of the access road parallel to the access road. As a result of the additional spacing requirements for an above-ground collection system, some arrays were shifted within the Preliminary Development Area. For example, in the layout using the above-ground collection system (Figure 5 – Above-Ground Preliminary Project Layout), arrays were shifted to the perimeter of the Preliminary Development Area along U.S. 10 and in the west-central portion of the Project (compare Figures 3 and 5 - Below-Ground Preliminary Project Layout and Above-Ground Preliminary Project Layout, respectively).

Images 2-4 below visually show the general racking equipment and dimensions of a linear axis tracking rack system.

Image 2: Tracking Rack System

Image 3: Approximate Tracking Rack System Dimensions

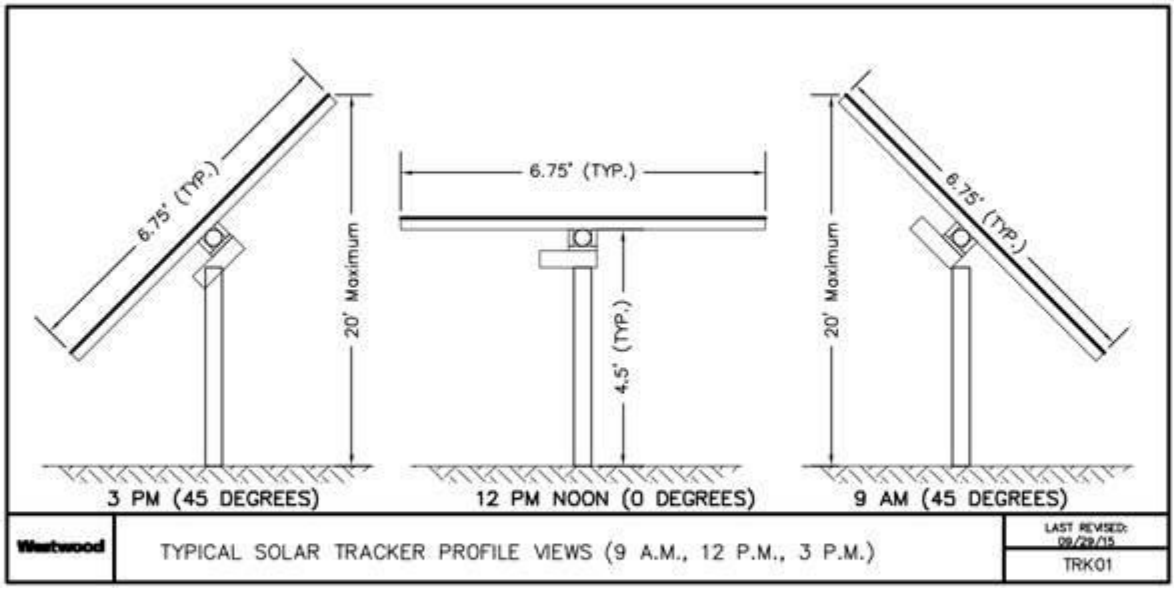


Image 4: Standard Steel Pier Foundations

3.1.2 Inverters, Transformers, and Electrical Collection System

Electrical wiring will connect the panels to inverters, which will convert the power from DC to AC. The AC will be stepped up through a transformer from the inverter output voltage to 34.5 kV and brought via the collection cables to the Project substation. The electrical collection system will be installed below-ground, above-ground, or a combination of both. The type of electrical system will be determined prior to construction based on technology, availability of materials, and costs. It should be noted that both the below-ground and above-ground collection systems are currently used at utility-scale solar projects. The inverters and electrical cables that would be used for each type of electrical collection system are described below.

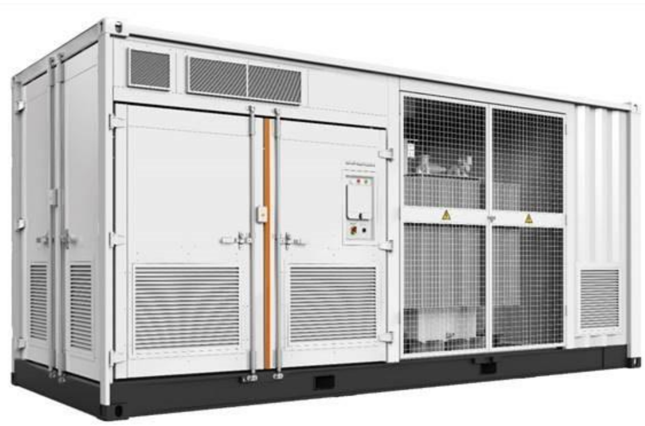
3.1.2.1 Inverters – Below-ground Electrical Collection System

Inverters convert approximately 1,500 volts of direct current (DC) output of the PV panels to between 650-950 volts of AC. Then a step-up transformer converts the inverter AC voltage to an intermediate voltage of 34.5kV. The panels deliver DC power to the inverters through cabling that will be located in a below-ground trench (approximately four feet deep and one to two feet wide). Below-ground AC collection systems from the inverter skids to the substation will be installed in trenches or ploughed into place at a depth of at least four feet below grade. During all trench excavations the topsoil and subsoil will be removed and stockpiled separately in accordance with the AIMP. Once the cables are laid in the trench, the area will be backfilled with subsoil followed by topsoil. Electrical collection technology is rapidly evolving and will be site-specific depending on geotechnical analysis, constructability, and availability of materials. Final engineering and procurement will help determine the construction method for the electrical collection system.

For belowground cabling, inverter skids will be utilized at locations throughout the Preliminary Development Area and include a transformer to which the inverters will feed electricity (Image 5). The final number of inverters for the Project will depend on the inverter size, as well as inverter and panel availability. The Project's preliminary design assumes below-ground cabling to represent the maximum potential impacts and has proposed 40 central inverter skids (one inverter is required for every 2-3 MW). These skids provide the foundation for the inverter, transformer, and SCADA system. The skids will be placed atop a concrete slab or pier foundations and typically measure 10 feet wide by 25 feet long, with a structure height of approximately 12 feet above grade (Image 5). Concrete foundations will be poured onsite or precast and assembled off-site.

The inverters are within the interior of the Project along access roads. Typical drawings of inverters are included in the Site Plan in Appendix B and Image 5 below shows a central inverter and step-up transformer station.

Image 5: Typical Inverter and Transformer Station



3.1.2.2 Above-ground Electrical Collection System

An above-ground electrical system is being considered for the Regal Solar Project for several reasons including ease of access for operations and maintenance, reduced ground disturbance, and cost considerations. If above-ground cabling is utilized, the DC collection cables will be strung under each row of panels on steel arms and a steel cable attached to the piles. At the end of each row, hanging brackets would connect several racks/rows of cables to a common collection point near their assigned inverter/transformer skid where the cables will be routed below-ground at a minimum depth of at least four feet below grade to the inverter/transformer skid where the current is converted to AC and voltage is stepped up to 34.5 kV. A typical drawing of the hanging brackets at the end of each row is provided below in Image 6. The electrical cables will then be routed below-ground at a minimum depth of at least four feet below grade to a distribution-type pole. These poles would be made of wood, approximately 18” in diameter, up to 30 feet in height, and spaced approximately 200 feet apart. Image 7 provides a schematic of the above-ground collection system components and configuration. The electrical cables will then be strung on poles to the Project substation. Above-ground medium voltage collection technology is rapidly evolving and, if utilized, the number of poles will be determined based on final engineering. Cables connecting each unit of solar arrays will be directionally bored under or spanned over county roads.

For above-ground cabling, inverter skids will be utilized at locations throughout the Preliminary Development Area and include a transformer to which the inverters will feed electricity (Image 4). The final number of inverters for the Project will depend on the inverter size, as well as inverter and panel availability. The Project’s preliminary design for above-ground cabling represents the maximum potential impacts and has proposed 40 central inverter skids (one inverter is required for every 2-3 MW). These skids provide the foundation for the inverter, transformer, and SCADA system. The skids will be placed atop a concrete slab or pier foundations and typically measure 10 feet wide by 25 feet long, with a structure height of approximately 12 feet above grade (Image 5). Concrete foundations will be poured onsite or precast and assembled off-site.

The inverters are within the interior of the Project along access roads. Typical drawings of inverters are included in the Site Plan in Appendix B and Image 5 above shows a central inverter and step-up transformer station.

Image 6: Typical Above-Ground Collection Hanging Bracket

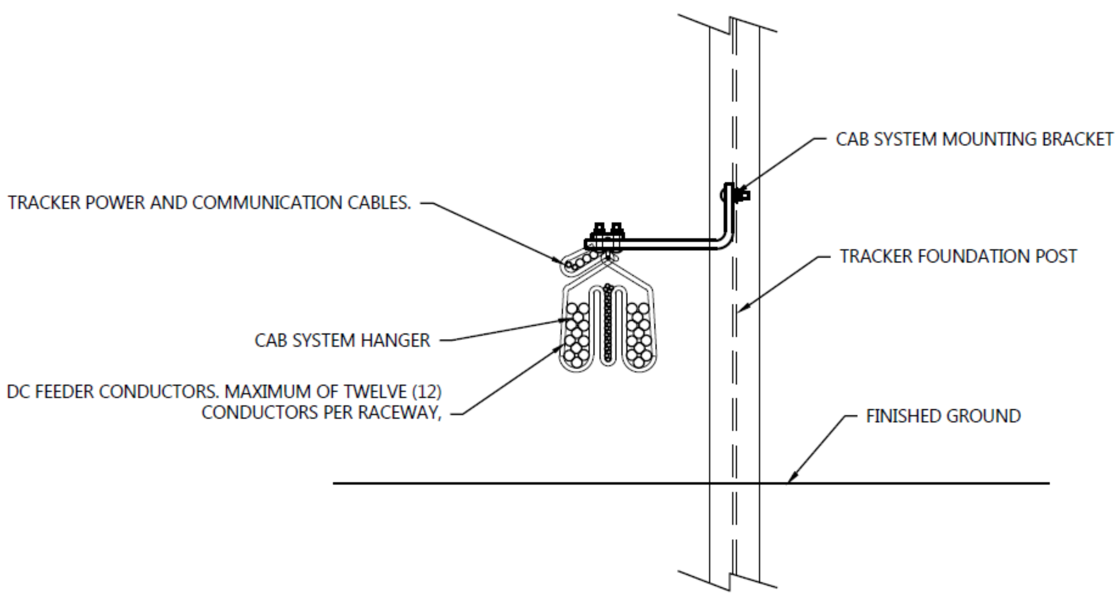
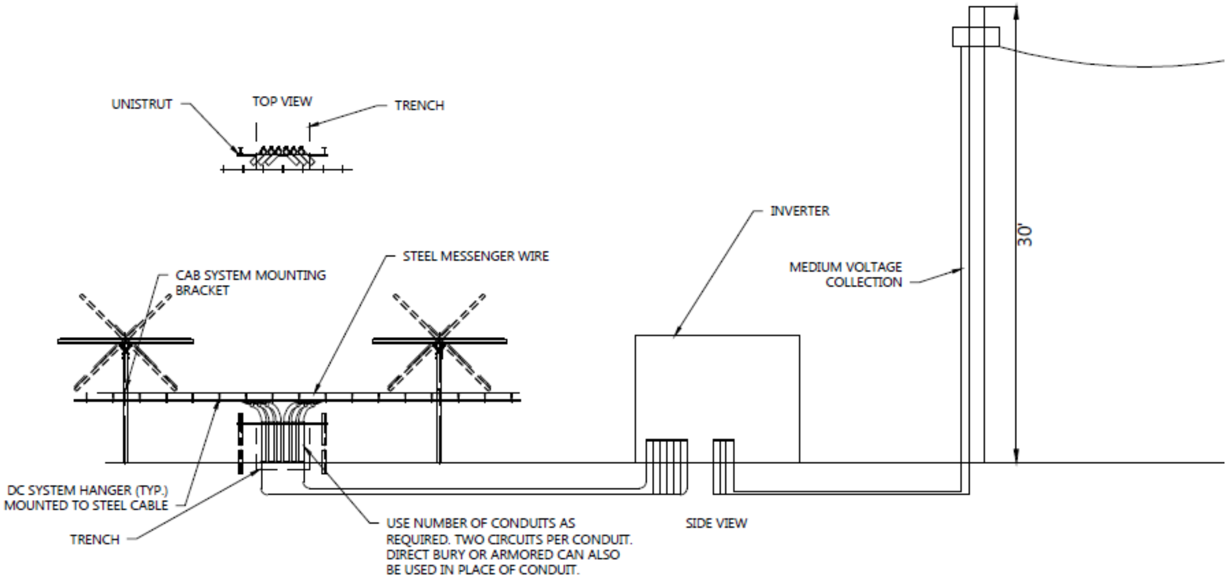


Image 7: Typical Above-Ground Collection System Components and Configuration



3.1.2.3 Hybrid Below-ground and Above-ground Electrical Collection System

A hybrid below-ground and above-ground electrical system is also being considered for the Regal Solar Project for several reasons that are also advantageous to the above-ground electrical system, including ease of access for operations and maintenance, reduced ground disturbance, and cost considerations. Similar to the above-ground system, the DC collection cables will be strung under each row of panels on steel arms and a steel cable attached to the piles. At the end of each row, hanging brackets would connect several racks/rows of cables to a common collection point near their assigned inverter/transformer skid where the cables will be routed below-ground at a minimum depth of at least four feet below grade to the inverter/transformer skid where the current is converted to AC and voltage is stepped up to 34.5 kV. A typical drawing of the hanging brackets at the end of each row is provided above in Image 6. The electrical cables will then be routed below-ground at a minimum depth of at least four feet below grade to the Project substation. Cables connecting each unit of solar arrays will be directionally bored under county roads.

For the hybrid below-ground and above-ground cabling, inverter skids will also be utilized at locations throughout the Preliminary Development Area and include a transformer to which the inverters will feed electricity (Image 5). The final number of inverters for the Project will depend on the inverter size, as well as inverter and panel availability. The Project's preliminary design for the hybrid below-ground and above-ground cabling represents the maximum potential impacts and has proposed 40 central inverter skids (one inverter is required for every 2-3 MW). These skids provide the foundation for the inverter, transformer, and SCADA system. The skids will be placed atop a concrete slab or pier foundations and typically measure 10 feet wide by 25 feet long, with a structure height of approximately 12 feet above grade (Image 5). Concrete foundations will be poured onsite or precast and assembled off-site.

The inverters are within the interior of the Project along access roads. Typical drawings of inverters are included in the Site Plan in Appendix B and Image 5 above shows a central inverter and step-up transformer station.

3.1.3 Access Roads

The Project will include approximately 12.4 miles of graveled access roads for the below-ground and hybrid below-ground and above-ground configurations and 12.5 miles of graveled access roads for the above-ground configuration that lead to the inverters and Project substation for operation and maintenance. The final length of the access roads will depend on the equipment selected and final engineering. These roads are up to 16 feet wide along straight portions of the roads and wider along curves at internal road intersections (approximately 45 feet). There are four access points to the Project from existing county roads. These entrances will have locked gates.

Per the request of Benton County and Langola Township, Regal has included an access road around the parameter of the Project to provide an additional buffer from the railroad adjacent to Highway 10 to mitigate concerns related to passing trains potentially producing sparks. Access roads around entire facilities this large are necessary for effective and efficient access for operations and maintenance and for safe ingress and egress of employees, visitors and emergency responders. Regal has minimized the amount of access roads within the Preliminary Development Area. Prior versions of the site plan had access roads between every block of racking, which resulted in approximately 15.6 miles of access roads. The site plan included in this Application has removed ancillary access roads that don't provide direct access to inverters resulting in a nearly 20% decrease in the miles of access roads included in the Project design.

Some upgrades or other changes to the public roads may be required for construction or operation of the Project. Regal will work with Benton County to facilitate and pay for required upgrades that meet the required public standards. Upgrades or changes could include, but are not limited to, road improvements, additional aggregate, and driveway changes. Driveway changes will require a county entrance permit from Benton County, which will be obtained prior to construction.

3.1.4 Safety Features

Permanent security fencing will be installed along the perimeter of the solar arrays and Preliminary Development Area. Fencing will be secured to posts which will be directly embedded in the soil or set in concrete foundations as required for structural integrity. The fencing will consist of an agricultural woven wire fence and will extend approximately 6 feet above grade. At the request of MNDNR, barbed wire will not be used around the perimeter of the Project, and instead one foot of 3-4 strands of smooth wire will be used. However, the fencing around the substation will be a 6-feet above grade chain-link fence and include one foot of barbed wire to comply with the National Electric Code. This fencing will be designed to prevent the public from gaining access to electrical equipment which could cause injury. Additionally, the fencing will prevent larger wildlife from entering the facility.

The Project will also have security cameras. Regal will have security lighting at the entrances that will be down lit. The typical pole height will be ten feet and manual by switch as well as motion activated if an intrusion is detected. There will be lights at each inverter that will be down lit and switch controlled for repair purposes. For more detail about the lighting proposed at the Project site, see Appendix B.

3.1.5 Associated Facilities

3.1.5.1 Project Substation

The Project substation will be a 34.5/115 kV step-up substation with metering and switching gear required to connect to the transmission grid. It will be designed according to regional utility practices, Midcontinent Independent Transmission System Operator Standards, Midwest Reliability Organization Standards, National Electrical Safety Code, and the Rural Utility Service Code. The area within the substation will be graveled to minimize vegetation growth in the area and reduce fire risk. The substation will be fenced with a 6-foot chain-link fence, topped with one foot of barbed wire for security and safety purposes. The substation's area will be approximately 150 feet by 150 feet once construction is complete.

3.1.5.2 Operation and Maintenance Building

An O&M building will provide access and storage for Project maintenance and operations and will be located adjacent to the Project substation. The Project will obtain a building permit for the O&M building from Benton County prior to construction. The O&M building will measure approximately 60 feet long by 40 feet wide and will be made of metal (similar to a pole barn). It will contain an office for the onsite Plant Manager, a technician room, restroom, and storage area for equipment to operate and maintain the Project. Equipment includes a Supervisory Control and Data Acquisition (SCADA) cabinet, spare panels, spare parts for the substation and equipment to operate the substation, as well as safety equipment for working with live electricity.

A SPCC Plan is required by the Environmental Protection Agency (EPA) if any facility associated with the Project (O&M or substation) has oil storage of more than 1,320 gallons. The Project substation will contain a single, industry-standard main power transformer, which will require a SPCC Plan. Other onsite storage at the O&M facility may include hydraulic oil stored in a plastic or poly tote or 55-gallon drums on secondary containment pallets and potentially a fuel tank, for maintenance vehicles, that would be a double walled tank with additional secondary containment. Additionally, the Project's Stormwater Pollution Prevention Plan (SWPPP) will describe pollution prevention measures for storage, handling and disposal of hazardous materials, solid waste, concrete and equipment wash water, portable toilets, construction products and materials.

3.1.5.3 Parking

A parking lot will be located adjacent to the O&M building and will be approximately 500 square feet with the final size being determined in accordance with the Benton County Development Code. The parking lot will be gravel or paved depending on the size to comply with the off-street parking provisions detailed in Section 9.2 of the Benton County Development Code (Benton County, 2016).

3.1.5.4 Weather Stations

The Project will include up to two weather stations up to 20 feet in height (see Image 8 below). Both weather stations will be within the Preliminary Development Area; the final locations will be determined following final engineering.

Image 8: Weather Station

3.1.6 Temporary Facilities

Regal will utilize four temporary laydown areas within the Preliminary Development Area, totaling approximately 7.0 acres. These areas will serve both as a parking area for construction personnel and staging areas for Project components during construction. These laydown areas have been sited to avoid any tree clearing. After construction, they will be reseeded using a pollinator friendly seed mix as described in Section 4.5.6.

3.1.7 Transmission System

The Project will interconnect into the existing Platte River Substation via a 115-kV overhead gen-tie transmission line of less than 1,500 feet. There will be a single dead-end structure within the Project substation and likely 2-3 additional structures to enter the Platte River Substation with an overall length currently estimated to be approximately 300 feet, pending final engineering. The structures will likely be made of wood and will be less than 150 feet tall. The type of conductor will be determined following the completion of detailed electrical design. Per Minn. Stat. 216E.01 subd. 4, the transmission line does not meet the high voltage transmission line definition because it's less than 1,500 feet. As such, a separate route permit from the Commission will not be required for the gen-tie line.

3.1.8 Pipeline System

Minnesota Rules 7850.1900, subp. 1(J) is not applicable to the Project because no pipelines will be accessed or built as part of the Project.

3.2 Project Layout

The Project's final layout will optimize electrical generation and efficiency of the solar Project while avoiding and minimizing environmental, cultural, and infrastructure impacts. The Project's facilities will be sited to comply with the county's setback requirements, where applicable. To the extent applicable, the Project will also comply with all other local, state, and federal regulatory standards.

The township and county road and utility setback regulations are provided in Table 3.2-1. Regal will meet all county setbacks. Setbacks are displayed on the detailed Site Plan in Appendix B.

Table 3.2-1 Benton County Setback Requirements

Feature	Setback Requirement (feet)	Project Design
U.S. Highway 10	100' from ROW	At its closest, Project facilities are at least 145 feet from these features
County Road	125' from centerline	
Township Road	65' from centerline	
Rear Yard	30'	
Fence	Outside of ROW	

The Project's proposed components include PV panels mounted on a linear axis tracking system, inverters, transformers, and weather stations. The panels vary in size with approximate dimensions of 4 to 6.5 feet long by 2 to 3.5 feet wide, and 1 to 2 inches thick. The Project will use driven steel piles for the tracking and tracker system foundations. Geotechnical soil testing and pile pull testing will determine the final pile specifications and embedment depth requirements.

Sets of panels will be electrically connected in series and terminated at an inverter. The inverters will convert the DC power (approximately 1,500 volts) from the panels to AC power (650-950 volts depending on the panels). Next, a transformer will step up the AC voltage of generated electricity to 34.5 kV. From the transformers, electrical cable will be buried below-ground, or pole mounted above-ground for routing to the Project substation where the electricity will be stepped up to 115 kV to interconnect to the existing transmission infrastructure.

The Project will use a SCADA system, which allows remote control and monitoring of the status of the Project. The monitoring system provides status views of electrical and mechanical data, operation and fault status, meteorological data, and grid station data. For security, the Project will be fenced and have site security cameras. Access to Preliminary Development Area is through lockable gates.

3.3 Estimated Project Facility Acreages

Table 3.3-1 describes the Project facilities' estimated acreage within the approximately 711-acre Preliminary Development Area based on the preliminary design for the below-ground, hybrid below-ground and above-ground and above-ground electrical collection configurations. For all three configurations, the Preliminary Development Area, footprint of the laydown areas, inverters, Project substation, and O&M facility are the same. However, as described in Section 3.1.1, the configuration of arrays access roads, and the fence are slightly different between the below-ground and hybrid system, which are essentially the same and the above-ground system.

Table 3.3-1 Estimated Project Facility Acreages within Preliminary Development Area

Project Facilities	Acres	
	Below-Ground Configuration	Above-Ground Configuration
Access Roads	24.5	24.6
Inverters	0.4	0.4
Project Substation and O&M Building	1.4	1.4
Laydown Areas	7.0 [1]	7.0 [1]
Fenced Area with Solar Panels	673.2 [2]	677.4 [2]
Preliminary Gen-tie Routing Area	0.6	0.6
Project Total	**707.1**	**711.4**

[1] The laydown areas are temporary impacts to be used only during construction
[2] The impacts associated with solar panels include 16-foot-wide grass area between every row of panels

3.4 Project Construction

A variety of activities must be completed to carry the Project through construction. Below is a preliminary list of activities necessary to develop the Project. Pre-construction, construction, and post-construction activities for the Project include:

- Pre-construction
  - Geotechnical analysis;
  - Design substation and electrical collection system;
  - Design solar array, access roads, and O&M building;
  - Underground utility discovery; and
  - Procure all necessary facility components (solar panels, tracking system, transformers).
- Construction
  - Site preparation, grubbing, and grading;
  - Construct laydown areas and set up temporary job site trailers;
  - Construct fencing;
  - Civil construction of access roads;
  - Install PV mounting posts;
  - Install below-ground or above-ground collection system;
  - Install electrical enclosure/inverter;
  - Tracker installation;
  - PV panel installation; and

- Construct gen-tie line.
- Post-construction
  - Restore disturbed areas not intended for permanent above-ground facilities. Permanent above-ground facilities include the substation, O&M building, inverter skids and electrical cabinets, and access roads;
  - Test facility; and
  - Begin commercial production.

3.4.1 Construction Activities

During construction, equipment and work vehicles will travel to and from the site. Daily construction duration is anticipated to be consistent throughout the construction season when the majority of the access road construction, electrical and substation work is taking place. Typical construction equipment such as scrapers, dozers, dump trucks, watering trucks, motor graders, vibratory compactors and pile drivers, pickup trucks, and backhoes will be used during construction. Specialty construction equipment that may be used during construction will include:

- Skid steer loader;
- Medium duty crane;
- All-terrain forklift;
- Concrete truck and boom truck;
- High reach bucket truck; and
- Truck-mounted auger or drill rig.

Upon completion of construction, heavy equipment will be removed from the site. An overview of construction activities follows.

3.4.1.1 Geotechnical

Geotechnical and pull testing studies will be performed to determine the topsoil and subsoil types, and the mechanical properties of the soils. These variables will be used to engineer the solar array foundation system. Typically, the foundation is a steel pile, which is driven into the ground with a hydraulically powered high-frequency hammer mounted on a tracked carrier. The piles are installed at pre-defined locations throughout the array area to an embedment depth of 8 feet to 14 feet below grade, depending on soil properties and other factors.

3.4.1.2 Site Clearing & Vegetation Removal

After the necessary permits are received, construction will begin with the initial site preparation work, including utility locates within the Project boundary. Depending on timing of the start of construction, the Project may require the clearing of residual row-crop debris from the 2020 harvest season. Alternatively, and depending on construction timing, Regal may plant a cover crop in Spring 2020 that is compatible with the Project's Vegetation Management Plan (Appendix C). This cover crop will stabilize soils if row crops are not planted that year.

3.4.1.3 Earthwork

Areas of the site to be graded will have topsoil and organic matter stripped and segregated from the subsoil (depending on the depth of grading cut) in accordance with the Project's Agricultural Impact Mitigation Plan (AIMP), as discussed in Section 4.2.8.3. Some grading will be required to provide a more level workspace and maintain soil stability in areas with a slope greater than five percent. Topsoil shall have temporary and permanent erosion control and soil stabilization measures established in accordance with the Project's storm water pollution prevention plan. The earthwork activities will be completed using typical civil construction equipment – scrapers, bulldozers, front-end loaders, back-hoes or skid-steers.

3.4.1.4 Access Road Construction

As a component of earthwork, permanent access roads and permanent turnouts will be developed. This work will start with the stripping and segregating of topsoil materials from the anticipated 16-foot-wide road width. The subgrade materials will be compacted 16-feet wide to the specified compaction requirements as laid out by the civil and geotechnical engineer. After compaction is reached and verified, the road will be installed as designed, typically done with or without geo-fabric depending on the soil type, and then, with a surface of 4 to 12 inches of gravel. The gravel will be placed level with the existing grade to facilitate drainage and minimize ponding.

After gravel is installed and compacted to engineers' requirements, the Project drainage ditches will be shaped as identified on the final grading plan. Finally, the previously stripped and windrowed topsoil material will be re-spread throughout the Project area.

Topsoil removed from permanent access roads will be removed to suitable locations near the site of removal and spread across existing topsoil for storage. Storage locations will be identified (GPS boundary and depth) and recorded on site maps to facilitate final reclamation after decommissioning.

3.4.1.5 Solar Array Construction

Once grading activities are complete, the racking system supports will be constructed using steel piles driven into the ground. The solar facilities will be constructed in blocks, and multiple blocks could be constructed simultaneously. Construction of the blocks will include pre-positioning and driving piles, mounting the tracking rack system to the piles, pre-positioning of panel pallets, mounting panels to the tracking rack system, the completion of electrical connections, terminations and grounding, and installation of cable management systems. In some situations where soils are low strength or consist of loose, non-cohesive sand, helical screw or auger-type foundation posts may be used. Foundations are typically galvanized steel and used where high load bearing capacities are required. The pile is driven using a hydraulic ram that moves along tracks and is operated by two workers. Soil disturbance would be restricted to the hydraulic ram/ screw machinery, about the size of a small tractor, temporarily disturbing soil at each pile insertion location and while driving between drilling locations.

The remainder of the tracking rack system will be installed by construction crews using hand tools and all-terrain tracked equipment to distribute materials. Array racking will be bolted on top of the foundation piling to create a "rack" to which the solar panels can be fastened.

During array and racking assembly, multiple crews and various types of vehicles will be working within the Project Area. To the extent practicable, vehicular traffic will be limited to permanent and temporary access roads to minimize soil disturbance, mixing and compaction; however vehicular traffic will occur off of roads throughout the Project during construction. These vehicles include flatbed trucks for transporting array components, small all-terrain vehicles, rough-terrain forklifts and skid-steers, as well as pick-up trucks for transporting equipment and workers throughout the Project Area. Panels will be staged in advance throughout the Project Area and brought to specific work areas for installation by wagon-type trailers pulled by small tractors or by all-terrain tracked equipment. The solar panels will be installed by multiple crews using hand tools. Installation crews will proceed in serpentine fashion along staked temporary access roads in a pre-established route to minimize off-road traffic.

3.4.1.6 Electrical Collection System

Electrical wiring will connect the panels to inverters, which will convert the power from DC to AC. The AC will be stepped up through a transformer from the inverter output voltage to 34.5 kV and brought via the collection cables to the Project substation. These cables may be installed in an above-ground or below-ground system. Above-ground DC collection cables will be strung under the panels on steel arms and a steel cable attached to the piles. The collection will hang on the steel cable with cable hangers and be pole mounted along access roads at the end of rows. If above-ground AC collection cabling is utilized, the poles will be wood, up to 18 inches in diameter and up to 30 feet in height. From the transformer, above-ground cables will be routed to the Project substation.

Below-ground AC collection systems will be installed in trenches or ploughed into place at a depth of at least four feet below grade. During trench excavation the topsoil and subsoil will be removed and stockpiled separately in accordance with the AIMP. Once the cables are laid in the trench, the area will be backfilled with subsoil followed by topsoil. Electrical collection technology is rapidly evolving and will be site-specific depending on geotechnical analysis, constructability, and availability of materials. Final engineering and procurement will help determine the construction method for the electrical collection system.

3.4.1.7 Project Substation Construction

Construction work within the substation site will include site preparation and installation of substructures and electrical equipment. Installation of concrete foundations and embedments for equipment will require the use of trenching machines, concrete trucks and pumpers, vibrators, forklifts, boom trucks, and large cranes. Above-ground and below-ground conduits from this equipment will run to a control enclosure that will house the protection, control, and automation relay panels. A station service transformer will be installed for primary AC power requirements. Batteries and battery chargers will be installed inside the enclosure for auxiliary power to the switchyard’s control system. Crushed rock will cover the area of the substation and adequate lighting will be installed around the substation for worker safety during construction and operation.

One of two methods will be used to install substation foundations. Option 1 would be to use a small rubber tire backhoe to dig out major foundations prior to pouring the concrete slabs. Option 2 would use an auger/drill type machine for minor foundations.

In both scenarios, the limit of disturbance will be within the footprint of the substation for both the foundation equipment and the concrete delivery trucks. All topsoil from the Substation footprint will be removed to a pre-established suitable location for storage. The storage area would be near the site where the soil was removed, accurately located (GPS boundary, soil depth) and graded to facilitate revegetation. Subsoil would be removed, if necessary, to an acceptable preestablished and approved area for storage. After decommissioning, subsoil will be returned to the area from which it was excavated (as needed), topsoil will be replaced, and the area will be brought back to pre-construction contours.

3.4.2 Construction Management

Regal will designate an on-site construction manager. This manager's responsibilities include scheduling and coordinating the activities of engineering, procurement and construction contractors. The construction manager will be supported by other members of Regal's team who specialize in engineering, permitting, meteorology, environmental compliance, real estate and Geographic Information Systems (GIS) mapping.

Throughout the construction phase, ongoing coordination occurs among the Project's development, design, and construction teams. The construction manager coordinates execution of the work. This coordination includes safety and quality control programs, cost and schedule forecasting, as well as site security and ongoing communication with local officials, citizen groups, and landowners.

3.4.3 Commissioning

During and upon completion of the construction phase, the Project will undergo inspection testing and commissioning. Inspection and testing will occur for each component of the solar array, as well as the associated communication, meteorological, collection, and SCADA systems.

3.4.4 Restoration

Following construction, areas that will not contain permanent facilities (area under the arrays and the laydown yards) will be stabilized with sediment stabilization and erosion control measures such as silt fence and biologs and re-vegetated according to the Vegetation Management Plan (VMP; Appendix C). The site will be seeded with site specific seed mixes developed in coordination with the MNDNR and include three native seed mixes: a low growing mix within the arrays, an open mix, and a wet mix (Appendix B – Site Plan). Additionally, a cover crop will be planted with the native mixes to stabilize the soil and prevent erosion during the time it takes for the native seeds to establish.

The VMP provides a guide to site preparation, installation of prescribed seed mixes, management of invasive species and noxious weeds, and control of erosion/sedimentation. The required restoration management is designed to continue for three years. The VMP outlines vegetation management tasks during the establishment and perpetual maintenance phases including monitoring for and treating any invasive species, mowing, and re-seeding. Additionally, vegetation community establishment targets are defined for each of the first three years of implementation of the VMP.

3.5 Project Operation and Maintenance

Following commissioning and commercial operation, the care, custody, and control of the facility transfers from the construction team to the operations staff. The construction manager works with the operations staff, the equipment suppliers, and other construction and maintenance personnel to ensure a smooth transition from the start of construction to the commercial operation date of the Project. The operations staff will have full responsibility for the facility to ensure operations and maintenance are conducted in compliance with approved permits, prudent industry practice and the equipment manufacturer's recommendations.

The Project will be professionally maintained and operated by Regal, an affiliate, or contractor. Primary tasks include scheduled monthly and quarterly inspection(s) of electrical equipment, vegetation management as well as snow removal on access drives.

The expected service life of the Project is 25 to 40 years, and Regal estimates that the Project will result in up to five full-time permanent positions to operate and maintain the Project facilities. A maintenance plan will be created for the Project to ensure the performance of the solar facilities, including a scheduled check of the main items and a predictive maintenance approach of the devices subjected to derating/degradation. Derating/degradation refers to the known process of components losing some efficiency or otherwise degrading over the course of the Project's life cycle; like all technology and physical components, a certain amount of this is unavoidable, and Regal will plan for it and maintain the facility as needed. Once construction is complete, the solar facility will see one to two trucks on site daily, and at intervals associated with the maintenance schedule in Section 3.5.5 during normal operations. The main scheduled activities are described in more detail below in Sections 3.5.2 through 3.5.4.

All maintenance activities will be performed by qualified personnel. Maintenance activities will be performed during the day to the extent that they do not disrupt energy production. As an example, if a panel needs repair, that particular section of the array can be disconnected from the array by opening the combiner box circuit. The panel can then be replaced, and the combiner box circuit closed. Additionally, the power production circuits are separated from the tracking circuits. This allows the PV panels to operate during an unscheduled outage of the tracker system. Upon occasion, it may be desirable to perform maintenance when the sun is down. Activities that have the potential for substantial noise generation will be performed during the day to minimize impacts in areas where residents are present.

There will be an area for the storage of the spare parts and the tools as described in Section 3.1.5.2. The generating facility will be operated through a real-time control system for most operations functions.

3.5.1 Supervisory Control and Data Acquisition System

The solar arrays will communicate directly with the SCADA system for remote performance monitoring, energy reporting and troubleshooting. The SCADA system provides data on solar generation and production, availability, meteorology, and communications. The SCADA system allows monitoring of, and communications with, the Project and relays alarms and communication errors. All the monitored data will be managed by Regal on-site in addition to a qualified subcontractor that will remotely monitor the site 24 hours a day, 7 days a week through the SCADA system.

3.5.2 Equipment Inspection

Inspection of the main equipment will occur at regular intervals, including:

- PV panels: visual check of the panels, tracking system and surrounding grounds to verify the integrity of the panels and tracking structure, the presence of animals and nests, etc.
- Inverters, transformer and electrical panels: visual check of the devices including the connection cabinet and the grounding network. Check for presence of water and dust;
- Electrical check: measurement of the insulation level and dispersion. Check of the main switches and safety devices (fuses);
- Noise: check of abnormal sounds; and
- Cabling and wiring: visual check of the buried and aerial electrical line and connection box to verify their status.

3.5.3 Performance Monitoring

Performance monitoring of the Project facilities will consist of a weekly or monthly download of the data acquired by the onsite meteorological stations (energy produced, alarms, faults, etc.).

3.5.4 Facility Maintenance

Housekeeping of the Project facilities will include road maintenance, vegetation maintenance (method is to be determined; either traditional mowing or sheep and/or lamb grazers will be utilized), fence and gate inspection, lighting system checks, and PV panel washing (if required; minimal to no washing is anticipated to be needed at Project facilities due to the naturally occurring and frequent precipitation).

3.5.5 Maintenance Schedule

Table 3.5-1 provides more information on the anticipated frequency of the operations and maintenance tasks associated with the Project. The table represents the anticipated preliminary frequency of these tasks; the frequency of inspection may be varied based on facility demands and experience with performance of certain components and Project features.

Table 3.5-1 Operations and Maintenance Tasks and Frequency

Plant Device	Task	Preliminary Frequency
Photovoltaic (PV) Field	PV Panels visual check	Once Yearly
	Wirings and junction boxes visual check	Once Yearly
	PV strings measurement of the insulation	Once Yearly
	PV strings and string boxes faults	Once Yearly
	PV panels washing	No regular washing planned (only as site-specific conditions warrant)

Table 3.5-1 Operations and Maintenance Tasks and Frequency

Plant Device	Task	Preliminary Frequency
	Vegetation Management (if necessary at site)	Up to three times a year depending on site conditions
Electric Boards	Case visual check	Once Yearly
	Fuses check	Once Yearly
	Surge arresters check	Once Yearly
	Torque check	Once Yearly
	DC voltage and current check	Once Yearly
	Grounding check	Once Yearly
Inverter	Case visual inspection	Once Yearly
	Air intake and filters inspections	Once Yearly
	Conversion stop for lack of voltage	Once yearly
	AC voltage and current check	Once yearly
	Conversion efficiency inspection	Once yearly
	Datalogger memory download	Once yearly
	Fuses check	Once yearly
	Grounding check	Once yearly
	Torque check	Once yearly
Support Structures	Visual check	Once yearly
	PV panels toque check on random sample	Once yearly

3.5.6 Operations and Maintenance Building

As described above, the O&M building will be located adjacent to the Project substation. The size of a typical building used for this purpose is between 2,000-4,000 square feet and constructed of metal (similar to a pole barn). It will house the necessary equipment to operate and maintain the Project. The O&M building will allow maintenance staff to conduct on-site diagnostics, repairs, predictive maintenance, and preventive maintenance activities. This facility will also serve as an office space for the on-site Plant Manager and a warehouse for critical spare parts outlined in Section 3.1.5.2.

3.6 Decommissioning and Repowering

At the end of the Project's useful life, Regal will either take necessary steps to continue operation of the Project (such as re-permitting and retrofitting) or will decommission the Project and remove facilities. Decommissioning activities will include:

- Removing the solar arrays, transformers, electrical collection system, fencing, lighting and substations, and possibly the O&M facility (the O&M facility may be useful for other purposes);
- Removal of below-ground electrical cables to a depth of four feet (cables buried below four feet will be left in place);
- Removal of buildings and ancillary equipment to a depth of four feet;

- Removal of surface road material and restoration of the roads to substantially the same physical condition that existed immediately before construction. If the Project is decommissioned and the land sold to a new owner, Regal would retain any access roads the new landowner requested be retained;
- Grading, adding or re-spreading topsoil, and reseeding according to the Natural Resources Conservation Service (NRCS) technical guide recommendations and other agency recommendations, areas disturbed by the construction of the facility or decommissioning activities, grading and soil disturbance activities will be kept to the minimum necessary to restore areas where topsoil was stripped in construction, topsoil in decommissioned roads and compaction only in areas that were compacted during decommissioning activities so that the benefits to the soil that were achieved over the life of the Project are not counteracted by decommissioning; and
- Standard decommissioning practices would be utilized, including dismantling and repurposing, salvaging/recycling, or disposing of the solar energy improvements, and restoration.

3.6.1 Timeline

Decommissioning is estimated to take six to twelve months to complete and the decommissioning crew will ensure that all equipment is recycled or disposed of properly.

3.6.2 Removal and Disposal of Project Components

The removal and disposal details of the Project components are found below.

- Panels: Panels inspected for physical damage, tested for functionality, and removed from racking. Functioning panels packed and stored for reuse (functioning panels may produce power for another 25 years or more). Non-functioning panels packaged and sent to the manufacturer or a third party for recycling or another appropriate disposal method;
- Racking: Racking uninstalled, sorted, and sent to metal recycling facility;
- Steel Pier Foundations: Steel piles removed and sent to a recycling facility;
- Wire: below-ground wire abandoned in place at depths greater than four feet. Wire above four feet removed and packaged for recycling or disposal;
- Conduit: Above-ground conduit disassembled onsite and sent to recycling facility;
- Junction boxes, combiner boxes, external disconnect boxes, etc.: Sent to electronics recycler;
- Inverter/Transformer: Evaluate remaining operation life and resell or send to manufacturer and/or electronics recycler;
- Concrete pad(s): Sent to concrete recycler;
- Fence: Fence will be sent to metal recycling facility and wooden posts for the agricultural fence will be properly disposed; and
- Computers, monitors, hard drives, and other components: Sent to electronics recycler. Functioning parts can be reused.

3.6.3 Restoration/Reclamation of Facility Site

After all equipment is removed, the facility would be restored to an agricultural use, in accordance with the AIMP or to another use if the economic conditions at that time indicate another use is an appropriate use for the site. Holes created by steel pier foundations and fence poles, concrete pads, re-claimed access road corridors and other equipment will be filled in with soil to existing conditions and seeded. Grading and other soil disturbance activities during decommissioning will be kept to the minimum necessary to effectively decommission the site to maintain the soil benefits realized during the long-term operation of the Project, such benefits include: building topsoil through plant matter decay, carbon capture, and beneficial, soil bacteria that are often absent from soil subject to rowcrop agriculture. This will include the revegetation.

Regal reserves the right to extend operations instead of decommissioning at the end of the site permit term. In this case, a decision may be made on whether to continue operation with existing equipment or to retrofit the facilities with upgrades based on newer technologies. If the decision is made to continue operations, the Project will be re-permitted.

3.6.4 Financial Resource Plan

Beginning in year fifteen of the Project’s operational life, Regal will either create a reserve fund, enter into a surety bond agreement, create an escrow account, or provide another form of security that will ultimately fund decommissioning and site restoration costs after Project operations cease, to the extent that the salvage value does not cover decommissioning costs. The exact amount to be allocated for decommissioning will be determined by a third-party study in year fourteen that will assess the difference between estimated decommissioning costs and the salvage value.