Exhibit G

Materials Analysis

Bakeoven Solar Project
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Prepared for

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Acronyms and Abbreviations

Applicant	Bakeoven Solar, LLC
Facility	Bakeoven Solar Project
Mgal	million gallons
MW	megawatt
O&M	operations and maintenance
OAR	Oregon Administrative Rule
OERS	Oregon Emergency Response System
SPCC Plan	Spill Prevention, Control, and Countermeasure Plan
y^3	cubic yards

1.0 Introduction

Bakeoven Solar, LLC (Applicant) proposes to construct and operate a solar energy generation facility and related or supporting facilities in Wasco County, Oregon. This Exhibit G was prepared to meet the submittal requirements in Oregon Administrative Rule (OAR) 345-021-0010(1)(g).

2.0 Construction Materials Inventory

OAR 345-021-0010(1)(g) A materials analysis including:

(A) An inventory of substantial quantities of industrial materials flowing into and out of the proposed facility during construction and operation.

For the Bakeoven Solar Project (Facility), the Applicant will use photovoltaic solar modules composed of mono- or poly-crystalline cells supported on galvanized steel and aluminum components. The modules are inert and will not introduce any hazardous materials to Facility site. Each tracker will be supported by steel posts. Other on-site equipment will include overhead and buried conduits, inverters, combiners, and transformers.

The Applicant is considering one of two battery options—lithium-ion batteries or a flow battery package. Regardless of the technology selected, batteries will be manufactured off site and will be shipped to the site as self-enclosed, prefabricated modules, which will be installed and electrically connected on site.

The primary construction materials for the Facility are rock, gravel, water, concrete, steel, and assorted electrical equipment. Table G-1 provides an inventory of materials that will be used during construction. The amount of water required for construction is provided in Exhibit O. Solid wastes generated and flowing out of the Facility during construction are discussed in Section 5.1 and outlined in greater detail in Exhibit V.

Table G-1. Inventory of Construction Materials

Material	Quantity/Units	Ultimate Disposition
Solar modules	951,900 modules	Throughout each solar module string
Solar modules per string	19 modules (38 modules per rack, 50,100 strings)	Throughout each solar module string
Aggregate (rock and gravel)	94,400 tons total	See below by location
• Battery storage	5,200 tons (10 acres)	On-site graveled area
• Inverters/Transformers	67 tons (153 stations)	On-site graveled area
• Access roads	65,118 tons (24.3-miles, new and existing)	On-site graveled area
• Substation	10,332 tons (3 acres)	On-site graveled area

Material	Quantity/Units	Ultimate Disposition
• O&M building	3,283 tons (3 acres)	On-site graveled area
• Staging areas	10,400 tons (10 acres each, 3 staging areas)	On-site graveled area
Concrete	50,439 cubic yards (yd^3) total	See below by location
• Battery storage	2,038 to 4,077 yd^3 (19.6 yd^3 per pad)	Foundation
• Solar array (tracker posts)	45,090 yd^3	Foundation
• Inverters/Transformers	2,233 yd^3 (153 stations)	Foundation
• Substation	985 yd^3	Foundation
• O&M building	93 yd^3	Foundation
Steel solar module tracker posts	150,300 posts, 11,273 tons steel (150 pounds per post)	Throughout each solar module string
Steel battery containers	208 containers, 832 tons steel (4 tons per container)	Battery storage system
Lithium-ion battery racks	950 racks	Battery storage system
Combiner boxes	25,050 boxes	Aboveground throughout each solar module string
Collector lines (overhead [OH] and underground [UG])	27.2 miles (23 miles UG, 4.2 miles OH)	Between solar array and substation, buried underground or aboveground structure
Transmission line	11 miles	Between collector substation and Maupin Interconnection Substation
Inverter/transformers	153 (2-MW) stations	Aboveground throughout solar array
Fencing	117,744 feet	Will remain around solar area

2.1 Rock and Gravel

Road construction will use rock and gravel (aggregate) for new, permanent access roads, as well as improvement to existing roads. Rock and gravel will also be used as ground-surfacing material for the battery storage area, around inverter/transformer stations in the solar array, and for the collector substation, the operations and maintenance (O&M) building, and the staging areas. Table G-1 above provides the estimated tons of aggregate for each of these purposes.

The gravel placed at staging areas will be removed following construction. The construction contractor will acquire the rock and gravel from existing or new commercial gravel pit sources in Wasco County.

2.2 Water and Concrete

Concrete will be required to lay foundations for the battery storage containers, solar array tracker system posts, inverter/transformer stations, collector substation, and O&M building (Table G-1). This analysis conservatively assumes that all posts for the solar tracker system will require concrete foundations; however, the actual foundation method may vary depending on the final tracker system and site-specific geological conditions.

Water will be required during construction for dust control, road compaction, concrete mixing, and drinking/sanitation. The amount of water needed for construction will depend on site weather conditions during the construction period, as well as the final design of Facility components. Exhibit O provides detail on water quantities, assumptions, and sources.

2.3 Steel

Large quantities of steel will be needed for the solar array, as listed in Table G-1. The estimate is based on the proposed solar array layout using 150,300 steel posts to support the solar module trackers. Each post is assumed to have an average length of 10 feet, requiring 150 pounds of steel per post.

Steel containers will house the battery storage system. The amount of steel will vary depending on the type and configuration of the battery system. However, this analysis assumes that 208 containers will be used, each requiring approximately 4 tons of steel. The associated quantity of steel is listed in Table G-1.

2.4 Other Typical Construction Materials

A number of other materials will be brought on site to construct the solar array, battery storage system, and other related or supporting facilities (Table G-1). Electrical cable and combiner boxes will be used to connect the solar strings within the array and to the collector substation. The solar array will be constructed from prefabricated solar modules composed of mono- or poly-crystalline cells supported on galvanized steel and aluminum components. Depending on the battery technology selected, additional elements associated with the battery storage area will include fire-suppression systems and the batteries themselves. The Facility will include approximately 11 miles of new 230-kilovolt transmission line from the proposed collector substation to the existing Bonneville Power Administration Maupin Interconnection Substation. The transmission system will be aboveground (see Exhibit B for example support structures). The solar array will include up to 153 inverter and transformer stations, which will be placed together on the same slab of concrete. Chain-link fencing will be used to enclose the solar area (see Exhibit C, Figure C-2).

3.0 Operational Materials Inventory

Table G-2 provides an inventory of industrial materials that will be used in substantial quantity during operation of Facility elements.

Table G-2. Inventory of Operational Materials

Material	Quantity/Units	Ultimate Disposition
Lithium-ion batteries	4,750 racks	Disposed of at approved facility
Electrolyte solution (Flow batteries)	1.4 million gallons	Disposed of at approved facility
Transformer oil	Substation transformers: 49,385 gallons Solar array transformers: 37,332 gallons (244 gallons per station)	Within transformer boxes for cooling (No extra oil stored outside of transformers. Additional oil only required due to failure, provided on an as-needed basis.)

3.1 Solar Array and Collector Substation

No substantial quantities of industrial materials will be brought onto or removed from the Facility site during operations. The only materials that will be brought onto or removed from the site will relate to maintenance or replacement of damaged equipment (e.g., solar module components, electrical equipment). The materials replaced and removed will not constitute significant amounts. Table G-2 includes materials and amounts that will be used during operation of the transformers for the solar array and collector substation.

Solar modules may require periodic washing to minimize the effects of solar module dust and dirt on energy production (referred to as soiling). For the purpose of this analysis, it is conservatively assumed that all modules will be washed twice per year and require 475,950 gallons per wash, for a total of approximately 1 million gallons (Mgal) per year. Water will be applied via robotic panel cleaners and will not have any cleaning solvents in it. Washwater will be discharged by evaporation and seepage into the ground. See Exhibit O for further information.

3.2 Battery Storage System

The types and quantities of industrial materials used during operation of the battery storage system are listed in Table G-2. A lithium-ion system will require regular change out of batteries, as they degrade over time, whereas a flow battery system will need infrequent maintenance.

If a lithium-ion system is used, the batteries will be replenished at a rate depending on usage. For example, a battery that is cycled more often will degrade faster than one that is used less often. For this analysis, it is assumed that the battery will be fully discharged each day and that all batteries will need to be replaced every 7 years, or 5 times over the life of the Facility (40 years). This assumption likely overestimates the number of batteries that will flow into and out of the Facility, because not all batteries will be replaced during each replenishment cycle (e.g., fewer batteries will need replacing early in the Facility life). A group of lithium-ion battery cells will comprise a “rack.” Because approximately 950 battery racks will be needed for the proposed 100-megawatt (MW) storage system, 4,750 battery racks will be used over operation term of the battery storage system.

Lithium-ion battery systems typically are air cooled, and do not have a liquid component. However, some lithium-ion battery systems are liquid cooled, such as the Tesla Powerpack, which uses coolant similar to automotive antifreeze. The coolant, if used, is recirculated through a closed system to cool the batteries.

If a flow battery system is used, it will require infrequent replacement of the electrolyte solutions because there is negligible degradation of the battery (i.e., electrolyte solutions) over time. This analysis assumes 7,000 gallons per 1 MW of electrolyte solution will be needed every 20 years. For the proposed 100 MW battery system, about 1.4 Mgal of solution will be replaced during the life of the Facility.

4.0 Hazardous Substances

OAR 345-021-0010(1)(g)(B) The applicant's plans to manage hazardous substances during construction and operation, including measures to prevent and contain spills.

4.1 Construction Materials

Potentially hazardous materials that will be used for construction include paint, unused solvents, and spent vehicle and equipment fluids and components (e.g., used oil, used hydraulic fluids, spent fluids, oily rags, and spent lead-acid or nickel-cadmium batteries). During construction, on-site fuel storage may be placed in designated areas within the temporary staging areas. Secondary containment and refueling procedures for on-site fuel storage will follow the contractor's Spill Prevention, Control, and Countermeasure Plan (SPCC Plan).

Hazardous materials will be used in a manner that is protective of human health and the environment, and will comply with all applicable local, state, and federal environmental laws and regulations. Accidental releases of hazardous materials will be prevented or minimized through proper containment of these substances during use and transportation to the Facility site as described in the SPCC Plan.

In the unlikely event of an accidental hazardous materials release, any spill or release will be cleaned up and the contaminated soil or other materials impacted by the spill will be disposed of and treated according to applicable regulations as described in the SPCC Plan. As specified in the contractor's SPCC Plan, spill kits with absorbents, absorbent pads, spill socks, and disposable bags will be maintained in close proximity to construction activities. Any reportable spills will be immediately called in to the Oregon Emergency Management Division's Oregon Emergency Response System (OERS), per OAR Chapter 340 Division 142. See Exhibit CC for a listing of applicable regulations.

4.2 Operational Materials

Hazardous materials will be used in a manner that is protective of human health and the environment and will comply with all applicable local, state, and federal environmental laws and regulations. Use of the battery storage system may include hazardous substances within internal battery components; however, batteries are considered non-hazardous equipment when used according to the recommendations of the manufacturer and as long as their integrity is maintained (not damaged and internal seal is intact). While lithium-ion batteries can present a flammability hazard and require cooling systems to prevent overheating, flow batteries use an electrolyte solution that is nonflammable and nonexplosive, and do not require an associated cooling system. The battery storage system, regardless of type, will have intergraded safety systems that monitor battery performance to detect malfunctions and implement response measures (such as notifying operators, depowering the system, or deploying fire suppression devices). Batteries will be housed in leak-proof containers to prevent inadvertent releases of hazardous materials. O&M staff will conduct periodic inspections of the battery cells for damage.

Small quantities of lubricants, degreasers, herbicides, or other chemicals may be stored in the O&M building. Storage of these chemicals will follow label instructions. No underground storage tanks will be installed at the O&M building. No extremely hazardous materials (as defined by 40 Code of Federal Regulations 355) are anticipated to be produced, used, stored, transported, or disposed of at this Facility during operation.

The Applicant will have an operational SPCC Plan to detail appropriate response measures. In the unlikely event of an accidental hazardous materials release, any spill or release will be cleaned up and the contaminated soil or other materials disposed of and treated according to applicable regulations. See Exhibit CC for a list of applicable regulations. The Applicant will report spills or releases of hazardous materials during operation as noted above to the OERS per reporting requirements detailed in OAR Chapter 340 Division 142.

For the replacement of batteries during operation, the Applicant will follow the handling guidelines of 49 Code of Federal Regulations 173.185 – Department of Transportation Pipeline and Hazardous Material Administration related to the shipment of lithium-ion batteries. The regulations include requirements for prevention of a dangerous evolution of heat, prevention of short circuits, and prevention of damage to the terminals. They also require that no battery will come into contact with other batteries or conductive materials. Licensed third-party battery suppliers will be responsible for transporting batteries to and from the Facility in accordance with applicable regulations.

Adherence to the requirements and regulations (including personnel training, safe interim storage, and segregation from other potential waste streams) will minimize safety hazards related to transport, use, or disposal of batteries.

5.0 Non-Hazardous Waste Materials

OAR 345-021-0010(1)(g)(C) The applicant's plans to manage non-hazardous waste materials during construction and operation.

5.1 Construction Materials

Waste construction materials generated from construction may include scrap steel, wood, concrete, excavated soil, and packaging material waste. Further information regarding waste materials is included in Exhibit V.

Construction will not require the use of specialized structures, systems, or equipment for waste management or disposal. Standard construction waste bins will be kept on site to keep construction debris until it is hauled off site by a licensed waste hauler (see Exhibit U for waste service provider information). Excess excavated material will be used to restore ground contours after construction, and to provide fill on site or be transported off site for disposal.

Waste concrete will consist of concrete solids contained in the concrete chute washout water. Washdown methods will be determined by the contractor, and may occur at contractor-owned batch plants or a designated concrete washout. Any excess concrete will be incorporated into the foundation, rather than disposal of the material. There will be no disposal of hardened waste concrete on site other than as described here.

Portable toilets will be provided for on-site sewage handling during construction and will be pumped and cleaned regularly by the construction contractor.

5.2 Operational Materials

Little solid waste will be generated from Facility operations. The solar array and battery storage system will rely on the O&M building for sanitation. Therefore, it will not generate any additional sewage streams. Administrative activities related to the solar array and battery storage system will be conducted at the O&M building. Office waste generated at the O&M building will be at the Wasco County Landfill or other local contractors. Sewage from the O&M building will be disposed of on site with a septic system.

Washing of solar panels will be conducted, but this limited quantity of washwater will evaporate or will infiltrate into the ground near the point of use (see Exhibit V). No additional industrial wastewater streams will be generated at the solar array.

If the flow battery system is selected, operation of the system will require periodic replacement of the electrolyte solution. Based on manufacturer descriptions, spent electrolyte fluid is nonhazardous, and can be treated and disposed of at a licensed facility.

6.0 Conclusion

Based on the information presented in this exhibit, the Applicant has satisfied the requirements of OAR 345-021-0010(1)(g).

7.0 Submittal Requirements and Approval Standards

7.1 Submittal Requirements

Table G-3. Submittal Requirements Matrix

Requirement	Location
OAR 345-021-0010(1)(f) A materials analysis including:	–
(A) An inventory of substantial quantities of industrial materials flowing into and out of the proposed facility during construction and operation.	Sections 2.0 and 3.0
(B) The applicant's plans to manage hazardous substances during construction and operation, including measures to prevent and contain spills.	Section 4.0
(C) The applicant's plans to manage non-hazardous waste materials during construction and operation.	Section 5.0

7.2 Approval Standards

OAR 345 Division 22 does not provide an approval standard specific to Exhibit G.