**Attachment B to Appendix 1**

**Interconnection Request**

**GENERATING FACILITY DATA**

**SOLAR PHOTOVOLTAIC (PV) GENERATION FACILITY APPLICATIONS**

**Note** – The following data request assumes that the PV inverter technology is similar to the inverter technology applicable for Type 4 wind turbine generators (see Attachment A Data Forms). PV solar applicants should modify the model data as appropriate for power flow, dynamics, and short-circuit simulation.

**1. One-line Diagram.** Should be similar to Figure 1 shown on this Attachment. Please include as separate attachment.

**2. Interconnection Transmission Line.**

|  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| * Line voltage = | |  | | | | | kV | | | | |
| * Line Conductor Size = | | | | | |  | | | | | kcmil | | | |  | | | (Type ACSR, etc.) | |  | | | (# Cond per Phase) | | |
| * Line Length = | | | |  | | | | miles | | | | | | | |
| * Line Thermal Rating = | | | | |  | | | | | MVA | | |  | | | | Amps @ | |  | | @ Cond Temp (deg C) | | | |
| * R = |  | | Ohm or | | | | | |  | | | | | pu on 100 MVA and line kV base (positive sequence) | | | | | | | | | |
| * X = |  | | Ohm or | | | | | |  | | | | | pu on 100 MVA and line kV base (positive sequence) | | | | | | | | | |
| * B = |  | | µmho or | | | | | |  | | | | | pu on 100 MVA and line kV base | | | | | | | |

**3. Main Substation Transformer.** (NOTE: If there are multiple transformers, data for each transformer should be provided. If final impedance data is not known at this time, the IC should supply typical data for use in completing the short-circuit portion of the System Impact Study (SIS).)

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| * Rating (ONAN/ONAF1/ONAF2): | | /     / | | | | | | | | | | MVA / MVA / MVA | | | | | |
| * Nominal Voltage for each winding (Low/High/Tertiary): | | | | | | /     / | | | | | | | | kV / kV / kV | | |
| * Winding Connections (Low/High/Tertiary): | | | | | /     / | | | | | | | | | | (e.g. Delta, Wye-gnd) | | | | |
| * HV DETC (NLTC), LTC or None: | | | | Available Taps: | | | |  | | | | | Operating tap: | | |  | | | kV | | |
| * Impedances: HV-LV, HV-TV, LV-TV, assuming 3-winding design, in per-unit on transformer self-cooled (ONAN) MVA Base Rating: | | | | | | | | | | | | | | | | | | | | |
| * Positive sequence Z1: | HV-LV: R1: | |  | | | pu | X1: | |  | pu |
|  | HV-TV: R1: | |  | | | pu | X1: | |  | pu |
|  | LV-TV: R1: | |  | | | pu | X1: | |  | pu |
| * Zero sequence Z0: | HV-LV: R0: | |  | | | pu | X0: | |  | pu |
|  | HV-TV: R0: | |  | | | pu | X0: | |  | pu |
|  | LV-TV: R0: | |  | | | pu | X0: | |  | pu |

**4. Collector System Equivalent Model.** This can be found by applying the equivalencing methodology described in Section 3.4 of the WECC WPP Power Flow Modeling Guide.

|  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| * Collector system voltage= | | |  | kV |  | | Equiv. Collector System Thermal Rating | |  | MVA |
| * R= |  | ohm or | | | |  | | pu on 100 MVA and collector kV base | | | |
| * X= |  | ohm or | | | |  | | pu on 100 MVA and collector kV base | | | |
| * B= |  | µmho or | | | |  | | pu on 100 MVA and collector kV base | | | |
| * **NOTE: Please include an electrical system one-line diagram which includes the collector system equivalences**. | | | | | | | | | | | | |

**NOTE:** Typical collector system equivalent impedances are shown in following table, and will be used if actual collector system data is not supplied by the IC.

**Typical Collector System Equivalent Impedance Data:**

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Plant Size  (MW Total) | Collector  Voltage | Feeder Ckt Make-up | R (pu) | X (pu) | B (pu) |
| 100 MW | 34.5 kV | All UG | 0.017 | 0.014 | 0.030 |
| 100 MW | 34.5 kV | 67% UG / 33% OH | 0.018 | 0.079 | 0.030 |
| 200 MW | 34.5 kV | Mostly UG / Some OH | 0.007 | 0.025 | 0.055 |
| 300 MW | 34.5 kV | Mostly UG / Some OH | 0.005 | 0.020 | 0.085 |

\*Per Unit (pu) values are on a 100 MVA base, and collector system kV base (34.5 kV).

**5. Solar PV Inverter Step-Up Transformer.** These are typically two-winding air-cooled transformers. If the proposed project contains different types or sizes of pad-mounted transformers, please provide data for each type.

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| * Rating: |  | | | MVA | | |
| * Nominal Voltage for each winding (Low/High): | | | | | | | | / | | | | | kV | | |
| * Winding Connections: | | | / | | | | | | | (Delta, Wye, Wye grounded) | | | |
| * Available Taps: | |  | | | | (please indicate fixed or DETC), Operating Tap: | | | | | | | | |  | | kV |
| * Positive sequence impedance (Z1): | | | | |  | | | | %, | |  | X/R on transformer self-cooled MVA | | | | | | |
| * Zero sequence impedance (Z0): | | | | |  | | | | %, | |  | X/R on transformer self-cooled MVA | | | | | | |

**6. PV Inverter Power Flow Data.**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| * Number of Inverters: | |  | | |
| * Nameplate Rating (each Inverter): | | | |  | | MW |
| * Inverter Manufacturer and Model: | | | |  | | |
| * Inverter Type: |  | | (Assumed to be Type 4; see Note 6.1 and 6.2 below) | | | | |

**For Type 4 Inverters:**

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| * Maximum (uncompensated) over-excited power factor (producing MVAR) at full load: | | |  | | |
| * Maximum (uncompensated) under-excited power factor (absorbing MVAR) at full load: | | |  | | |
| * Control mode: |  | (voltage control, fixed power factor) (See Note 6.2) | |
| * Please attach capability curve describing reactive power or power factor range from 0 to full output, including the effect of shunt compensation. | | | | |

**NOTE 6.1:**  PV Inverter Type 4 is assumed, per the following. Please indicate if an inverter other than typical Type 4 is to be used.

* Type 4 –Full converter interface

**NOTE 6.2:** Unless otherwise noted by the IC, Type 4 Inverters are assumed to operate either on: (1) **fixed power factor** mode for a wide range of output, aided by power factor correction capacitors (shunt compensation); or (2) **voltage control** mode with a suitable plant-level controller. Voltage control operation is preferred by the Transmission Provider, however, this feature is not always available. The data requested must reflect the PV Inverter capability that can be used in practice. Please consult with the manufacturer when in doubt. The interconnection study will determine the voltage control requirements for the project. PV Inverter reactive capability data can significantly impact study results and plant-level reactive compensation requirements.

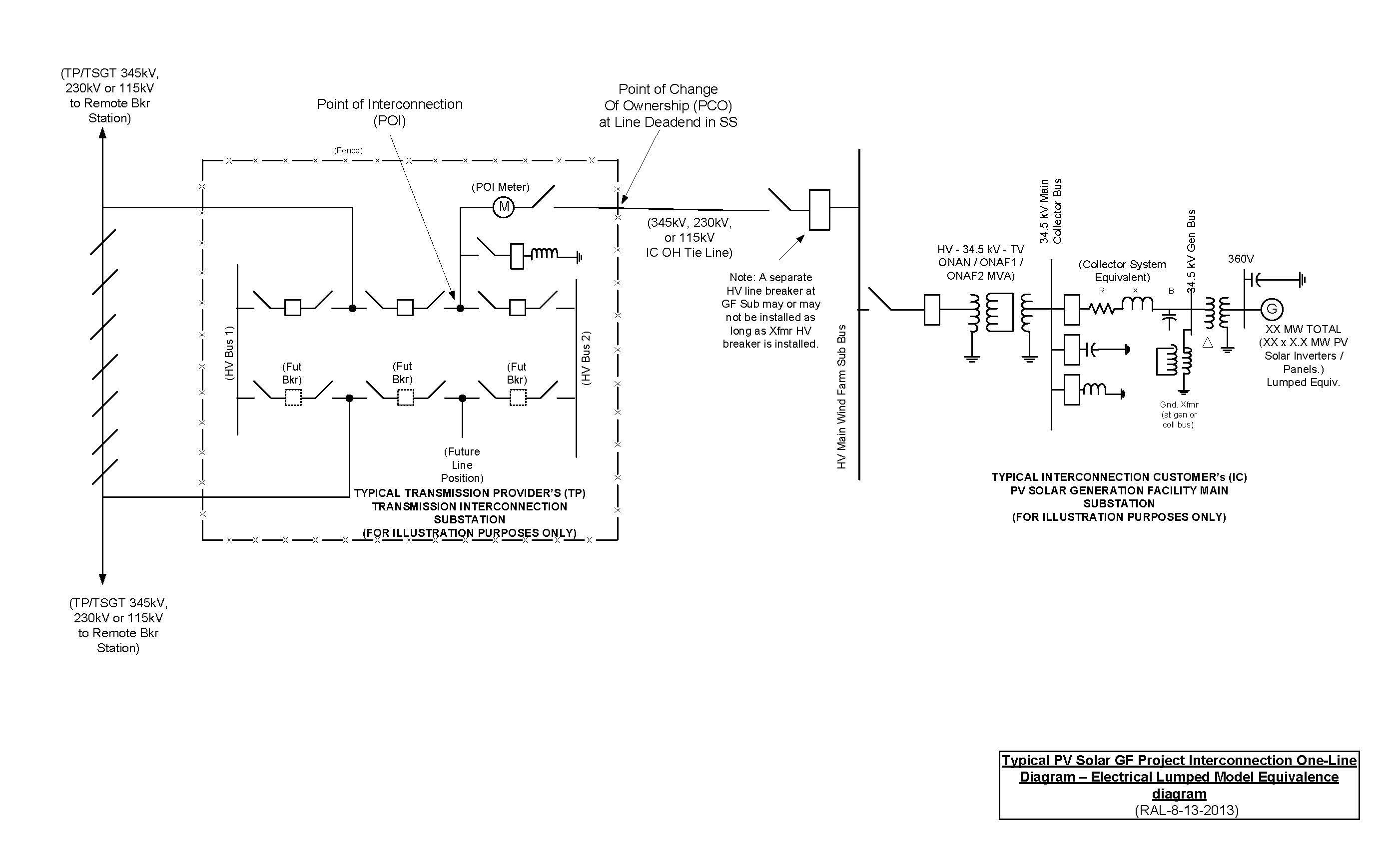
**7. PV Facility Reactive Power Compensation.** Provide the following for PV facility reactive compensation, if applicable, to supplement Invertor reactive capability in order to meet Transmission Provider’s (TP) reactive capability criteria:

|  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| * Individual shunt capacitor quantity and size of each: | | |  | | | | x |  | | MVAR | |
| * Individual shunt reactor quantity and size of each: | | |  | | | | x |  | | MVAR | |
| * Dynamic reactive control device, (SVC, STATCOM): | | | |  | | | | | | | |
| * Control range |  | | | | MVAR (lead and lag) | | | | |
| * Control mode (line drop, voltage droop, voltage control): | | | | | |  | | | | |
| * Regulation point | |  | | | | | | | (i.e. ref. bus voltage / name) | | | | |
| * Describe the overall reactive power control strategy: | | | | | | | | | | | | |

**8. PV Inverter Dynamic Data.** Model data required for transient stability analysis is specific to each PV Inverter make and model. The dynamic models supplied must be in an approved WECC format, specifically in Siemens-PTI PSS/E and GE PSLF software compatible electronic file formats that are acceptable to the transmission provider.

|  |  |  |
| --- | --- | --- |
| * Library model name: |  | |
| * Model type (standard library or user-written): | |  |
| * Model access (proprietary or non-proprietary): | |  |
| * Attach full model description and parameter data | | |
|  | | |
| **9. PV Inverter Short-Circuit Model Data.** Model and parameter data required for short-circuit analysis is specific to each PV Inverter make and model. All data to be provided in per-unit ohms, on the equivalent inverter MVA base.   * Inverter Equivalent MVA Base:       MVA * Short-Circuit Equivalent Pos. Seq. Resistance (R1), valid for initial 4 to 6 cycles:       p.u. * Short-Circuit Equivalent Pos. Seq. Reactance (XL1), valid for initial 4 to 6 cycles:       p.u. * Short-Circuit Equivalent Neg. Seq. Resistance (R2), valid for initial 4 to 6 cycles:       p.u. * Short-Circuit Equivalent Neg. Seq. Reactance (XL2), valid for initial 4 to 6 cycles:       p.u. * Short-Circuit Equivalent Zero Seq. Resistance (R0), valid for initial 4 to 6 cycles:       p.u. * Short-Circuit Equivalent Zero Seq. Reactance (XL0), valid for initial 4 to 6 cycles:       p.u. * Special notes regarding short-circuit modeling assumptions: | | |

**Figure 1 (Sample Generation Facility (GF) Interconnection One-Line Diagram)**

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