**REQUEST FOR PROPOSALS**

**FOR**

**RENEWABLE DISPATCHABLE GENERATION**

**AND ENERGY STORAGE**

**ISLAND OF O‘AHU**

JANUARY 20, 2023

Docket No. 2017-0352

# *Appendix H – Interconnection Facilities Cost and Schedule Information*

Hawaiian Electric

# TABLE OF CONTENTS

Section 1 – Cost Responsibilities ..... 1
1.1 – Definitions ..... 1
1.2 – Abbreviations ..... 1
1.3 – Facilities At Proposer Site ..... 2
1.4 – Proposer Facility Service Power and Company Switching Station Power ..... 2
1.5 – Remote Substation Facilities ..... 3
1.6 – Interconnection to Specific Company Sites ..... 4
1.7 – Line Extension from Grid Connection Point (GCP) To Proposer Site ..... 4
1.8 – T&D System Upgrades ..... 4
1.9 – Company-Owned Fiber ..... 5
1.10 – Telecommunication Facilities ..... 5
1.11 – Control System Acceptance Test (CSAT) ..... 6
1.12 – Proposer Payments ..... 6
Section 2 – Interconnection Requirements and Costs ..... 7
2.1 – Substation & Meter Baseline Costs ..... 7
A. Not Used ..... 7
B. Typical Subtransmission Interconnection ..... 7
C. Typical Transmission Interconnection ..... 8
2.2 – Interconnection to Specific Company Sites ..... 9
A. Waiau 46kV GIS Substation ..... 9
B. Company-Identified 138kV Sites ..... 10
C. Costs for Interconnection to Company-Identified 138kV Sites ..... 11
2.3 – T&D Baseline and Line Extension Costs ..... 12
A. Not Used ..... 12
B. Typical Subtransmission Interconnection Baseline ..... 12
C. Typical Transmission Interconnection Baseline ..... 13
D. Line Extensions and Upgrades ..... 14
46kV (O‘ahu) ..... 14
138kV (O‘ahu) ..... 14
E. Service Power ..... 15

2.4 – Project Management Baseline Costs ..... 16
A. Not Used ..... 16
B. Subtransmission Projects ..... 16
C. Transmission Projects ..... 16
2.5 – Typical Telecommunications Requirements and Costs ..... 17
A. Not Used ..... 17
B. Variable Projects ≥ 1 MW and ≤ 3 MW ..... 17
C. Variable Projects > 3 MW ..... 17
D. Firm Projects ..... 17
E. Projects Interconnecting to a Company Switching Station ..... 18
F. Telecommunications Baseline Costs ..... 18
Communications Cabinet or Enclosure ..... 18
Lease Line Options ..... 19
Fiber-Optic Cable Option ..... 19
Microwave Option ..... 19
Projects Interconnecting to a Company Switching Station Only ..... 20
2.6 – Typical Security Requirements and Costs ..... 20
A. Proposer Responsibilities at Proposer Facility ..... 21
B. Proposer Responsibilities for New Company-Owned Substations ..... 21
Section 3 – Proposer-Build Responsibilities ..... 22
3.1 – COIF at Proposer Site ..... 22
3.2 – COIF at Existing Company-Owned Substations ..... 23
3.3 – T&D Line Work ..... 23
3.4 – Telecommunications ..... 24
3.5 – Security ..... 25
Section 4 – Typical Company Durations for Interconnection Projects ..... 25
4.1 – Not Used ..... 25
4.2 – Subtransmission Projects ..... 25
4.3 – Transmission Projects ..... 26
4.4 – Additional Durations to Interconnect at an Existing Substation ..... 26

To assist Proposers in estimating costs of potential projects, the information provided in this document can be used to approximate the cost for Company-Owned Interconnection Facilities (COIF), including substation, telecommunications, security, transmission and distribution lines, and project management.

Tariff Rule No. 19, approved by the PUC, establishes provisions for Interconnection and Transmission Upgrades (https://www.hawaiianelectric.com/billing-and-payment/rates-and-regulations/). The tariff provisions are intended to simplify the rules regarding who pays for, installs, owns, and operates interconnection facilities in the context of competitive bidding. Tariff Rule No. 19 and applicable RFP requirements will be utilized as the basis for addressing interconnection and transmission upgrades for any projects developed. Proposers will comply with the terms and conditions as specified therein.

# SECTION 1 – COST RESPONSIBILITIES

The purpose of Section 1 is to clearly define the cost responsibilities of construction, replacements, and upgrades of Company-Owned Interconnection Facilities (COIF) and existing Company-owned facilities in compliance with Tariff Rule No. 19.

## 1.1 – DEFINITIONS

1. Betterment – Any upgrading to a facility made solely for the benefit of and at the election of the Company and is not required by applicable laws, codes, Company Standards, and the interconnection requirements in accordance with Tariff Rule No. 19.
2. Company – Hawaiian Electric, Maui Electric, or Hawai‘i Electric Light.
3. Company-Owned Interconnection Facilities – The equipment and devices owned by Company that are required to permit a generating facility to operate in parallel with and deliver electric energy to Company’s system and provide reliable and safe operation of, and power quality on, Company’s system.
4. Grid Connection Point – The point that the new interconnection facilities associated with the Proposer’s project interconnects to the Company’s existing electrical grid.
5. Interconnection Agreement – The executed contract between the Company and Proposer (e.g., Power Purchase Agreement, Standard Interconnection Agreement, etc.).
6. Point of Interconnection – The point of delivery of energy supplied by Proposer to Company, where the Facility owned by the Proposer interconnects with the facilities owned or to be owned by the Company.
7. Proposer – The developer proposing a renewable project in response to a Company RFP.

## 1.2 – ABBREVIATIONS

1. ADSS – All Dielectric Self-Supporting
2. COIF – Company-Owned Interconnection Facilities
3. CT – Current Transformer
4. DFR – Digital Fault Recorder

5. DTT – Direct Transfer Trip
6. FS – Facility Study
7. GCP – Grid Connection Point
8. HVAC – Heating, Ventilation, and Air Conditioning
9. IRS – Interconnection Requirements Study (includes both SIS and FS)
10. NDA – Non-Disclosure Agreement
11. OPGW- Optical Ground Wire
12. POI – Point of Interconnection
13. PT – Potential Transformer
14. RTU – Remote Terminal Unit
15. SCADA – Supervisory Control and Data Acquisition
16. SIS – System Impact Study
17. UFLS – Under-Frequency Load Shed

## 1.3 – FACILITIES AT PROPOSER SITE

1. Proposer shall be responsible for all costs related to COIF at the Proposer site required by any relevant Rule or Tariff, Request for Proposal, and/or the IRS. This may include, but is not limited to:
    a. Project management, design, permitting/regulatory fees and approvals, land rights, installation labor, inspection, construction management, and testing
    b. Site work (grading, trenching, manholes/handholes, conduits, cable trench, concrete pads/foundations, fencing, roadways/driveways, ground grid, lighting, etc.)
    c. Substation structures, design, and configuration (i.e., breaker and a half, ring bus, etc.)
    d. Control equipment enclosure/cabinet
    e. Equipment (circuit breakers, transformers, relays, switches, arresters, batteries, HVAC, RTU, DFR, DTT, meters, PTs, CTs, etc.)
    f. Telecommunication equipment (See Telecommunication Facilities section below)
    g. Electrical work (bussing, wiring, lightning protection, fiber optic cable, etc.)
    h. Security systems/equipment
2. Company shall be responsible for Betterment costs.

## 1.4 – PROPOSER FACILITY SERVICE POWER AND COMPANY SWITCHING STATION POWER

1. For all distribution-level service power, Proposer shall submit an Electrical Service Request Form via www.hawaiianelectric.com. Please refer to the Large Customer New Service Request brochure for milestones and estimated timeline.
2. Proposer shall be responsible for all costs related to providing service power to the Proposer's facility. Facility service power is NOT a part of COIF, but Proposers should account for it in the total costs to build the project.
3. Station power is required if a new Company switching station or substation is built to allow the interconnection of the Proposer's project. If station power is required, the

Proposer shall be responsible for all costs related to the primary and backup station power sources. This may include, but is not limited to:

a. Project management, design, permitting/regulatory fees and approvals, land rights, installation labor, inspection, construction management, and testing
b. Overhead electrical facilities (poles, conductor, insulators, crossarms, guy wires, transformers, etc.)
c. Underground electrical facilities (cables, splices, termination, grounding, transformers, switchgears, etc.)
d. Step-down transformer
e. Civil/structural work (survey, grading, trenching, conduits, manholes/handholes, concrete pads, concrete pier foundations, pole hole excavation, etc.)
f. Vegetation trimming and traffic control

4. Options for primary station power sources for the Company's various switching station voltages are:
   a. Tap off the bus through a step-down transformer for 23kV through 69kV
   b. 12kV line extension and service transformer for 23kV through 138kV
   c. Gensets are not an allowable substitute for the above options
5. Proposer shall be responsible for obtaining all permitting and land rights.

## 1.5 – REMOTE SUBSTATION FACILITIES

1. Proposer shall be responsible for all costs for work at remote substations caused by the interconnection of Proposer's project. This may include, but is not limited to:
   a. Project management, design, permitting/regulatory fees and approvals, land rights, installation labor, inspection, construction management, and testing
   b. Site work (grading, trenching, manholes/handholes, conduits, cable trench, concrete pads/foundations, fencing, roadways/driveways, ground grid, lighting, etc.)
   c. Substation structures
   d. New control equipment cabinet or existing enclosure expansion
   e. Equipment (circuit breakers, transformers, relays, switches, arresters, batteries, HVAC, DFR, DTT, meters, PTs, CTs, etc.)
   f. Electrical work (bussing, wiring, lightning protection, fiber optic cable, etc.)
   g. Telecommunications equipment
   h. Company has completed a high-level analysis to determine anticipated remote substation requirements prior to the RFP. Proposer may ask Company for a list of those requirements based on Proposer's indicated interconnection point after Proposer has signed a Non-Disclosure Agreement (NDA). Such requirements will be confirmed in the Interconnection Requirements Study.
2. Company shall be responsible for the following costs:
   a. Betterment
   b. Changes to the Under-Frequency Load Shed (UFLS) scheme

## 1.6 – INTERCONNECTION TO SPECIFIC COMPANY SITES

1. Proposer shall be responsible for all costs related to COIF required at the Company's site by any relevant Rule or Tariff, Request for Proposal, and/or the IRS. This may include, but is not limited to:
    a. Project management, design, permitting/regulatory fees and approvals, land rights, installation labor, inspection, construction management, and testing
    b. Site work (grading, trenching, manholes/handholes, conduits, cable trench, concrete pads/foundations, fencing, roadways/driveways, ground grid, lighting, etc.)
    c. Substation structures, design, and configuration (i.e., breaker and a half, ring bus, etc.)
    d. Control equipment enclosure/cabinet
    e. Equipment (circuit breakers, transformers, relays, switches, arresters, batteries, HVAC, RTU, DFR, DTT, meters, PTs, CTs, etc.)
    f. Telecommunication equipment (See Telecommunication Facilities section below)
    g. Electrical work (bussing, wiring, lightning protection, fiber optic cable, etc.)
    h. Security systems/equipment
2. Company shall be responsible for Betterment costs.

## 1.7 – LINE EXTENSION FROM GRID CONNECTION POINT (GCP) TO PROPOSER SITE

1. Proposer shall be responsible for all costs related to the line extension between the GCP and the Proposer site. This may include, but is not limited to:
    a. Project management, design, permitting/regulatory fees and approvals, land rights, installation labor, inspection, construction management, and testing
    b. Overhead electrical facilities (poles, conductor, insulators, crossarms, guy wires, etc.)
    c. Underground electrical facilities (cables, splices, terminations, grounding, transformers, switchgears, etc.)
    d. Civil/structural work (survey, grading, trenching, conduits, manholes/handholes, concrete pads, concrete pier foundations, pole hole excavation, etc.)
    e. Company fiber (ADSS fiber, OPGW shieldwire, splice boxes, etc.)
    f. Vegetation trimming and traffic control
2. The Company shall be responsible for the following costs:
    a. Betterment

## 1.8 – T&D SYSTEM UPGRADES

1. Proposer shall be responsible for all costs related to system upgrades or changes required to accommodate the Proposer's project (e.g., reconductoring or recircuiting of existing lines that do not have the required ampacity, re-fusing or re-programming of protective devices upstream of the GCP, etc.).

## 1.9 – COMPANY-OWNED FIBER

1. If Company-owned fiber is used to satisfy the communications requirements in the IRS, then the Proposer shall be responsible for all costs related to routing the ADSS fiber or OPGW from the nearest existing splice point to the Proposer site. This may include, but is not limited to:
    a. Project management, design, permitting/regulatory fees and approvals, land rights, installation labor, inspection, construction management, and testing
    b. Company fiber-optic cable (ADSS fiber cable or OPGW shieldwire) and associated equipment/hardware (splice boxes, innerduct, vibration dampers, etc.)
    c. Splicing and Testing of fiber strands
    d. Pole replacements and additional equipment if needed for additional capacity
    e. Civil/structural work (survey, grading, trenching, conduits, manholes/handholes, concrete pads, concrete pier foundations, pole hole excavation, etc.)
    f. Vegetation trimming and traffic control
2. Company will provide the location(s) of the nearest fiber splice point(s) after the Proposer has signed a Non-Disclosure Agreement (NDA).
3. Company shall be responsible for Betterment costs.

## 1.10 – TELECOMMUNICATION FACILITIES

1. Telecommunication Cabinet
    a. If a control equipment enclosure will not be built, the Proposer shall be responsible for all costs related to installing a telecommunication cabinet required to accommodate the telecommunication equipment at the Proposer's facility. This may include, but is not limited to equipment racks and ancillary infrastructure, 48V DC Power System (includes 48V DC Charger w/ at least 12-hr battery backup), alarming, and air conditioning.
2. Telecommunication Power
    a. Proposer shall be responsible for all costs related to providing reliable 48V DC power to Company equipment at a new Company switching station or a Proposer-owned station. This may include, but is not limited to battery racks, banks, fuse panels, and associated power system equipment.
3. Fiber Termination Equipment
    a. If Company-owned fiber is used to satisfy the communication requirements in the IRS, then the Proposer shall be responsible for all costs related to terminating the ADSS fiber or OPGW at the new Company switching station and point of interconnection to Company's existing system. This may include, but is not limited to a fiber termination panel and associated equipment/hardware (fiber guide, splice trays, connectors, etc.).
4. Microwave Radio or Wireless Radio
    a. If Company-owned microwave radio (6GHz, 10/11 GHz, etc.) or Company-owned wireless radio (900MHz, 450MHz, etc.) is used to satisfy the communications requirements in the IRS, then the Proposer shall be

responsible for all costs related to installing the microwave or wireless radio/link at the new Company switching station and remote site(s). This may include, but is not limited to:

i. Pre-design requirements (path survey/engineering, FCC frequency coordination, licensing, filings, EME study if required, etc.)
ii. Project management, design, permitting, regulatory fees and approvals, land rights, labor, inspection, construction management, and testing
iii. Pole or tower facilities to support the microwave dish and its connection to the microwave equipment (waveguide, cables, conduit, etc.)
iv. Civil/structural work (survey, grading, trenching, conduits, manholes/handholes, concrete pads, concrete pier foundations, pole hole excavation, etc.)
v. Antenna system design and installation

5. Leased Service
   a. If 3rd party leased service will provide telecommunication connectivity to the new Company switching station, then the Proposer shall be responsible for all costs related to ordering and installing the leased service at the site. This may include, but not be limited to the initial cost to establish the leased line(s) required for the project, monthly recurring leased cost of the service(s), and on-going maintenance of the service(s).
6. Telecommunication Service Equipment
   a. Telecommunication equipment is required to provide circuits to support the various applications at the new Company switching station. The Proposer shall be responsible for all costs related to installing the telecommunication equipment. This may include, but is not limited to:
      i. Project management, design, installation, and testing
      ii. Telecommunication routers, multiplexors, and associated equipment/hardware

## 1.11 – CONTROL SYSTEM ACCEPTANCE TEST (CSAT)

1. Proposer shall be responsible for all costs related to the CSAT, including all Company costs in support of the Proposer's CSAT.

## 1.12 – PROPOSER PAYMENTS

1. The Company shall require upfront payment prior to the commencement of any phase of work based on an estimate of Company costs for that phase. A true-up at the end of the project shall be completed and a refund or bill shall be processed in accordance with the Interconnection Agreement when necessary.
2. Proposer is also responsible for payments to the Company related to service contracts for service power.

# SECTION 2 – INTERCONNECTION REQUIREMENTS AND COSTS

The information in Section 2 is based on typical interconnections as shown in the Attachments referenced. Conceptual design is not intended to cover all interconnection requirements. Final interconnection design will be subject to the results of a technical review. The per-unit cost figures below should not be used to create a detailed project estimate. A detailed project estimate typically requires a certain level of engineering to assess project site conditions and to factor in other parameters specific to the project.

The Proposer should identify the components assumed for their project and the quantity assumed for each. Each table below provides notes on the assumptions for each of the unit cost estimates. If a Proposer's project requirements are different than what is assumed in the notes, the Proposer should identify each difference and provide an estimated additional cost or savings resulting from those differences. Please see Attachment 1 for examples of how to apply the per-unit costs provided. All costs provided are Company costs only and do not include costs related to Proposer responsibilities including, but not limited to, permitting, land rights, community outreach, biological and/or cultural (archeological) surveys. Proposers should do their own due diligence for these costs.

For the purposes of Section 2, voltages are classified as follows:

- Subtransmission – 46kV
- Transmission – 138kV

## 2.1 – SUBSTATION & METER BASELINE COSTS

### A. Not Used

### B. Typical Subtransmission Interconnection

The costs in Section 2.1B are reflective of typical standard interconnections to existing circuits at subtransmission voltages. Costs for interconnection to specific Company sites are shown in Section 2.2. Costs are for Proposer-Build projects.

| Item | Description | Cost |
|---|---|---|
| 15 | Attachment 2 – 46kV Variable Project | $403,000 |
| 16 | Attachment 3 – 46kV Firm Project | $1,041,000 |
| **Remote Sub Work** | | |
| 21 | For Radial Circuits – Components at Company's 46kV remote substation, including DTT and relaying requirements | $435,000 / site |
| 22 | For Paralleled Circuits – Components at Company's 46kV remote substation, including DTT and Relay Upgrades | $561,000 / site |

| Item | Description | Cost |
|---|---|---|
| Notes:<br>a) Costs provided are in 2022 dollars.<br>b) Includes Company costs for engineering, materials, construction, and testing for Company-responsible items (See Section 3) related to Substation & Meter components as shown in the referenced attachment.<br>c) Does NOT include T&D, Project Management, Telecommunications, or Security costs.<br>d) Civil infrastructure and space for COIF for Items 15 and 16 provided by Proposer.<br>e) Substation relay protection requirements have not been identified so costs are based upon typical line protection relaying requirements.<br>f) Does not include costs for permitting, land rights, or a Relay Coordination Study.<br>g) For T&D costs (including service power costs) – See Section 2.3.<br>h) For Project Management costs – See Section 2.4.<br>i) For Telecommunications costs – See Section 2.5.<br>j) For Security requirements – See Section 2.6. | | |

## C. Typical Transmission Interconnection

The costs in Section 2.1C are reflective of typical standard interconnections to existing circuits at transmission voltages. Costs for interconnection to specific Company sites are shown in Section 2.2. Costs are for Proposer-Build projects.

| Item | Description | Cost |
|---|---|---|
| **At New 138kV Switching Station** | | |
| 32 | Attachment 4 – 138kV Interconnection to Two (2) Existing Circuits (4-Bay BAAH configuration) | $2,105,000 |
| **Remote Sub Work** | | |
| 36a | 138kV line relay upgrades | $452,000 each |
| 36b | 138kV circuit breaker replacement | $569,000 each |
| 36c | DTT for anti-islanding | $108,000 each |
| Notes:<br>a) Costs provided are in 2022 dollars.<br>b) Includes Company costs for engineering, materials, construction, and testing for Company-responsible items (See Section 3) related to Substation & Meter components as shown in the referenced attachment.<br>c) Item 32 is required for all interconnections to existing 138kV lines. Please contact Company for more information on if Items 36a-c are required for a proposed GCP.<br>d) Does NOT include T&D, Project Management, Telecommunications, or Security costs.<br>e) Civil infrastructure and space for COIF for Item 32 provided by Proposer.<br>f) Substation relay protection requirements have not been identified so costs are based upon typical line protection relaying requirements.<br>g) Does not include costs for permitting, land rights, or a Relay Coordination Study.<br>h) For T&D costs (including service power costs) – See Section 2.3.<br>i) For Project Management costs – See Section 2.4.<br>j) For Telecommunications costs – See Section 2.5.<br>k) For Security requirements – See Section 2.6. | | |

| Item | Description | Cost |
|---|---|---|
| | | |

## 2.2 – INTERCONNECTION TO SPECIFIC COMPANY SITES

Section 2.2 includes baseline costs for interconnection at specific Company sites identified in the RFP. Attachments 5-12 of Appendix H will be provided to Prospective Proposers who request the information via the communication method identified in Section 1.6 of the RFP and upon execution of an NDA as specified in Section 3.12.1 of the RFP. If a site is not specifically identified in the RFP, please use the typical costs in the previous sections for the applicable voltage and project size. Costs are for Proposer-Build projects. See Section 3 for responsibilities.

### A. Waiau 46kV GIS Substation

Please refer to Attachment 5 for a single line diagram depicting the required interconnection to the Company's system at the Waiau 46kV GIS Substation. There are two (2) terminations available for use with the planned retirement of Waiau 3 & 4. Proposers should assume the new GIS substation will be completed by mid-2025. Costs shown assume a Proposer-Build project.

| Item | Description | Cost |
|---|---|---|
| **At Proposer's Project Site** | | |
| 40a | Company work for components at the Project Site on the Company side of the demarcation as shown in Attachment 5 | $403,000 |
| **At Existing Waiau 46kV GIS Substation** | | |
| 40b | 1st Termination – Terminate into existing spare breaker position. Utilize existing spare GIS breaker, switches, PTs and CTs | $213,000 |
| 40c | 2nd Termination – Add new GIS breaker and associated equipment into existing open bay position | $814,000 |

| Item | Description | Cost |
|---|---|---|
| Notes:<br>a) Costs provided are in 2022 dollars.<br>b) Includes Company costs for engineering, materials, construction, and testing for Company-responsible items (See Section 3) related to Substation & Meter components as shown in the referenced attachment.<br>c) Does NOT include T&D, Telecommunications, or Security costs.<br>d) Civil infrastructure and space for COIF for Item 40a provided by Proposer.<br>e) Substation relay protection requirements have not been identified so costs are based upon typical line protection relaying requirements.<br>f) Does not include costs for permitting, land rights, or a Relay Coordination Study.<br>g) For T&D costs (including service power costs) – See Section 2.3. Add Item 123 (1st and 2nd termination) for costs to riser into the substation.<br>h) For Project Management costs – See Section 2.4.<br>i) For Telecommunications costs – See Section 2.5.<br>j) For Security requirements – See Section 2.6.<br>k) For typical durations to support Proposer-Build facilities – See Section 4.2.<br>l) For additional durations to interconnect at Waiau 46kV GIS Substation – See Section 4.4. | | |

## B. Company-Identified 138kV Sites

The following table provides details about interconnecting to the available substations and how to apply the per unit costs to each site. Each termination is limited to the 142MW Single Point of Failure limit.

| Existing 138kV Substations Available for Interconnection |
|---|
| **AES Substation (Attachment 6)**<br>• Only available if replacing the existing IPP generation interconnected to this substation.<br>• 1st Termination – Available after AES decommissioned. Add Item 45.<br>• 2nd Termination – Space for additional BAAH bay with substation expansion. Add Items 42, 43, and 46. |
| **Ewa Nui Substation (Attachment 7)**<br>• Space for two (2) terminations is available. Routing new 138kV lines into the substation may be difficult due to future planned buildout around the existing substation. One (1) new BAAH bay required for each termination. Add Item 43 for each termination. |
| **Kahe Substation (Attachment 8)**<br>• Space for three (3) terminations is available. One (1) new BAAH bay required for each termination. Add Item 43 for each termination. |
| **Hoohana Substation (Attachment 9)**<br>• Assumes substation is completed (scheduled for 2023)<br>• Space for three (3) terminations is available.<br>• 1st Termination – Terminate into open position. Add Item 44.<br>• 2nd Termination – Expand substation perimeter for two (2) additional BAAH bays. Cut and terminate Kahe-Halawa 2 circuit into substation. Add one (1) full BAAH bay with two (2) terminations, one (1) BAAH bay with one (1) termination, and a new control house. Add Items 42 (x2), 43 (x2), 44, 46, and 47.<br>• 3rd Termination – Terminate interconnecting line to last open position. Add Item 44. |

| Existing 138kV Substations Available for Interconnection |
|---|
| **Waiau 138kV Substation (Attachment 10)**<br>• Four (4) terminations available (to replace existing Waiau 5 & 6 and/or Waiau 7 & 8 generation units).<br>• Add item 45 for each. |
| **CEIP Substation (Attachment 11)**<br>• One (1) termination is available. Routing new 138kV lines into the substation may be difficult due to future planned buildout around the existing substation. Add one (1) new BAAH bay with new termination. Add Item 43. |
| **Koolau Substation (Attachment 12)**<br>• One (1) termination is available. Add two (2) new breakers to an existing BAAH bay. Add Item 44 (x2).<br>• Routing lines to this site may be difficult due to permitting issues. |

## C. Costs for Interconnection to Company-Identified 138kV Sites

The following table provides the per unit costs of typical items required for interconnecting at the identified existing substations.

| Item | Description | Cost |
|---|---|---|
| **At Proposer's Project Site** | | |
| 41 | Company work for components at the Project Site on the Company side of the demarcation as shown in Attachments 6-12 | $408,000 |
| **At Existing Company Substation** | | |
| 42 | Expansion of substation perimeter (per BAAH bay)<br>• Includes grading, fencing, and ground grid | $500,000 |
| 43 | Add BAAH bay with one (1) new termination<br>• Includes 2 breakers, PTs, switches, structures, and relays<br>• Assumes no control house expansion needed | $2,975,000 |
| 44 | Add termination to an existing BAAH bay<br>• Includes 1 breaker, PTs, and relays | $1,151,000 |
| 45 | Replace existing termination for generation being retired<br>• Assumes line relays need to be upgraded but high voltage equipment and structures do not need to be replaced | $452,000 |
| 46 | New control house | $2,000,000 |
| 47 | Cut and terminate Kahe-Halawa 2 circuit into Hoohana Substation<br>• Includes 3 steel poles, 740 circuit feet of OH conductor, and undergrounding 270 feet of existing lines to accommodate OH termination | $3,557,000 |

Notes:
a) Costs provided are in 2022 dollars.
b) Includes Company costs for engineering, materials, construction, and testing for Company-responsible items (See Section 3) related to Substation & Meter components as shown in Attachments 6-12.
c) Does NOT include Telecommunications or Security costs.
d) Does NOT include T&D costs for the gen-tie line.

| Item | Description | Cost |
|---|---|---|
| | e) Civil infrastructure and space for COIF for Item 41 and 47 provided by Proposer.<br>f) Substation relay protection requirements have not been identified so costs are based upon typical line protection relaying requirements.<br>g) Does not include costs for permitting, land rights, or a Relay Coordination Study.<br>h) For T&D costs (including service power costs) – See Section 2.3.<br>i) For Project Management costs – See Section 2.4.<br>j) For Telecommunications costs – See Section 2.5.<br>k) For Security requirements – See Section 2.6.<br>l) For typical durations to support Proposer-Build facilities – See Section 4.3.<br>m) For additional durations to interconnect at an existing substation – See Section 4.4. | |

## 2.3 – T&D BASELINE AND LINE EXTENSION COSTS

### A. Not Used

### B. Typical Subtransmission Interconnection Baseline

The costs in Section 2.3B are the baseline T&D costs for interconnections at subtransmission voltages. It includes an OH or UG line extension as specified in the Item description below. For any extensions greater than the specified length, please add costs per Section 2.3D. Costs are for Proposer-Build projects.

| Item | Description | Cost |
|---|---|---|
| 120 | 46kV OH to OH Final Tap by Company (Attachments 2 and 3)<br>• Includes 1 wood pole, 1 span (100ft) OH line extension toward Proposer facility and assumes Proposer designs, procures, and installs the required gang-operated switch | $86,000 (1st tap)<br>$51,000 (2nd tap) |
| 121 | 46kV OH to UG Final Tap by Company (Attachments 2, 3, & 5)<br>• Includes 1 wood pole, 1 gang-operated switch, 100ft UG line extension and splice in Proposer-installed manhole | $241,000 (1st tap)<br>$188,000 (2nd tap) |
| 122 | 46kV UG to UG Final Tap by Company (Attachments 2 and 3)<br>• Includes cut and splicing in existing Company manhole, a 100ft UG line extension and terminations at a Proposer-installed riser pole for one set of cables, and 100ft UG line extension and splices in a Proposer-installed manhole | $263,000 (1st tap)<br>$210,000 (2nd tap) |
| 123 | 46kV Terminations to Existing Waiau 46kV GIS Substation<br>• Includes terminations at Waiau GIS Substation, cable racking under the GIS platform, 190ft UG line extension and splices at a Proposer-installed manhole<br>• Proposer is responsible for installing civil infrastructure connecting to the existing cable trench stubbed out 20ft from the south side of the GIS substation | $290,000 (1st termination)<br>$236,000 (2nd termination) |
| Notes:<br>a) Costs provided are in 2022 dollars. | | |

| Item | Description | Cost |
|---|---|---|
| | b) Includes Company costs for engineering, materials, construction, and testing of Company-responsible items. See Section 3 for Proposer-Build responsibilities.<br>c) Interconnection for variable RDG will require a final tap to one circuit (1st tap only).<br>d) Interconnection for firm RDG will require final taps to two circuits. Proposers should include a 1st and a 2nd tap cost as appropriate depending on the existing facilities in the area and/or the type of construction for any line extension.<br>e) OH or UG line extensions greater than specified length in the Item description – Add applicable costs per Section 2.3D.<br>f) OH/UG route and civil infrastructure drawings provided by Proposer.<br>g) Civil infrastructure (pads, MH/HHs, conduits, etc.) is designed, procured, and installed by Proposer.<br>h) Includes review of Proposer civil infrastructure designs and materials and inspection of Proposer civil infrastructure construction.<br>i) Does not include vegetation clearing, grading, dewatering, permitting or land rights. | |

## C. Typical Transmission Interconnection Baseline

The costs in Section 2.3C are the baseline T&D costs for interconnections at transmission voltages. It includes 100ft of OH or UG line extension. For any extensions > 100ft, please add costs per Section 2.3D. Costs are for Proposer-Build projects.

| Item | Description | Cost |
|---|---|---|
| 133 | 138kV OH to OH Final Tap by Company (Attachment 4)<br>• Includes 2 steel poles, 1 span (100ft) OH line extension from each new pole toward Proposer facility and the removal of existing conductors between the new poles | $962,000 per circuit |
| 135 | 138kV OH Final Span for Termination to Existing Substation by Company (Attachments 6-12)<br>• Includes 1 span (100ft) of 138kV conductors and 2 spans (100ft each) of shield wire from steel pole to substation termination structure | $100,000 each |
| 136 | 138kV UG Termination to an Existing Substation by Proposer (Attachments 6-12)<br>• Includes Company costs for Company-responsible items – See Section 3. | $34,000 each |
| Notes:<br>a) Costs provided are in 2022 dollars.<br>b) Includes Company costs for engineering, materials, construction, and testing of Company-responsible items. See Section 3 for Proposer-Build responsibilities.<br>c) Interconnection will typically require one of these items depending on the existing facilities in the area and/or the type of construction for any line extension.<br>d) OH or UG line extensions (if > 100ft) – Add applicable costs per Section 2.3D.<br>e) OH/UG route and civil infrastructure drawings provided by Proposer.<br>f) Civil infrastructure (pads, MH/HHs, conduits, etc.) is designed, procured, and installed by Proposer. | | |

| Item | Description | Cost |
|---|---|---|
| | g) Includes review of Proposer civil infrastructure designs and materials and inspection of Proposer civil infrastructure construction.<br>h) Does not include vegetation clearing, grading, dewatering, permitting or land rights. | |

## D. Line Extensions and Upgrades

The costs in Section 2.3D are typical per unit costs for T&D line extensions using typical assumptions based on the Company's current standards and practices. Costs are for Proposer-Build projects.

**46kV (O'ahu)**

| Item | Description | Cost |
|---|---|---|
| 160 | Additional 100ft 46kV OH Line Extension | $3,300 each |
| 161 | Additional 100ft 46kV UG Line Extension | $5,700 each |
| 165 | 46kV overbuild on existing accessible 12kV (200ft spans) | $1,293,000 / mile |
| 166 | 46kV overbuild on existing inaccessible 12kV (250ft spans) | $2,191,000 / mile |
| 170 | Upgrade existing 46kV OH lines (250ft spans, accessible) | $744,000 / mile |

Notes:
a) Costs provided are in 2022 dollars.
b) OH/UG route and civil infrastructure drawings provided by Proposer.
c) Civil infrastructure (pads, MH/HHs, conduits, etc.) designed, procured, and installed by Proposer.
d) Does not include vegetation clearing, grading, dewatering, permitting or land rights.
e) Includes Company costs for Company-responsible items – See Section 3.
f) Items 160 and 161 should be added to the T&D baseline costs for each additional 100ft of Proposer-Build OH or UG line that does not involve Company's existing energized facilities. Includes review and inspection of Proposer design/construction.
g) Items 165 and 166 includes Company costs to design/construct an OH line extension above Company's existing energized facilities and assumes all poles need to be replaced.
h) Item 170 includes Company costs to reconductor an existing Company line to a larger size as determined by the SIS and assumes no poles need to be replaced.

**138kV (O'ahu)**

| Item | Description | Cost |
|---|---|---|
| 175 | Additional 100ft OH Line Extension | $5,000 each |
| 176 | Additional 100ft UG Line Extension | $7,000 each |
| 180 | Overbuild on existing accessible 46kV (400ft spans, 2-556.5 AAC) | $6,190,000 / mile |
| 183 | Upgrade existing OH lines (400ft spans, accessible) | $1,231,000 / mile |

Notes:
a) Costs provided are in 2022 dollars.
b) OH/UG route and civil infrastructure drawings provided by Proposer.

| Item | Description | Cost |
|---|---|---|
| | c) Civil infrastructure (pads, MH/HHs, conduits, etc.) designed, procured, and installed by Proposer.<br>d) Does not include vegetation clearing, grading, dewatering, permitting or land rights.<br>i) Includes Company costs for Company-responsible items – See Section 3.<br>j) Items 175 and 176 should be added to the T&D baseline costs for each additional 100ft of Proposer-Build OH or UG line that does not involve Company's existing energized facilities. Includes review and inspection of Proposer design/construction.<br>k) Item 180 includes Company costs to design/construct an OH line extension above Company's existing energized facilities and assumes all poles need to be replaced.<br>l) Item 183 includes Company costs to reconductor an existing Company line to a larger size as determined by the SIS and assumes no poles need to be replaced. | |

## E. Service Power

Section 2.3E provides typical requirements and costs for distribution-level service power to the Proposer's facility and/or the proposed Company switching station. Execution of a proposal letter provided by Company in response to Proposer's electrical service request, and separate from the Interconnection Agreement, will be required for service power.

Service power to the Proposer's facility shall emanate from an existing distribution line via new Company overhead and/or underground facilities to the Proposer's service connection point.

For 138kV interconnections, primary station service power requires a line extension and a separate padmount transformer at the proposed Company switching station. Proposer is responsible for providing a backup station power source.

| Item | Description | Cost |
|---|---|---|
| 188 | Facility or Station Service Power<br>• Includes 100ft UG 12kV line extension of two (2) feeders and one (1) padmount transformer and assumes no switchgear is required | $84,000 each |
| 189 | Distribution OH accessible (200ft spans, #1/0 AAC) | $719,000 / mile |
| 190 | Distribution OH underbuild accessible (200ft spans, #1/0 AAC) | $441,000 / mile |
| 191 | Distribution OH inaccessible (250ft spans, #1/0 AAC) | $1,469,000 / mile |
| 192 | Distribution UG double feeder (200ft spans, #2 AL XLPE) | $1,048,000 / mile |
| 193 | Distribution 3ph double riser w/ fuses (including pole/anchor) | $41,000 each |
| Notes:<br>a) Costs provided are in 2022 dollars.<br>b) OH/UG route and civil infrastructure drawings provided by Proposer.<br>c) Civil infrastructure (pads, MH/HHs, conduits, etc.) is designed, procured, and installed by Proposer.<br>d) Does not include vegetation clearing, grading, dewatering, permitting or land rights.<br>e) Includes engineering, materials, construction labor for electrical work, and inspection for UG civil infrastructure. | | |

| Item | Description | Cost |
|---|---|---|
| | f) OH line extension – Add applicable costs per Items 189-191.<br>g) UG line extension (if > 100ft) – Add costs per Item 192.<br>h) Additional OH/UG transitions – Add costs per Item 193.<br>i) OH assumes wood poles and 3ph overhead conductor with neutral underbuild.<br>j) Item 190 assumes no poles need to be replaced.<br>k) Accessible assumes vehicles can be used during construction.<br>l) Inaccessible assumes helicopters are needed during construction. | |

For 46kV interconnections, the cost for primary and backup station power is included in the Substation baseline costs in Section 2.1B and assumes distribution-level service is not needed or preferred for station power.

## 2.4 – PROJECT MANAGEMENT BASELINE COSTS

Section 2.4 provides typical Project Management costs for interconnection projects which require a dedicated project manager. The total costs will be dependent on the Proposer's schedule and durations for engineering, construction, and testing/closeout.

### A. Not Used

### B. Subtransmission Projects

| Item | Description | Cost |
|---|---|---|
| 196 | Engineering Phase<br>• Includes facilitation, coordination, and support for Engineering Design and Procurement periods | $18,300 / month |
| | Construction Phase<br>• Includes facilitation, coordination, and support from the start of construction through back feed (energization) | $23,000 / month |
| | Testing/Closeout Phase<br>• Includes facilitation, coordination and support for Developer system testing and CSAT | $11,700 / month |
| Notes:<br>a) Costs derived using 2022 rates.<br>b) Total costs are tied to schedule and duration of the entire project.<br>c) The Closeout Phase shall extend 4 months past GCOD. | | |

### C. Transmission Projects

| Item | Description | Cost |
|---|---|---|
| 197 | Engineering Phase<br>• Includes facilitation, coordination, and support for Engineering Design and Procurement periods | $18,300 / month |

| Item | Description | Cost |
|---|---|---|
| | Construction Phase<br>• Includes facilitation, coordination, and support from the start of construction through back feed (energization) | $23,000 / month |
| | Testing/Closeout Phase<br>• Includes facilitation, coordination and support for Developer system testing and CSAT | $11,700 / month |

Notes:
a) Costs derived using 2022 rates.
b) Total costs are tied to schedule and duration of the entire project.
c) The Closeout Phase shall extend 4 months past GCOD.

## 2.5 – TYPICAL TELECOMMUNICATIONS REQUIREMENTS AND COSTS

Section 2.5 provides typical telecommunications requirements and costs for interconnection projects. The communications equipment will require a communications channel(s). Some options include lease line, fiber, or microwave.

### A. Not Used

### B. Variable Projects ≥ 1 MW and ≤ 3 MW

1. Primary communications links can consist of lease line, licensed radio, fiber, or microwave.
2. Back-up communications links are optional (can consist of lease line, licensed radio, fiber, or microwave).
3. Additional analog leased telephone lines are required to support revenue meters (Proposer shall do their own due diligence for costs on this).

### C. Variable Projects > 3 MW

1. Primary communications links can consist of lease line, fiber, or microwave.
2. Back-up communications links are required (can consist of lease line, licensed radio, fiber, or microwave).
3. Back-up communications links must be transport diverse until the "last mile" for projects greater than 10MW.
4. Additional analog leased telephone lines are required to support revenue meters (Proposer shall do their own due diligence for costs on this).
5. Project shall be capable of providing SCADA communications to both primary and backup System Operation Control Centers.

### D. Firm Projects

1. Primary communications links must be Company-owned fiber or microwave.

2. Back-up communications links are required (can consist of leased line or Company-owned fiber or microwave).
3. For interconnection to a new Company switching station, primary and back-up communications links must be transport diverse, with a minimum separation of 6 feet, to the new Company switching station.
4. For interconnection to an existing Company switching station, primary and back-up communications links must be transport diverse, with a minimum separation of 6 feet, from the existing Company switching station to the Proposer's substation.
5. Additional analog leased telephone lines are required to support revenue meters (Proposer shall do their own due diligence for costs on this).
6. Project shall be capable of providing SCADA communications to both primary and backup System Operation Control Centers.

## E. Projects Interconnecting to a Company Switching Station

1. If Proposer's substation is not adjacent to the proposed Company switching station, then Proposer is responsible for providing the communications links between the two (2) sites.
    a. If Proposer chooses to run fiber between the sites, Proposer will own the fiber from their site up to a splice box immediately outside of the Company switching station ("meet point"). Company will own fiber from the meet point to the termination into the Company switching station – See Item 220.
    b. All UG infrastructure will be designed, procured, and constructed by Proposer.
    c. If interconnection is to a new Company switching station, a communications cabinet may be required at both sites – See Item 202.
    d. If interconnection is to an existing Company switching station, a new communications cabinet will be required at the Proposer's substation and may be required at the existing Company switching station – See Item 202.
2. If Proposer's substation is adjacent to the proposed Company switching station, no additional Company costs are anticipated to be required for the Proposer's substation.

## F. Telecommunications Baseline Costs

The costs below are high level per unit costs for communications requirements in support of the Project. Sections 2.5A through 2.5E above provide typical scenarios of when these options may be utilized.

**Communications Cabinet or Enclosure**

| Item | Description | Cost |
|---|---|---|
| 201 | Communications Cabinet with circuits to support SCADA (Projects ≥ 1 MW and ≤ 3 MW)<br>• Projects with SCADA and DTT but no diverse communication circuits | $164,000 / site |
| 202 | Communications Cabinet with circuits to support SCADA, Relay Protection, monitoring devices, etc. | $192,000 / site |

| Item | Description | Cost |
|---|---|---|
| | • Projects with SCADA, DTT, and diverse communication circuits | |

Notes:
a) Costs provided are in 2022 dollars.
b) All projects that require communications will require facilities to store the communications equipment. The examples above are provided but other alternatives may be available upon request.
c) Cabinet is used to support Company equipment and capable of providing communications circuit for SCADA, DTT, monitoring devices, etc.
d) Communications cabinet cost does not include fiber, microwave equipment or lease circuits.
e) Proposer will provide all conduits, foundations, HHs, AC power, grounding as required per Company standards.

**Lease Line Options**

| Item | Description | Cost |
|---|---|---|
| 205 | Lease Line one-time and recurring costs | Will vary based on 3rd party provider |

Notes:
a) Add cost of Communications Cabinet – See Items 201-202.
b) Check with Company to understand the current lease line requirements.
c) Communication circuit requirements will be based on applications needed for the project.
d) Company can provide communication circuit interconnection requirements and assist with review of circuit order from the 3rd party provider as needed.
e) Proposer to work directly with 3rd party provider if a lease line circuit is needed.
f) Cost will be the responsibility of the Proposer and is to be negotiated with the 3rd party provider.

**Fiber-Optic Cable Option**

| Item | Description | Cost |
|---|---|---|
| 210 | New Fiber-only pole line (200' avg spans, 60-strand ADSS)<br>• Includes new wood poles | $312,000 / mile |
| 211 | Fiber underbuild on new or existing pole line (200' avg spans, 60-strand ADSS)<br>• Assumes no replacements of existing poles are needed | $166,000 / mile |

Notes:
a) Costs provided are in 2022 dollars.
b) Add cost of Communications Cabinet – See Items 201-202.
c) Assumes no splices are needed along the route.

**Microwave Option**

| Item | Description | Cost |
|---|---|---|
| 215 | Point-to-Point Microwave Link<br>• Includes 2 each antenna equipment to create a radio link | $697,000 / link |
| 216 | 50ft Microwave Tower | $612,000 each |
| 217 | 100ft Microwave Tower | $888,000 each |

Notes:
a) Costs provided are in 2022 dollars.
b) Add cost of Communications Cabinet – See Items 201-202.
c) Assumes there is radio line-of-site clearance between the communication endpoints.
d) Assumes FCC licensed microwave frequencies are available.
e) Assumes there are existing structures/buildings with space available on both ends to house the radio equipment.
f) Assumes Telecommunications grounding standards are up to date at both sites.
g) Assumes 48 V DC power with 12-hour battery backup is available.
h) Does not include special site-specific permit/approval activities that may be required including, but not limited to, Neighborhood Board(s), Conservation District Use Application, Environmental Assessment, Shoreline Management Area approval, biological (endangered species or habitat) surveys, and/or cultural (archeological) surveys or the cost of any migration required for approvals to be granted. Proposers should conduct their own due diligence for these costs.
i) Assumes space is available at both ends to construct antenna towers or structures that are rated to survive a Saffir-Simpson category 4 hurricane.
j) Other options for Microwave Towers of varying heights may be available.

**Projects Interconnecting to a Company Switching Station Only**

| Item | Description | Cost |
|---|---|---|
| 220 | Fiber from "meet point" to termination in Company switching station<br>• Assumes 24-strand fiber cable.<br>• Includes splicing, termination, and testing work.<br>• Civil infrastructure (HHs, conduits, etc.) is designed, procured, and installed by Proposer. | $31,000 |

Notes:
a) Costs provided are in 2022 dollars.
b) Required if the Proposer's substation is not adjacent to the Company switching station per Section 2.5E.
c) Assumes the "meet point" is within 500ft of the termination in the Company switching station.

## 2.6 – TYPICAL SECURITY REQUIREMENTS AND COSTS

Section 2.6 provides typical security requirements and costs for new facilities installed as a part of the interconnection. Security requirements and costs can vary based on many factors including, but not limited to, location, crime rate, environment, aspects of the surrounding

area, terrain, accessibility, layout of the facility, etc. The specific requirements for each facility will be subject to final review during the design and engineering phase. Additional information, including the Company's Physical Security Strategy, is available upon request after execution of an NDA with the Company.

## A. Proposer Responsibilities at Proposer Facility

The Proposer shall be responsible to incorporate security components and systems for **their facilities** that consider the Security Guidelines for the Electricity Sector (CIP-014-2): Physical Security, as published by the North American Electric Reliability Corporation (NERC) and that at a minimum, meet the requirements below.

For Company-owned facilities within the Proposer's Facility, Company requires:

1. Standard 8ft high security fence with 3-strand barbed wire V-top.
2. Interior mounted 4' high cattle fencing.
3. All gates will be secured using a proprietary padlock system.
4. Proposer-owned cabinets/enclosures housing Company equipment shall be secured with a lock provided by Company.
5. Company requires 24/7 access to Company facilities within the Proposer facility.

## B. Proposer Responsibilities for New Company-Owned Substations

Company-owned substations interconnecting firm generation typically require high levels of security due to the critical role they play in the Company's system which may include, but is not limited to:

1. Camera Monitoring – Proposer to procure and install all camera mounts and cameras. Specific models required for cameras, mounts, caps, and other associated hardware will be provided to Proposer after an NDA is executed with the Company. Company's Security Integrator will terminate cables, adjust, and optimize as needed.
2. Electronic Card Access System – For control & microwave houses, Proposer procures/mounts card access devices and installs any cables necessary. Company Security Integrator will terminate cables and program and test devices and peripherals.
3. Infrastructure – Conduits and associated electrical and junction boxes shall be installed by the Proposer as a part of the substation site development. Conduits shall be rigid PVC, dedicated for Security systems purposes only, and sealed properly from the origin to the termination point.
4. Cabling – Cabling shall be installed by the Proposer as a part of the substation site development and shall be of the type specified below for the applicable voltage. Company's Security Integrator will terminate both ends.
    a. 69kV Substations – CAT 5E
    b. 138kV Substations – CAT 6
5. Integrator – Company's Security Integrator will procure the server and necessary switches, terminate all ends, program the server, and set all fields of view for all camera shots.

6. Fencing – Schedule 40 galvanized fence post and fence fabric is required for fencing. The fencing shall be 8 feet high with heavy gauge support wire along the length of the bottom. 3-strand barbed wire shall be mounted atop the fence at a 45-degree angle on the inside and outside for the entire length of fence and gates.
7. Locks – All gates shall be secured using a proprietary padlock system. Company will provide physical padlocks for gates and electrical equipment.
8. Lighting – Motion and static lighting are necessary for additional safety and security deterrent measures and to enhance camera viewing at night. Proposer shall procure and install all lighting as a part of the substation site development. Motion LED lighting arrays shall be placed on all corners and entrances. Static LED lighting arrays shall be placed on the control house and throughout the yard to meet required lighting levels. Lighting shall be Dark Sky compliant.
9. Perimeter Intrusion Detection (138kV only) – Proposer shall procure and install devices and cables using a contractor that is trained and qualified to install the specified system. Company's Security Integrator will terminate cables, program, and test system. The specific models for the system will be provided to Proposer after execution of an NDA with the Company.

The costs below are the Company costs for the Company-responsible items above.

| Item | Description | Cost |
|---|---|---|
| 251 | Substation Security | $104,000 / site |

Notes:
a) Costs provided are in 2022 dollars.
b) Includes Company costs for internal labor, materials, and contractors to support design, installation, programming, and testing of all security systems.
c) Location has flat terrain, is accessible, and is rural with a moderate to low crime rate and little to no homeless population.
d) Fire break is not needed.

# SECTION 3 – PROPOSER-BUILD RESPONSIBILITIES

Section 3 defines Company and Proposer responsibilities for Proposer-Build interconnections.

## 3.1 – COIF AT PROPOSER SITE

Company will perform the following:
1. Review and approval of Proposer drawings and material selection.
2. Inspect Proposer construction.
3. Programming and functional testing of digital devices (i.e., DFR, RTU, etc.).
4. Terminate wiring between RTU and IPP interface cabinet.
5. Perform acceptance testing.
6. Procurement, installation, and testing of revenue meters.

Proposer is responsible for the following:

1. Design, procurement, and construction of:
    a. All COIF except what is identified above.
        i. Pull wiring between RTU and IPP interface cabinet and coil up on both ends.
    b. All civil infrastructure (conduits, equipment pads, etc.) at the Proposer facility.
2. As built drawings prior to acceptance testing.

## 3.2 – COIF AT EXISTING COMPANY-OWNED SUBSTATIONS

Company will perform all engineering, material procurement, and construction at existing Company-owned substations except as described below.

1. For a 138kV OH termination into an existing substation, Proposer is responsible for design, procurement, and construction of the OH T&D facilities from the project site up to and including the last pole/foundation before the substation termination structure.
2. For a 138kV UG termination into an existing substation, Proposer is responsible for design, procurement, and construction of the UG T&D lines and associated civil infrastructure up to the termination on the riser structure.

## 3.3 – T&D LINE WORK

Company will perform the following:

1. Review and approve Proposer drawings.
2. Inspection of Proposer construction.
3. Design, procurement, and construction of electrical facilities for the final tap at the GCP.
4. Design, procurement, and construction of electrical facilities within the existing Company right-of-way (i.e., where Company's energized facilities are).
5. Procurement does not include the conductors or cable required for the last span as discussed below.
6. Break into Company's existing UG facilities for interception point (i.e., at an existing MH/HH/vault)

Proposer is responsible for the following:

1. Route design of the OH or UG lines (locations of poles, MHs, HHs, vaults, conduits, equipment, etc.).
2. Design, procurement, and construction of:
    a. All civil infrastructure (vaults, manholes, conduits, equipment pads, etc.) between the Proposer facility and the GCP.
    b. All electrical facilities from the Proposer facility up to and including the last pole or manhole/vault prior to existing Company facilities.
3. For OH to existing OH final tap

   a. Coil enough OH conductor on the last pole for Company to string and terminate the last span of conductor to the GCP.
4. For UG tap to existing OH final tap
   a. Stub-up the riser conduit above ground level at the bottom of the riser pole.
   b. Pull cable to the last MH/HH/vault prior to the riser.
   c. Provide enough cable for Company to make the last pull up the riser and terminate the cables.
5. For UG tap to existing UG
   a. Conduits to connect to interception point provided by Company.
   b. Pull cable to the last MH/HH/vault prior to intercepting Company's existing facilities.

## 3.4 – TELECOMMUNICATIONS

Company will perform the following:

1. Review and approval of Proposer drawings.
2. Design, procurement, installation, and testing of network equipment such as routers, multiplexers and associated hardware required at Proposer Site, Company Switching Station and/or Remote Substation Facilities to provision circuits required for the project.
3. Design, procurement, and installation of fiber termination equipment within Company owned or managed facilities at Proposer Site, Company Switching Station and/or Remote Substation Facilities, as needed, to support the communication requirements.
4. Design, procurement, and installation of microwave radio within Company owned or managed facilities at Proposer Site, Company Switching Station and/or Remote Substation Facilities, as needed, to support the communication requirements.

Proposer is responsible for the following:

1. Preparation of drawings related to the installation of telecommunication equipment to be turned over for Company ownership and/or Company management, including telecommunications cabinets and/or racks and telecommunications power.
2. Design, procurement, and installation of telecommunications cabinets and/or racks at the Proposer site and/or Company Switching Station to support the telecommunications equipment, as well as supporting equipment including air conditioning, alarming equipment, ground bars and fuse panels.
3. Design, procurement, and installation of equipment at the Proposer site and/or Company Switching Station to support telecommunications power requirements, including, but not limited to, batteries, battery racks, rectifiers, and distribution panels.
4. Design, procurement, and installation of fiber cable, as needed, to support communications requirements, including SCADA connection from the Developer's RTU to the Company's RTU.
5. Ordering and installation of leased services, as needed, to support communications requirements.

### 3.5 – SECURITY

Responsibilities for Proposer-Build projects are the same as for Company-Build projects. See Section 2.6 for those responsibilities.

## SECTION 4 – TYPICAL COMPANY DURATIONS FOR INTERCONNECTION PROJECTS

The tables below in Section 4 are to be used as a reference when developing an overall project schedule to assist Proposers in setting realistic durations and deadlines for critical milestones. These tables represent typical durations for the Company to complete the listed critical milestones that assist in moving the interconnection project through the IRS, Engineering, Procurement, and Construction phases. The durations below do not include time for Proposer to complete items they are responsible for. These high-level typical durations are for planning purposes only and is not intended to cover all project specific requirements. Specific project details can increase or decrease these durations. The detailed project schedule will be determined after the IRS is completed.

### 4.1 – NOT USED

### 4.2 – SUBTRANSMISSION PROJECTS

| Milestone | Duration Proposer-Build | Notes |
|---|---|---|
| **IRS Phase** | | |
| Model Validation | 1 month | May increase depending on # of iterations |
| System Impact Study (SIS) | 150 calendar days | Following Model Acceptance |
| Facility Study (FS) | 40 business days | Following completion of SIS, SLD Acceptance, and Receipt of Developer Drawings and Schedules |
| **Engineering Phase** | | |
| 30% Design & Review | 20 business days | |
| 60% Design & Review | 20 business days | Following 30% Design acceptance. |
| 90% Design & Review | 20 business days | Following 60% Design acceptance |
| Issued for Construction (IFC) Design & Review | 20 business days | Following 90% Design acceptance. |
| **Procurement Phase** | | |
| Procurement | N/A | Procurement of materials typically happens at 60% design completion |
| **Construction Phase** | | |
| Construction | N/A | Based on scope/complexity of work |
| Acceptance Testing | 25 business days | Approximately 3 weeks after construction completion |
| CSAT | 30 business days | To occur after commissioning of Proposer's Facility. Duration depends on Proposer's ability to meet the Performance Standards. |
| **Notes** | | |

| Milestone | Duration Proposer-Build | Notes |
|---|---|---|
| a) For Proposer-Build projects, the Engineering Phase includes design reviews of Proposer designs for COIF and review of SOIF supporting/impacting COIF.<br>b) N/A indicates that the task is the responsibility of the Proposer in a Proposer-Build project. | | |

## 4.3 – TRANSMISSION PROJECTS

| Milestone | Duration Proposer-Build | Notes |
|---|---|---|
| **IRS Phase** | | |
| Model Validation | 1 month | May increase depending on # of iterations |
| System Impact Study (SIS) | 150 calendar days | Following Model Acceptance |
| Facility Study (FS) | 40 business days | Following completion of SIS, SLD Acceptance, and Receipt of Developer Drawings and Schedules |
| **Engineering Phase** | | |
| 30% Design & Review | 20 business days | |
| 60% Design & Review | 20 business days | Following 30% Design acceptance. |
| 90% Design & Review | 20 business days | Following 60% Design acceptance |
| Issued for Construction (IFC) Design & Review | 20 business days | Following 90% Design acceptance. |
| **Procurement Phase** | | |
| Procurement | N/A | Procurement of materials typically happens at 60% design completion |
| **Construction Phase** | | |
| Construction | N/A | Based on scope/complexity of work |
| Acceptance Testing | 25 business days | Approximately 3 weeks after construction completion |
| CSAT | 30 business days | To occur after commissioning of Proposer's Facility. Duration depends on Proposer's ability to meet the Performance Standards. |
| **Notes** | | |
| a) For Proposer-Build projects, the Engineering Phase includes design reviews of Proposer designs for COIF and review of SOIF supporting/impacting COIF.<br>b) N/A indicates that the task is the responsibility of the Proposer in a Proposer-Build project. | | |

## 4.4 – ADDITIONAL DURATIONS TO INTERCONNECT AT AN EXISTING SUBSTATION

| Milestone | Duration Company-Build | Notes |
|---|---|---|
| **Engineering Phase** | | |
| 30% Design & Review | 40 business days | |
| 60% Design & Review | 50 business days | Following 30% Design acceptance. |

| Milestone | Duration Company-Build | Notes |
|---|---|---|
| 90% Design & Review | 50 business days | Following 60% Design acceptance |
| Issued for Construction (IFC) Design & Review | 30 business days | Following 90% Design acceptance. |
| **Procurement Phase** | | |
| Procurement | Up to 24 months | Procurement of materials typically happens at 60% design completion and after PUC approval. Material lead times dependent on manufacturer availability. |
| **Construction Phase** | | |
| Construction | Up to 12 months | Duration increases up to 12 months for larger sized projects. Construction to begin after procurement completion. |
| **Notes** | | |
| a) The durations listed are in addition to the durations listed in Section 4.2 and 4.3<br>b) The Engineering Phase includes Company design & review of Company-Owned Interconnection Facilities (COIF) & reviews of Proposer-Owned Interconnection Facilities (SOIF) supporting/impacting COIF. | | |

# PROJECT EXAMPLES - APPENDIX H UNIT COST TABLE

Examples provided for illustrative purposes only and is not binding for actual facility costs.
Estimated costs represent Company costs charged to the Proposer.

**Projects interconnecting to subtransmission**

**Example 1**

15MW variable project interconnecting to an existing 46kV OH circuit per Attachment 2 of this Appendix H. The line extension includes an OH to OH tap to the existing line, 0.1 miles overbuild on existing 12kV lines, and 300ft of new 46kV OH lines to the Proposer substation. All lines are accessible. Company will complete the OH to OH final tap and the overbuild. Proposer to construct the new OH lines between the termination structure and the last pole before the tap to the overbuild portion. DTT and sync/deadline check required at 1 remote sub. No T&D line upgrade work needed. Company to install 0.1 miles of ADSS fiber (underbuild) to the Proposer substation and install Company-owned equipment in Proposer-provided communications cabinet. Proposer to provide leased line telecommunications with a 3rd party provider for backup communications. Assumed durations: Engineering = 12 months, Construction = 10 months, Testing/closeout = 6 months.

| Appx H Item | Description | Quantity | Unit | Unit Price ($) | Total Cost ($) |
|---|---|---|---|---|---|
| 15 | 46kV Variable Project | 1 | EA | $403,000 | $403,000 |
| 21 | Remote substation work | 1 | EA | $435,000 | $435,000 |
| 120 | 46kV OH to OH (1st tap) | 1 | EA | $86,000 | $86,000 |
| 165 | 46kV overbuild on 12kV | 0.1 | MI | $1,293,000 | $129,300 |
| 160 | Additional 100ft OH Line Extension | 3 | EA | $3,300 | $9,900 |
| | 46kV OH line extension (by Proposer) | 1 | LS | $0 | $0 |
| 196 | Project Management - Engineering | 12 | MO | $18,300 | $219,600 |
| 196 | Project Management - Construction | 10 | MO | $23,000 | $230,000 |
| 196 | Project Management - Testing/Closeout | 6 | MO | $11,700 | $70,200 |
| 202 | Comm Cabinet | 1 | EA | $192,000 | $192,000 |
| 211 | Fiber underbuild | 0.1 | MI | $166,000 | $16,600 |
| 205 | Backup Leased line (by Proposer) | 1 | LS | $0 | $0 |
| | | | **ESTIMATED TOTAL =** | | **$1,791,600** |

**Example 2**

50MW firm project interconnecting to two (2) paralleled 46kV circuits. Proposer will construct a new 46kV Company-owned substation per Attachment 3 of this Appendix H. Proposer will construct a line extension of two circuits from the new substation up to the last pole before the taps. One line extension is 900ft OH and the other is 800ft OH and 100ft UG (not including the 100ft span at the tap). The second line tap is at a riser (OH to UG type). Company will complete the final taps. Relay upgrades required on one of the circuits. Company to install fiber from nearest splice point to the new substation (0.5 miles) underbuilt on existing lines for primary communications. Proposer provides a leased line for backup communications. Assumed durations: Engineering = 12 months, Construction = 10 months, Testing/closeout = 6 months.

| Appx H Item | Description | Quantity | Unit | Unit Price ($) | Total Cost ($) |
|---|---|---|---|---|---|
| 16 | 46kV Firm Project | 1 | EA | $1,041,000 | $1,041,000 |
| 22 | Remote Sub Work | 1 | EA | $561,000 | $561,000 |
| 120 | 46kV OH to OH (1st tap) | 1 | EA | $86,000 | $86,000 |
| 121 | 46kV OH to UG (2nd tap) | 1 | EA | $188,000 | $188,000 |
| 160 | Additional 100ft OH Line Extension | 17 | EA | $3,300 | $56,100 |
| 161 | Additional 100ft UG Line Extension | 1 | EA | $5,700 | $5,700 |
| | 46kV line extensions (by Proposer) | 1 | LS | $0 | $0 |
| | 46kV civil infrastructure (by Proposer) | 1 | LS | $0 | $0 |
| | New 46kV substation (by Proposer) | 1 | LS | $0 | $0 |
| 196 | Project Management - Engineering | 12 | MO | $18,300 | $219,600 |
| 196 | Project Management - Construction | 10 | MO | $23,000 | $230,000 |
| 196 | Project Management - Testing/Closeout | 6 | MO | $11,700 | $70,200 |
| 202 | Comm Cabinet | 1 | EA | $192,000 | $192,000 |
| 211 | Company fiber underbuild (primary) | 0.5 | MI | $166,000 | $83,000 |
| 205 | Backup Leased line (by Proposer) | 1 | LS | $0 | $0 |
| 252 | Security | 1 | EA | $104,000 | $104,000 |
| | | | **ESTIMATED TOTAL =** | | **$2,836,600** |

**Projects interconnecting to transmission**

**Example 3**

100MW firm project interconnecting to existing 138kV OH circuits. Proposer to build a new Company-owned 4-bay BAAH switching station per Attachment 4 of this Appendix H. Line extension includes interception of existing circuits and a 1500ft extension of four (4) new 138kV OH lines to new Company switching station (not including the 100ft spans at the tap). All lines are accessible. Proposer to construct the new OH lines between the termination structures at the substation and the last poles/structures before intercepting the existing lines. Company will construct the final tap from the last poles/structures to the GCP. Line relay upgrades are required for both circuits and a breaker replacement is required on one circuit. Company to install 0.25 miles of ADSS fiber (underbuild) to the new Company switching station and install Company-owned equipment in Proposer-provided communications cabinet; back-up communications is required. Proposer to provide leased line for backup telecommunications. Proposer's substation is adjacent to Company's switching station. Assumed durations: Engineering = 18 months, Construction = 10 months, Testing/closeout = 6 months.

| Appx H Item | Description | Quantity | Unit | Unit Price ($) | Total Cost ($) |
|---|---|---|---|---|---|
| ***COIF Costs Paid by Proposer*** | | | | | |
| 32 | Company work at new substation | 1 | EA | $2,105,000 | $2,105,000 |
| 36a | Line relay upgrades | 2 | EA | $452,000 | $904,000 |
| 36b | Breaker replacement | 1 | EA | $569,000 | $569,000 |
| 133 | 138kV OH to OH Final Tap | 2 | CKT | $962,000 | $1,924,000 |
| 175 | Additional 100ft OH Line Extension | 60 | EA | $5,000 | $300,000 |
| 197 | Project Management - Engineering | 18 | MO | $18,300 | $329,400 |
| 197 | Project Management - Construction | 10 | MO | $23,000 | $230,000 |
| 197 | Project Management - Testing/Closeout | 6 | MO | $11,700 | $70,200 |
| | 138kV OH line extension (by Proposer) | 1 | LS | $0 | $0 |
| 202 | Comm Cabinet | 1 | EA | $192,000 | $192,000 |
| 205 | Leased line (by Proposer) | 1 | LS | $0 | $0 |
| 211 | Company fiber underbuild (primary) | 0.25 | MI | $166,000 | $41,500 |
| 250 | Company security costs | 1 | LS | $104,000 | $104,000 |
| | | | **ESTIMATED TOTAL =** | | **$6,769,100** |

**Example 4**

200MW firm generation project interconnecting at Hoohana substation. The 142MW SPOF limit means project requires two (2) gen-tie lines to Hoohana from the Proposer's site. The first termination requires adding a termination to an existing bay. The second termination requires expansion of the substation for two (2) additional BAAH bays (less 1 breaker), a new control house, and interconnecting the Kahe-Halawa 2 circuit to Hoohana. Proposer to run two (2) OH gen-tie lines (1,000ft each, not including 100ft span into sub) from Proposer's site to Hoohana. First gen-tie into Hoohana will be overhead, and Company to string final OH span from last pole to termination structure at Hoohana. Second gen-tie will be underground to cross existing 138kV lines (500ft not including 100ft span into sub), and Proposer to terminate at Hoohana. Proposer to run fiber between Proposer's substation and Hoohana since substation is not adjacent to Hoohana. A comm cabinet is required at the Proposer's substation. Assumed durations: Engineering = 18 months, Construction = 10 months, Testing/closeout = 6 months.

| Appx H Item | Description | Quantity | Unit | Unit Price ($) | Total Cost ($) |
|---|---|---|---|---|---|
| *1st Termination* | | | | | |
| 41 | Company work at Proposer's substation | 1 | EA | $408,000 | $408,000 |
| 44 | Add termination to existing bay | 1 | EA | $1,151,000 | $1,151,000 |
| *2nd Termination* | | | | | |
| 42 | Expansion of substation | 2 | EA | $500,000 | $1,000,000 |
| 43 | Add BAAH bay w/ 1 termination | 2 | EA | $2,975,000 | $5,950,000 |
| 44 | Add termination to existing bay | 1 | EA | $1,151,000 | $1,151,000 |
| 46 | New control house | 1 | EA | $2,000,000 | $2,000,000 |
| 47 | Interconnect Kah-Hal #2 to Hoohana | 1 | LS | $3,557,000 | $3,557,000 |
| *Gen-tie Lines* | | | | | |
| 175 | Gen-tie 1 - Add'l 100ft OH Line Extension | 10 | EA | $5,000 | $50,000 |
| 135 | 138kV OH Final Span to Existing Sub | 1 | EA | $100,000 | $100,000 |
| 175 | Gen-tie 2 - Add'l 100ft OH Line Extension | 10 | EA | $5,000 | $50,000 |
| 176 | Gen-tie 2 - Add'l 100ft UG Line Extension | 5 | EA | $7,000 | $35,000 |
| 136 | 138kV UG Termination to Existing Sub | 1 | EA | $34,000 | $34,000 |
| | 138kV civil infrastructure (by Proposer) | 1 | LS | $0 | $0 |
| 197 | Project Management - Engineering | 18 | MO | $18,300 | $329,400 |
| 197 | Project Management - Construction | 10 | MO | $23,000 | $230,000 |
| 197 | Project Management - Testing/Closeout | 6 | MO | $11,700 | $70,200 |
| 202 | Comm Cabinet (at Proposer's sub) | 1 | EA | $192,000 | $192,000 |
| 220 | Fiber from "meet point" to sub | 1 | EA | $31,000 | $31,000 |
| | Fiber civil infrastructure by Proposer | 1 | LS | $0 | $0 |
| 251 | Company security costs | 1 | LS | $104,000 | $104,000 |
| | | | **ESTIMATED TOTAL =** | | **$16,442,600** |

**Electrical service to Proposer Facility**

**Example 5**

Proposer requests service from existing 12kV line 0.5 miles away from the facility (new OH line for 0.4 miles and 0.1 miles underbuilt on the Company-owned interconnection lines). The OH line risers down and 2 feeders will serve a padmount transformer 100ft away from the riser pole. Proposer to install civil infrastructure (ductlines, MH/HH/vaults, equipment pads, etc.).

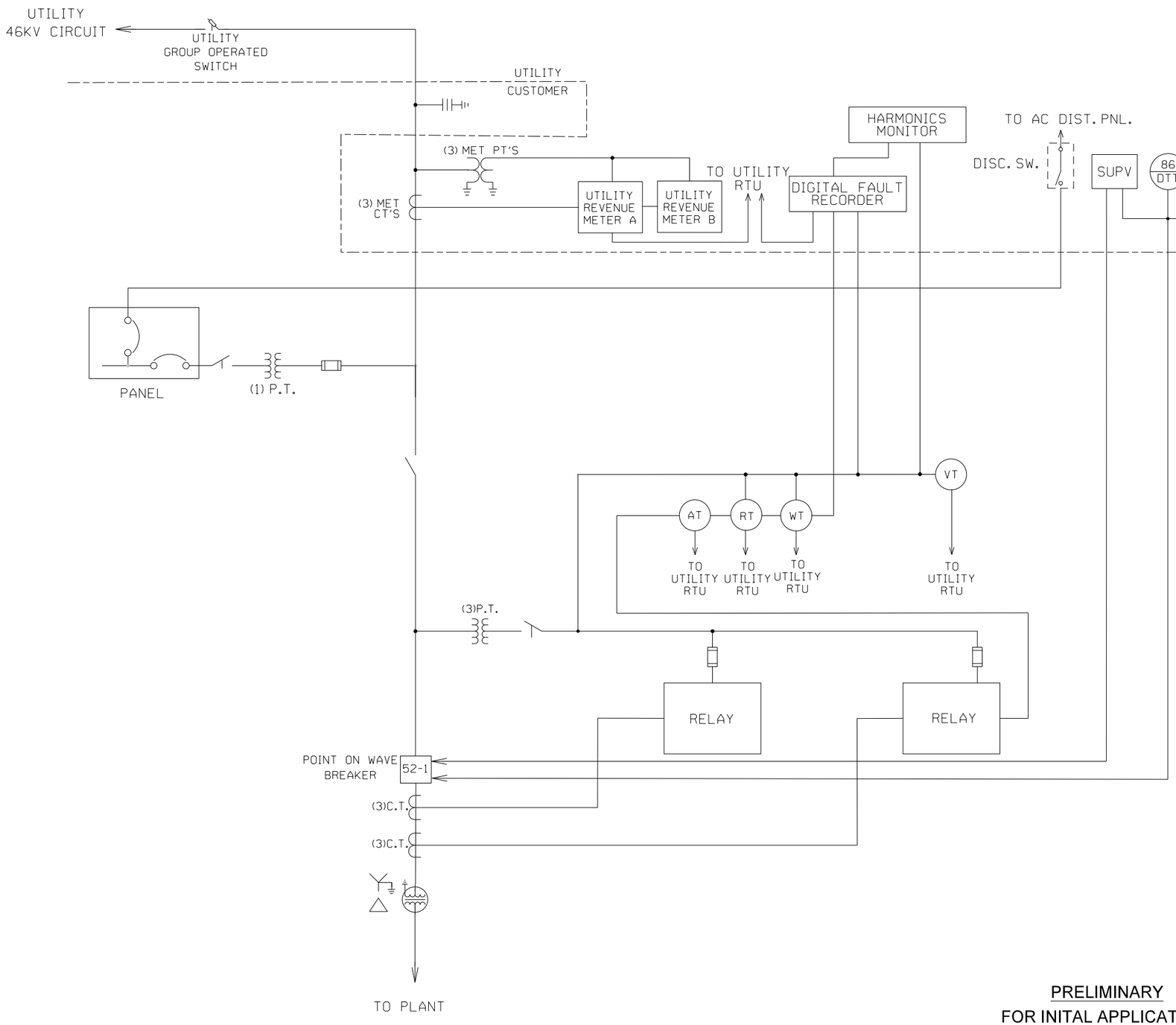
| Appx H Item | Description | Quantity | Unit | Unit Price ($) | Total Cost ($) |
|---|---|---|---|---|---|
| 188 | Padmount tsf for facility service | 1 | EA | $84,000 | $84,000 |
| 189 | 12kV OH accessible | 0.4 | MI | $719,000 | $287,600 |
| 190 | 12kV OH underbuild | 0.1 | MI | $441,000 | $44,100 |
| 193 | 12kV 3ph riser | 1 | EA | $41,000 | $41,000 |
| | 12kV civil infrastructure (by Proposer) | 1 | LS | $0 | $0 |
| | | | **ESTIMATED TOTAL =** | | **$456,700** |

**Electrical service to Proposer Facility and Primary station service for Company-owned switching station**

**Example 6**

Proposer requests service from existing 12kV line 0.2 miles away from the facility. Line extension is a new OH accessible line. The OH line riser down and 2 feeders will serve a padmount transformer 100ft away from the riser pole. Primary station service for the Company-owned switching station will be tapped off of the facility service line extension, riser underground, with 2 feeders going to a padmount station service transformer in the switching station located 300ft away from the tap point. Proposer to install civil infrastructure (ductlines, MH/HH/vaults, equipment pads, etc.).

| Appx H Item | Description | Quantity | Unit | Unit Price ($) | Total Cost ($) |
|---|---|---|---|---|---|
| 188 | Padmount tsf for station service | 2 | EA | $84,000 | $168,000 |
| 189 | 12kV OH accessible (facility service) | 0.2 | MI | $719,000 | $143,800 |
| 193 | 12kV 3ph riser (facility service) | 1 | EA | $41,000 | $41,000 |
| 193 | 12kV 3ph riser (station service) | 1 | EA | $41,000 | $41,000 |
| 192 | UG dbl feeder (station service) | 0.04 | MI | $1,048,000 | $39,697 |
| | 12kV civil infrastructure (by Proposer) | 1 | LS | $0 | $0 |
| | | | **ESTIMATED TOTAL =** | | **$433,497** |




LOC NOTE:
REQUIRED FOR PROJECTS > 5MW
REQUIRING RAMP DOWN BEFORE TRIPPING

## NOTES:

1. 24 HOUR ACCESS:
   ALL UTILITY EQUIPMENT MUST BE READILY ACCESSIBLE AT ALL TIMES (24 HOURS/7 DAYS) BY UTILITY PERSONNEL FOR EMERGENCIES, METER READING, INSPECTION, TESTING, AND MAINTENANCE.
2. ANTI-ISLANDING NOTE:
   AN INDEPENDENT ANTI-ISLANDING PREVENTION METHOD MUST BE INSTALLED SUCH THAT UPON OCCURRENCE OF AN ISLAND, THE DISTRIBUTED GENERATION RESOURCE SHALL AUTOMATICALLY DISCONNECT FROM UTILITY.
3. ENERGIZATION OF THE MAIN SITE TRANSFORMER AND/OR FACILITY CIRCUITS SHOULD NOT VIOLATE IEEE 1453.
4. THE 46KV MAIN CIRCUIT BREAKER AND THE MAIN BREAKER(S) FOR THE COLLECTOR CIRCUIT(S) SHALL BE POINT-ON-WAVE TYPE.
5. INSTALL RELAYS AND COMMUNICATIONS TO ENABLE UFLS AT 12KV BREAKERS IF 46KV CIRCUIT IS ON THE UFLS SCHEME.
6. PROJECT TO PROVIDE A RELIABLE DC SOURCE FOR 12 HOUR BACKUP PERIOD; SPECIFIC VOLTAGE TO BE DETERMINED BY HECO AT A LATER DATE.
7. MAIN UTILITY SUBTRANSMISSION CIRCUIT BREAKER TO BE SYNC CHECKED ACROSS SUBTRANSMISSION BUS POTENTIAL (3 PHASE) AND LINE POTENTIAL (3 PHASE). SUPY AND MANUAL CLOSING SHALL BE ALLOWED FOR EITHER OF THE FOLLOWING CONDITIONS:
   A: VOLTAGE EQUAL IN MAGNITUDE AND PHASE
   B: THREE PHASE DEAD LINE

**PRELIMINARY**

FOR INITAL APPLICATION
NOT TO BE USED
FOR CONSTRUCTION

ALSO REFER TO SLD
DESIGN NOTES

| NO. | DATE | REVISIONS | BY | CHK'D | APP'D |
|---|---|---|---|---|---|
| | | | | | |

TYPICAL 46KV INTERCONNECT
SINGLE LINE DIAGRAM FOR VARIABLE GENERATION

| | | | |
|---|---|---|---|
| DESIGNED | DRAWN | DATE 12-12-2022 | SCALE NONE |
| CHECKED ELEC. MECH. STRUC. | | ENGINEERING DEPARTMENT HAWAIIAN ELECTRIC CO.,INC. HONOLULU,HAWAII | |
| APPROVAL | | DRAWING NUMBER | REV Ø |

SIGNATURE

EXPIRATION DATE OF THE LICENSE
THIS WORK WAS PREPARED BY ME OR UNDER MY SUPERVISION AND CONSTRUCTION OF THIS PROJECT WILL BE UNDER MY OBSERVATION

## Template notes to be added to the 46kV Variable Generation Project Single Line Diagram

## Additional requirements may be added based on project design.

| | |
|---|---|
| **PROPOSED PROJECT NAME:** | |
| **PROPOSED PROJECT SIZE:** | |
| **CUSTOMER SLD REVISION NUMBER AND DATE:** | |
| **HECO SLD REVISION NUMBER AND DATE:** | |
| UTILITY SUBSTATION: | |
| UTILITY 46KV CIRCUIT: | |
| UTILITY 46KV CIRCUIT BREAKER #: | |

**Section A: Planning Notes**

A1. By operation procedure(s), the Project shall be paralleled with the utility system only when the ___(46kV circuit name) 46 kV circuit is in normal operating configuration served via breaker ___(utility breaker #) at ___(utility substation name) Substation.

A2. Upon receipt of direct transfer trip signal from ___(utility substation name) Substation opening of breaker ___(utility breaker #), trip and block close Customer's 46 kV breaker 52-1 (utility# XXXX).

A3. All DTT loss of comm greater than or equal to 6 seconds:
   a. Utility to provide signal to Customer to initiate Customer performed ramp down and tripping of Customer's 46 kV breaker 52-1 (utility# XXXX).
   b. Utility to initiate trip and block close of Customer's 46 kV breaker 52-1 (utility# XXXX) after ___(Project size MW/2 MW per minute ramp down) minutes, assuming maximum Customer output of ___(Project size) MW and a 2.0 MW/min ramp down rate.

A4. Customer to ensure manual closing of Customer's 46 kV breaker 52-1 (utility# XXXX) shall be allowed only for hot line (___(utility 46kV line) 46 kV line-side) and dead bus (Customer-side). There shall be no auto reclosing on Customer's 46 kV breaker 52-1 (utility# XXXX).

A5. (If applicable) Disable Under Frequency Load Shed (UFLS) at ___(46kV circuit name) 46kV CB ___(utility Breaker #), if applicable. Install relays and communications to enable UFLS at ___(12kV circuit name(s)) 12kV CB ___(utility Breaker #(s)).

A6. Utility shall own a harmonics monitor and associated equipment at the point of interconnection. The monitor will be in continuous service and on a rolling window basis, monitor sub-cycle voltage and currents, and be capable of remote interrogation. The harmonics monitor shall comply with IEEE STD 1159-2019 and IEEE STD 519-2014. PTs and CTs need to meet relaying and harmonic monitoring applications capable of measuring up

to the 50th harmonic. Developer to submit specifications of PTs/CTs to HECO to confirm application. The following inputs shall be provided:

a. 46kV line current (3 phase) at point of interconnection; and
b. 46kV line-to-neutral voltage (3 phase) at point of interconnection

**Section B: System Operation Notes**

B1. Utility shall have SCADA trip control over Customer's 46 kV breaker 52-1 (utility# XXXX).

B2. Utility load dispatcher shall be enabled to issue the following to the Customer via DNP 3.0 interface:

a. Maximum Power Limit and Power Reference Limit (dispatch) set point control signals. Customer is not allowed to override utility's curtailment control; and
b. Line to line Voltage (analog kV) set point control signal.

B3. All control values must be retained in non-volatile memory such that they will be restored immediately upon return from a systems restart, power outage, loss of communication, etc.

B4. The following signals provided by the Customer shall be telemetered to utility load dispatch office:

a. Status of Customer's 46kV breaker 52-1 (utility# XXXX);
b. Status of remotely-resettable lockouts;
c. 46kV line amps (3 phase), 46kV voltage (3 phase L-N), frequency, NET MW, NET MVAR, and NET power factor at point of interconnection. Power factor to be a calculated value;
d. 46kV line amps (B phase), 46kV voltage (A-B phase), NET MW, and NET MVAR at point of interconnection through use of utility approved non-programmable analog transducers. Data to be provided in analog format (+/- 1mA) directly from the analog transducers;
e. PV MW and MVAR output;
f. BESS MW and MVAR output/charge;
g. Received KWh accumulator, sent KWh accumulator, received KVARh accumulator, Sent KVARh accumulator.
h. Status Indicating when Maximum Power Limit is in effect;
i. Latest received Maximum Power Limit and Power Reference Limit Setpoints;
j. EMS Control Status indicating who has control over dispatch and voltage (Local vs utility);
k. Voltage Regulator Status – Normal or Alarm (regular On or Off)
l. Frequency Response Status – Normal or Alarm (On or Off);
m. Latest received voltage set point;
n. Wind speed in Miles per Hour and direction;
o. Barometric Pressure;
p. Temperature in Celsius;
q. Solar Irradiance in Watts/m2;
r. Humidity in Percent;

s. KW output for each inverter;
t. KW setpoint for each inverter;
u. Status for each inverter (by DNP status);
v. Number of inverters available;
w. Grid Following/Grid Forming;
x. Ramp Rate;
y. Ramp Rate Limit;
z. Plant Power Possible (MW);
aa. Frequency Droop percent and deadband settings;
bb. BESS State of Charge (%);
cc. BESS Energy remaining (MWH);
dd. KW set point for each inverter;
ee. Global Horizontal Irradiance on same axis as array (Watts/m2);
ff. Plane of Array Irradiance on same axis as array (Watts/m2); and
gg. Back of Panel temperature at array height (Celsius).

B5. The following occurrences shall initiate separate alarm to utility load dispatch office.
a. DTT and RTU Loss of Communication;
b. 48VDC and/or 125VDC Charger Trouble. Specific alarms to be determined by utility at a later date;
c. Trouble alarm for loss of VDC source(s); and
d. Operation of utility-owned SCADA re-settable lockout relays;
e. Violation of Maximum Ramp Rate Upward (Performance Standard); and
f. Violation of Maximum Ramp Rate Downward (Performance Standard).

B6. Utility requires 24 hour access to utility-owned SCADA/RTU, communication, and utility-owned relaying and monitoring equipment.

B7. Utility shall own a high-speed digital fault recorder (DFR) (i.e., Tesla Model No. 4000) near the point of interconnection, which shall be in continuous service and on a rolling window basis monitoring sub-cycle voltages, currents and harmonics, as well as disturbance events and capable of remote interrogation following an event. Utility requires 24 hour access to this equipment. Customer to provide the following hard wired inputs to utility's power quality device:
a. Status of Customer's 46kV breaker 52-1 (utility# XXXX);
b. Status of remotely-resettable lockouts;
c. 46kV line amps (3 phase); and
d. 46kV line-to-neutral voltage (3 phase)

**Section C: Telecommunication Notes**

C1. Customer to provide a reliable DC Source for 12 hour backup period; specific voltage to be determined by utility at a later date.

C2. Customer to provide a source of station service power for its facility that will remain available when Customer's 46 kV breaker 52-1 (utility# XXXX) is opened and the facility is separated from utility's system.

C3. For DTT communication channel failure:
   a. Signal to Customer to initiate Customer performed ramp down and tripping of Customer's 46 kV breaker 52-1 (utility# XXXX) shall be utility-owned SEL-2411. Utility SEL-2411 signal is to be a continuous signal while communication channel is failed.
   b. Trip and block close of Customer's 46 kV breaker 52-1 (utility# XXXX) shall be utility-owned SEL-2411 via utility-owned SCADA resettable lockout relay ("86/LOSS COMM").

C4. Secure and reliable communication is required for the following:
   a. Direct transfer trip from ___(utility 46kV circuit) 46kV CB ___(utility Breaker #);
   b. SCADA to/ from Customer's facility;
   c. Back-up SCADA to/from Customer's facility;
   d. Revenue metering for power export and consumption readings;
   e. Power quality and fault recording and retrieval; and
   f. Phone circuits as required.

C5. All DTT loss of comm greater than or equal to 6 seconds shall cause the site to ramp down and trip (applies to both primary and backup).

**Section D: Metering Notes**

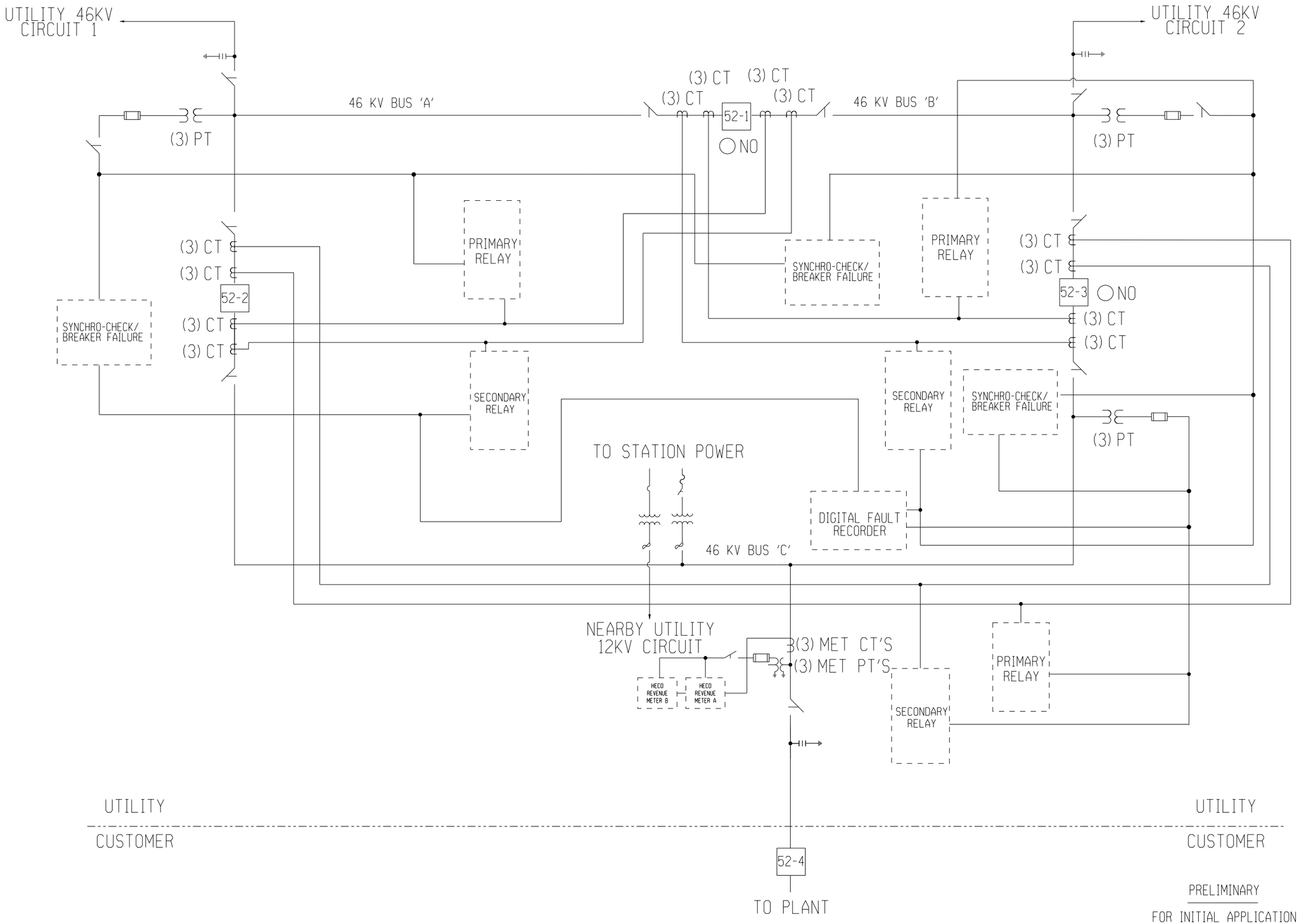
D1. Customer to design revenue metering facilities in accordance with the requirements in Chapter 6 of the Hawaiian Electric Company's Electric Service Installation Manual.

**Section E: Design Notes**

E1. PTs and CTs for Tesla and RTU transducers should be the same quality as the PTs and CTs for the 46kV protective relaying.

E2. Customer to provide raw count (DNP 3.0) for analog points to utility (except as identified in Note B4.d). Customer to provide hardwired dry contact pairs for status points to utility, and accept hardwired control points from utility (except for DNP control signals identified in Note B2 and DNP status points identified in Note B4.u).

E3. DTT trip signals from utility to Customer's 46 kV breaker 52-1 (utility# XXXX) shall be via utility-owned SCADA resettable lockout relay




NOTES:

1. 24 HOUR ACCESS:
   ALL UTILITY EQUIPMENT MUST BE READILY ACCESSIBLE AT ALL TIMES (24 HOURS/7 DAYS) BY UTILITY PERSONNEL FOR EMERGENCIES, METER READING, INSPECTION, TESTING, AND MAINTENANCE.

2. ANTI-ISLANDING NOTE:
   AN INDEPENDENT ANTI-ISLANDING PREVENTION METHOD MUST BE INSTALLED SUCH THAT UPON OCCURRENCE OF AN ISLAND, THE DISTRIBUTED GENERATION RESOURCE SHALL AUTOMATICALLY DISCONNECT FROM UTILITY.

3. ENERGIZATION OF THE MAIN SITE TRANSFORMER AND/OR FACILITY CIRCUITS SHOULD NOT VIOLATE IEEE 1453.

4. INSTALL RELAYS TO ENABLE UFLS AT 12KV BREAKERS IF 46KV CIRCUIT IS ON THE UFLS SCHEME.

5. PROJECT TO PROVIDE A RELIABLE DC SOURCE FOR 12 HOUR BACKUP PERIOD; SPECIFIC VOLTAGE TO BE DETERMINED BY HECO AT A LATER DATE.

6. MAIN UTILITY SUBTRANSMISSION CIRCUIT BREAKER TO BE SYNCHRONIZED ACROSS THE 46KV BUS POTENTIAL (3 PHASE) AND THE LINE POTENTIAL (3 PHASE). SUPY AND MANUAL CLOSING SHALL BE ALLOWED FOR VOLTAGE EQUAL IN MAGNITUDE AND PHASE.

7. ALL UTILITY SUBTRANSMISSION CIRCUIT BREAKERS TO BE SCADA ENABLED.

PRELIMINARY

FOR INITIAL APPLICATION
NOT TO BE USED
FOR CONSTRUCTION

ALSO REFER TO SLD
DESIGN NOTES

TYPLICAL 46KV INTERCONNECT
SINGLE LINE DIAGRAM FOR FIRM GENERATION

| | DATE 12-12-22 | SCALE NONE |
|---|---|---|
| | | REV. Ø |

## Template notes to be added to the 46kV PV/BESS Project Single Line Diagram

## Additional requirements may be added based on project design.

| | |
|---|---|
| **PROPOSED PROJECT NAME:** | |
| **PROPOSED PROJECT SIZE:** | |
| **CUSTOMER SLD REVISION NUMBER AND DATE:** | |
| **HECO SLD REVISION NUMBER AND DATE:** | |
| UTILITY SUBSTATION 1: | |
| UTILITY 46KV CIRCUIT 1: | |
| UTILITY 46KV CIRCUIT BREAKER 1 #: | |
| UTILITY SUBSTATION 2: | |
| UTILITY 46KV CIRCUIT 2: | |
| UTILITY 46KV CIRCUIT BREAKER 2 #: | |

**Section A: Planning Notes**

A1. By operation procedure(s), the Project shall be paralleled with the utility system only when the ___(46kV circuit name) 46 kV circuit 1 is in normal operating configuration served via breaker ___(utility breaker #) at ___(utility substation name) Substation or when the ___(46kV circuit name) 46 kV circuit 2 is in normal operating configuration served via breaker ___(utility breaker #) at ___(utility substation name) Substation.

A2. When the Project is paralleled with the utility system via ___(46kV circuit name) 46 kV circuit 1, upon receipt of direct transfer trip signal from ___(utility substation name) Substation opening of breaker ___(utility breaker #), trip and block close Customer's 46 kV breaker 52-4 (utility# XXXX).

A3. When the Project is paralleled with the utility system via ___(46kV circuit name) 46 kV circuit 2, upon receipt of direct transfer trip signal from ___(utility substation name) Substation opening of breaker ___(utility breaker #), trip and block close Customer's 46 kV breaker 52-4 (utility# XXXX).

A4. Upon receipt of direct transfer trip signal from ___(utility substation name) Substation for the following conditions, trip and block close Customer's 46 kV breaker 52-4 (utility# XXXX).
   a. When the Project is paralleled with the utility system via ___(46kV circuit name) 46 kV circuit 1 opening of breaker 52-2___(utility breaker #)
   b. When the Project is paralleled with the utility system via ___(46kV circuit name) 46 kV circuit 2 opening of breaker 52-3___(utility breaker #)

A5. All DTT loss of comm greater than or equal to 6 seconds:
   a. Utility to provide signal to Customer to initiate Customer performed ramp down and tripping of Customer's 46 kV breaker 52-4 (utility# XXXX).

b. Utility to initiate trip and block close of Customer's 46 kV breaker 52-4 (utility# XXXX) after ___(Project size MW/2 MW per minute ramp down) minutes, assuming maximum Customer output of ___(Project size) MW and a 2.0 MW/min ramp down rate.

A6. Customer to ensure manual closing of Customer's 46 kV breaker 52-4 (utility# XXXX) shall be allowed only for hot line (___(utility 46kV line) 46 kV line-side) and dead bus (Customer-side). There shall be no auto reclosing on Customer's 46 kV breaker 52-4 (utility# XXXX).

A7. Utility breaker 52-1___(utility Breaker #), shall be syncro-checked across bus 'A' potential and bus 'B' potential. Closing shall be allowed for the following conditions:
   a. No auto reclosing
   b. Manual closing
      i. Dead bus 'A' and dead bus 'B'
      ii. Hot bus 'A' and dead bus 'B'
      iii. Hot bus 'B and dead bus 'A'
      iv. Voltages equal in magnitude and phase

A8. Utility breaker 52-2___(utility Breaker #), shall be syncro-checked across bus 'A' potential and bus 'C' potential. Closing shall be allowed after load dispatch confirms that Customer's 46 kV breaker 52-4 (utility# XXXX) is open and for the following conditions:
   a. No auto reclosing
   b. Manual closing
      i. Dead bus 'A' and dead bus 'C'
      ii. Hot bus 'A' and dead bus 'C'
      iii. Voltages equal in magnitude and phase

A9. Utility breaker 52-3___(utility Breaker #), shall be syncro-checked across bus 'B' potential and bus 'C' potential. Closing shall be allowed after load dispatch confirms that Customer's 46 kV breaker 52-4 (utility# XXXX) is open and for the following conditions:
   a. No auto reclosing
   b. Manual closing
      i. Dead bus 'B' and dead bus 'C'
      ii. Hot bus 'B' and dead bus 'C'
      iii. Voltages equal in magnitude and phase

A10. (If applicable) Disable Under Frequency Load Shed (UFLS) at ___(46kV circuit 1 name) 46kV CB ___(utility Breaker #), if applicable. Install relays to enable UFLS at ___(12kV circuit name(s)) 12kV CB ___(utility Breaker #(s)).

A11. (If applicable) Disable Under Frequency Load Shed (UFLS) at ___(46kV circuit 2 name) 46kV CB ___(utility Breaker #), if applicable. Install relays to enable UFLS at ___(12kV circuit name(s)) 12kV CB ___(utility Breaker #(s)).

**Section B: System Operation Notes**

B1. Utility shall have SCADA trip control over Customer's 46 kV breaker 52-4 (utility# XXXX).

B2. Utility load dispatcher shall be enabled to issue the following to the Customer via DNP 3.0 interface:
   a. Maximum Power Limit and Power Reference Limit (dispatch) set point control signals. Customer is not allowed to override utility's curtailment control; and
   b. Line to line Voltage (analog kV) set point control signal.
   c. If applicable, status of Customer's medium voltage feeder breakers.

B3. All control values must be retained in non-volatile memory such that they will be restored immediately upon return from a systems restart, power outage, loss of communication, etc.

B4. The following signals provided by the Customer shall be telemetered to utility load dispatch office:
   a. Status of Customer's 46 kV breaker 52-4 (utility# XXXX);
   b. Status of remotely-resettable lockouts;
   c. 46kV line amps (A phase, B phase, and C phase), 46kV voltage (A phase L-N, B phase L-N, C phase L-N), frequency, NET MW, NET MVAR, and NET power factor at point of interconnection. Power factor to be a calculated value;
   d. 46kV line amps (B phase), 46kV voltage (A-B phase), NET MW, and NET MVAR at point of interconnection through use of utility approved non-programmable analog transducers. Data to be provided in analog format (+/- 1mA) directly from the analog transducers;
   e. MW and MVAR output;
   f. Accumulator Points:
      i. Total kWh From Utility,
      ii. Total kWh To Utility,
      iii. Total kVARh From Utility,
      iv. Total kVARh To Utility.
   g. Status Indicating when Maximum Power Limit is in effect;
   h. Latest received Maximum Power Limit and Power Reference Limit Setpoints;
   i. EMS Control Status indicating who has control over dispatch and voltage (Local vs utility);
   j. Voltage Regulator Status – Normal or Alarm (regular On or Off)
   k. Frequency Response Status – Normal or Alarm (On or Off);
   l. Latest received voltage set point;
   m. Wind speed in Miles per Hour and direction;
   n. Barometric Pressure;
   o. Temperature in Celsius;
   p. Humidity in Percent;
   q. Grid Following/Grid Forming;
   r. Ramp Rate;
   s. Ramp Rate Limit;

t. Facility MW Availability (%);
u. Plant Capability (MW);
v. Frequency Droop percent and deadband settings;
w. Status indicating when Power Reference Limit is in effect.

B5. The following occurrences shall initiate separate alarm to utility load dispatch office.
a. DTT and RTU Loss of Communication;
b. 48VDC and/or 125VDC Charger Trouble. Specific alarms to be determined by utility at a later date;
c. Trouble alarm for loss of VDC source(s); and
d. Operation of utility-owned SCADA re-settable lockout relays;
e. Violation of Maximum Ramp Rate Upward (Performance Standard); and
f. Violation of Maximum Ramp Rate Downward (Performance Standard).

B6. Utility requires 24 hour access to utility-owned SCADA/RTU, communication, and utility-owned relaying and monitoring equipment.

B7. Utility shall own a high-speed digital fault recorder (DFR) (i.e., Tesla Model No. 4000) near the point of interconnection, which shall be in continuous service and on a rolling window basis monitoring sub-cycle voltages, currents and harmonics, as well as disturbance events and capable of remote interrogation following an event. Utility requires 24 hour access to this equipment. Customer to provide the following hard wired inputs to utility's power quality device:
a. Status of Customer's 46 kV breaker 52-4 (utility# XXXX);
b. Status of remotely-resettable lockouts;
c. 46kV line amps (3 phase); and
d. 46kV line-to-neutral voltage (3 phase)

**Section C: Telecommunication Notes**

C1. Customer to provide a reliable DC Source for 12 hour backup period; specific voltage to be determined by utility at a later date.

C2. Customer to provide a source of station service power for its facility that will remain available when Customer's 46 kV breaker 52-4 (utility# XXXX) is opened and the facility is separated from utility's system.

C3. For DTT communication channel failure:
a. Signal to Customer to initiate Customer performed ramp down and tripping of Customer's 46 kV breaker 52-4 (utility# XXXX) shall be utility-owned SEL-2411. Utility SEL-2411 signal is to be a continuous signal while communication channel is failed.
b. Trip and block close of Customer's 46 kV breaker 52-4 (utility# XXXX) shall be utility-owned SEL-2411 via utility-owned SCADA resettable lockout relay ("86/LOSS COMM").

C4. Secure and reliable communication is required for the following:
   a. Direct transfer trip from ___(utility 46kV circuit) 46kV CB ___(utility Breaker #);
   b. SCADA to/ from Customer's facility;
   c. Back-up SCADA to/from Customer's facility;
   d. Revenue metering for power export and consumption readings;
   e. Power quality and fault recording and retrieval; and
   f. Phone circuits as required.

C5. All DTT loss of comm greater than or equal to 6 seconds shall cause the site to ramp down and trip (applies to both primary and backup).

**Section D: Metering Notes**

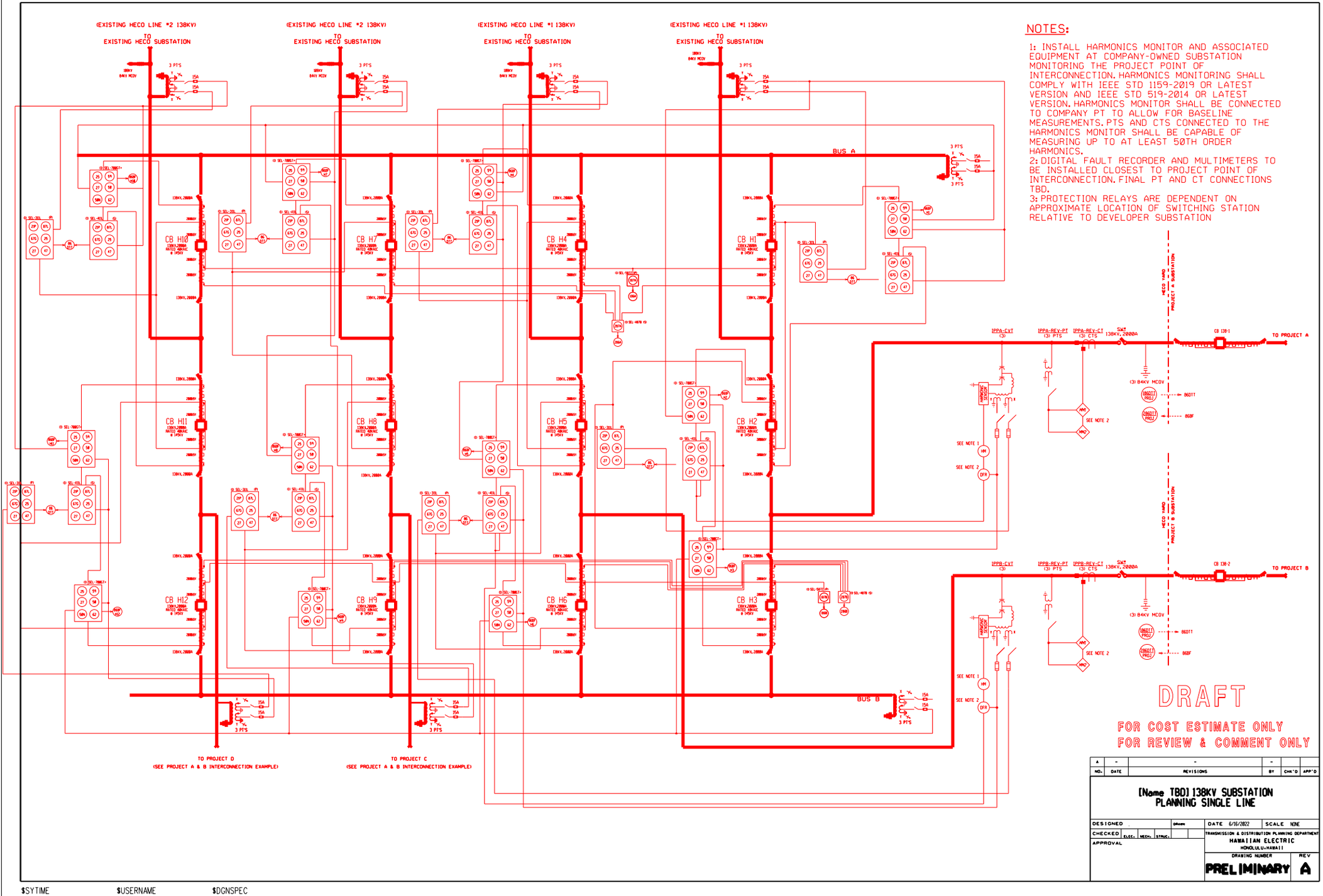
D1. Customer to design revenue metering facilities in accordance with the requirements in Chapter 6 of the Hawaiian Electric Company's Electric Service Installation Manual.

**Section E: Design Notes**

E1. PTs and CTs for Tesla and RTU transducers should be the same quality as the PTs and CTs for the 46kV protective relaying.

E2. Customer to provide raw count (DNP 3.0) for analog points to utility (except as identified in Note B4.d). Customer to provide hardwired dry contact pairs for status points to utility, and accept hardwired control points from utility (except for DNP control signals identified in Note B2).

E3. Relay operation shall trip and block close breakers 52-2, 52-3, and utility owned DTT lockout relay. Developer breaker 52-4 tripped and blocked closed via separate dedicated lockout relay owned by the Developer.




NOTES:

1: INSTALL HARMONICS MONITOR AND ASSOCIATED EQUIPMENT AT COMPANY-OWNED SUBSTATION MONITORING THE PROJECT POINT OF INTERCONNECTION. HARMONICS MONITORING SHALL COMPLY WITH IEEE STD 1159-2019 OR LATEST VERSION AND IEEE STD 519-2014 OR LATEST VERSION. HARMONICS MONITOR SHALL BE CONNECTED TO COMPANY PT TO ALLOW FOR BASELINE MEASUREMENTS. PTS AND CTS CONNECTED TO THE HARMONICS MONITOR SHALL BE CAPABLE OF MEASURING UP TO AT LEAST 50TH ORDER HARMONICS.

2: DIGITAL FAULT RECORDER AND MULTIMETERS TO BE INSTALLED CLOSEST TO PROJECT POINT OF INTERCONNECTION. FINAL PT AND CT CONNECTIONS TBD.

3: PROTECTION RELAYS ARE DEPENDENT ON APPROXIMATE LOCATION OF SWITCHING STATION RELATIVE TO DEVELOPER SUBSTATION

DRAFT

FOR COST ESTIMATE ONLY
FOR REVIEW & COMMENT ONLY

| NO. | DATE | REVISIONS | BY | CHK'D | APP'D |
|---|---|---|---|---|---|
| A | - | - | - | | |

[Name TBD] 138KV SUBSTATION
PLANNING SINGLE LINE

| | | | |
|---|---|---|---|
| DESIGNED | DRAWN | DATE 6/16/2022 | SCALE NONE |
| CHECKED ELEC. MECH. STRUC. | | TRANSMISSION & DISTRIBUTION PLANNING DEPARTMENT | |
| APPROVAL | | HAWAIIAN ELECTRIC HONOLULU, HAWAII | |
| | | DRAWING NUMBER PRELIMINARY | REV A |

$SYTIME $USERNAME $DGNSPEC

**Notes for Typical Project 138kV Substation Electrical Single Line (2 Existing Circuit Interconnection)**

1. 138kV bus equipment and breakers shall be rated 2000A continuous and shall be designed to withstand a short circuit current of 40 KAIC @ 145kV.
2. All 138kV Gas Circuit Breakers (GCB), disconnect switches, station post insulators, and instrument transformers are to be designed for 650kV BIL.
3. 138kV breaker H1 to be 3PH synchro-checked across its 138kV Bus A 3PH and line potentials 3PH and allowed to close only under the following conditions:
   A. Automatic Reclosing:
      1. [TBD by IRS]
   B. Manual and Supy Closing:
      1. Voltage magnitude, frequency, and phase difference within acceptable limit
      2. Dead-line and dead-bus
      3. Dead-line and hot-bus
      4. Hot-line and dead-bus
4. 138kV breaker H2 to be 3PH synchro-checked across its line potentials 3PH on both sides of the 138kV breaker and allowed to close only under the following conditions:
   A. No Automatic Reclosing
   B. Manual and Supy Closing:
      1. Voltage magnitude, frequency, and phase difference within acceptable limit
      2. Dead-line and dead-line
      3. Dead-line and hot-line
      4. Hot-line and dead-line
5. 138kV breaker H3 to be 3PH synchro-checked across its 138kV Bus B 3PH and line potentials 3PH and allowed to close only under the following conditions:
   A. No Automatic Reclosing
   B. Manual and Supy Closing:
      1. Voltage magnitude, frequency, and phase difference within acceptable limit
      2. Dead-line and dead-bus
      3. Dead-line and hot-bus
      4. Hot-line and dead-bus
6. 138kV breaker H4 to be 3PH synchro-checked across its 138kV Bus A 3PH and line potentials 3PH and allowed to close only under the following conditions:
   A. Automatic Reclosing:
      1. [TBD by IRS]
   B. Manual and Supy Closing:
      1. Voltage magnitude, frequency, and phase difference within acceptable limit
      2. Dead-line and dead-bus
      3. Dead-line and hot-bus
      4. Hot-line and dead-bus
7. 138kV breaker H5 to be 3PH synchro-checked across its line potentials 3PH on both sides of the 138kV breaker and allowed to close only under the following conditions:

A. No Automatic Reclosing
B. Manual and Supy Closing:
    1. Voltage magnitude, frequency, and phase difference within acceptable limit
    2. Dead-line and dead-line
    3. Dead-line and hot-line
    4. Hot-line and dead-line

8. 138kV breaker H6 to be 3PH synchro-checked across its 138kV Bus B 3PH and line potentials 3PH and allowed to close only under the following conditions:
    A. No Automatic Reclosing
    B. Manual and Supy Closing:
        1. Voltage magnitude, frequency, and phase difference within acceptable limit
        2. Dead-line and dead-bus
        3. Dead-line and hot-bus
        4. Hot-line and dead-bus
9. 138kV breaker H7 to be 3PH synchro-checked across its 138kV Bus A 3PH and line potentials 3PH and allowed to close only under the following conditions:
    A. Automatic Reclosing:
        1. [TBD by IRS]
    B. Manual and Supy Closing:
        1. Voltage magnitude, frequency, and phase difference within acceptable limit
        2. Dead-line and dead-bus
        3. Dead-line and hot-bus
        4. Hot-line and dead-bus
10. 138kV breaker H8 to be 3PH synchro-checked across its line potentials 3PH on both sides of the 138kV breaker and allowed to close only under the following conditions:
    A. No Automatic Reclosing
    B. Manual and Supy Closing:
        1. Voltage magnitude, frequency, and phase difference within acceptable limit
        2. Dead-line and dead-line
        3. Dead-line and hot-line
        4. Hot-line and dead-line
11. 138kV breaker H9 to be 3PH synchro-checked across its 138kV Bus B 3PH and line potentials 3PH and allowed to close only under the following conditions:
    A. No Automatic Reclosing
    B. Manual and Supy Closing:
        1. Voltage magnitude, frequency, and phase difference within acceptable limit
        2. Dead-line and dead-bus
        3. Dead-line and hot-bus
        4. Hot-line and dead-bus
12. 138kV breaker H10 to be 3PH synchro-checked across its 138kV Bus A 3PH and line potentials 3PH and allowed to close only under the following conditions:
    A. Automatic Reclosing:

1. [TBD by IRS]

B. Manual and Supy Closing:
   1. Voltage magnitude, frequency, and phase difference within acceptable limit
   2. Dead-line and dead-bus
   3. Dead-line and hot-bus
   4. Hot-line and dead-bus

13. 138kV breaker H11 to be 3PH synchro-checked across its line potentials 3PH on both sides of the 138kV breaker and allowed to close only under the following conditions:
    A. No Automatic Reclosing
    B. Manual and Supy Closing:
       1. Voltage magnitude, frequency, and phase difference within acceptable limit
       2. Dead-line and dead-line
       3. Dead-line and hot-line
       4. Hot-line and dead-line
14. 138kV breaker H12 to be 3PH synchro-checked across its 138kV Bus B 3PH and line potentials 3PH and allowed to close only under the following conditions:
    A. No Automatic Reclosing
    B. Manual and Supy Closing:
       1. Voltage magnitude, frequency, and phase difference within acceptable limit
       2. Dead-line and dead-bus
       3. Dead-line and hot-bus
       4. Hot-line and dead-bus
15. All trips from Project #1 to HECO shall trip and block close breakers H2 and H3.
16. All trips from Project #2 to HECO shall trip and block close breakers H5 and H6.
17. All trips from Project #3 to HECO shall trip and block close breakers H8 and H9.
18. All trips from Project #4 to HECO shall trip and block close breakers H11 and H12.
19. Install a harmonics recorder and associated equipment at each project point of interconnection, which will be in continuous service and on a rolling window basis monitor sub-cycle voltage and currents and capable of remote interrogation. Harmonics monitoring shall comply with IEEE Std 1159-2019 or latest version and IEEE Std 519-2014 or latest version. Harmonics monitor shall be connected to company-side PT to allow for baseline measurements. PTs and CTs connected to the harmonics monitor shall be capable of measuring up to at least 50th order harmonics. The following inputs shall be provided:
    A. 138kV voltage (3-ph) at or near the point of interconnection for Project
    B. 138kV current (3-ph) at or near the point of interconnection measuring total current from Project
20. Opening of 138kV breakers H2 and H3 shall trip HECO lockout relay which will trip and block close Project #1 138kV breaker 138-1 via separate dedicated lockout relay owned by the Developer.
21. Opening of 138kV breakers H5 and H6 shall trip HECO lockout relay which will trip and block close Project #2 138kV breaker 138-2 via separate dedicated lockout relay owned by the Developer.

22. Opening of 138kV breakers H8 and H9 shall trip HECO lockout relay which will trip and block close Project #3 138kV breaker 138-3 via separate dedicated lockout relay owned by the Developer.
23. Opening of 138kV breakers H11 and H12 shall trip HECO lockout relay which will trip and block close Project #4 138kV breaker 138-4 via separate dedicated lockout relay owned by the Developer.

Protection Notes:

The following Project Notes document is only for Project A. The Projects B, C, & D documents would have similar notes with the following changes in breaker number/letter.

| Project | Project Breaker # | Switching Station Breakers |
|---|---|---|
| A | 138-1 | H2 & H3 |
| B | 138-2 | H5 & H6 |
| C | 138-3 | H8 & H9 |
| D | 138-4 | H11 & H12 |

24. Bus A differential relay operation shall trip and block close breakers H1, H4, H7, and H10 via manual lockout relay.
25. Bus B differential relay operation shall trip and block close breakers H3, H6, H9, and H12 via manual lockout relay
26. Line current differential relay operation shall trip and block close breakers H2 and H3, via HECO lockout relay. Developer breaker 138-1 tripped and blocked closed via separate dedicated lockout relay owned by the Developer.
27. Line differential relays subject to telecom requirements as specified in the RFP for renewable dispatchable generation and energy storage, Appendix H, Section 2.5
28. The local breaker failure scheme shall trip and block close all adjacent breakers via non-electrically resettable lockout relays.
29. Breaker failure of 138kV breaker H2 or H3 to initiate direct transfer trip signal via the BFTT relay which will trip and block close Developer's 138kV breaker 138-1 via separate dedicated lockout relay owned by the Developer.
30. Breaker failure of 138kV breaker 138-1 to initiate direct transfer trip signal via the BFTT relay which will trip and block close breaker H2 and H3 at the HECO sub via dedicated remotely resettable lockout relay.

System Operations Notes

The following Project Notes document is only for Project A. The Projects B, C, & D documents would have similar notes with the following changes in breaker number/letter.

| Project | Project Breaker # | Switching Station Breakers |
|---|---|---|
| A | 138-1 | H2 & H3 |
| B | 138-2 | H5 & H6 |
| C | 138-3 | H8 & H9 |
| D | 138-4 | H11 & H12 |

31. All 138kV breakers are controlled and supervised by load dispatch via supervisory equipment and have control switches in the control equipment enclosure.

32. Install a digital fault recorder near point of interconnection, which will be in continuous service and on a rolling window basis monitor sub-cycle voltage, currents, as well as disturbance events and capable of remote interrogation following an event. The following inputs shall be provided and direct hard wired to the recorder:

    a. Status of [*Project*] (Developer) 138kV breaker
    b. Status of all Developer's 35kV breakers
    c. Status of all lockouts for Developer's breakers
    d. 138kV voltage (A phase L-N, B phase L-N, and C phase L-N) at point of interconnection
    e. 138kV current (A phase, B phase, and C phase) at point of interconnection measuring total current from [*Project*] project
    f. 138kV line fault distance (miles)

33. Each of the following control and status points for 138kV breakers, disconnect switches, the associated transmission lines and equipment shall be remotely controlled and supervised by HECO load dispatcher:

    a. Trip/Close and status of all 138kV breakers
    b. All 138kV breakers automatic reclosing status (Auto / Block)
    c. Open/Close and status of all 138kV disconnect switches
    d. Trip Only and status of Developer's 138kV breaker
    e. Status and control of each remotely resettable lockout
    f. Status of each manual-reset lockout

34. Each of the following analog points for 138kV breakers, 138kV motor operated switches, the associated transmission and equipment shall be telemetered to HECO load dispatcher:

    a. All 138kV line amps (A phase, B phase, and C phase), voltages (A phase L-N, B phase L-N, and C phase L-N), watts, and vars
    b. All 138kV bus voltages (A phase L-N, B phase L-N, and C phase L-N)

c. kWh and kVARh values via Revenue Meter “A”

35. For 138kV breakers, disconnect switches, the associated transmission lines and equipment, each of the following initiates an alarm to HECO load dispatcher:

a. DTT for CB H2 and H3 (*breakers to Project*)
b. 125V DC battery low voltage (both primary and backup battery)
c. 125V DC charger trouble (both primary and backup battery)
d. Loss of 125V DC circuit (individual alarm for each 125V DC circuit)
e. 48V DC battery low voltage
f. 48V DC charger trouble
g. Loss of normal AC station power source
h. Loss of emergency AC station power source
i. Operation of AC station power auto-transfer switch to emergency source
j. Loss of 138kV line and synchro-check potential
k. Low SF6 gas pressure for all GCB (individual alarm for each GCB)
l. Block operation due to SF6 low gas pressure for all GCB (individual alarm for each GCB)
m. Spring discharge alarm for all GCB (individual alarm for each GCB)
n. Trip Coil Loss of DC for all GCB (individual alarm for each GCB)
o. Each 138kV lockout relay (86) operation
p. Each 138kV digital protective relay trouble alarm
q. Loss of 138kV line relay primary & backup potential
r. Loss of DC for each lockout relay (86)
s. Comm Trouble and Loss of Comm alarms
t. RTU communication failure

The following Project Notes document is only for Project A. The Projects B, C, & D documents would have similar notes with the following changes in breaker number/letter.

| Project | Project Breaker # | Switching Station Breakers |
|---|---|---|
| A | 138-1 | H2 & H3 |
| B | 138-2 | H5 & H6 |
| C | 138-3 | H8 & H9 |
| D | 138-4 | H11 & H12 |

## Notes to be added to the 138kV Project Single Line Diagram

| | |
|---|---|
| **PROPOSED PROJECT NAME:** | - |
| **PROPOSED PROJECT SIZE:** | - |
| **DEVELOPER SLD REVISION NUMBER AND DATE:** | - |
| **HECO SLD REVISION NUMBER AND DATE:** | - |
| **HECO SUBSTATION:** | - |

1. The Project shall install point-on-wave breakers [TBD—For Projects without self-energization], specifically independent pole operated (IPO) breakers with residual flux calculation capability. Energizations is only to occur in coordination with the Company system operator. The voltage deviation at the point of interconnection (POI) must be limited to +/- 6% when energizing the Project. [TBD by IRS]
2. Opening of 138kV breakers H2 and H3 shall trip Developer's 138kV breaker 138-1 via Company-owned lockout relay.
3. Project breaker 138-1 shall be allowed to close only under the following conditions:
    a. No Automatic Reclosing
    b. Manual Closing shall be allowed for the following conditions under the coordination of the Company system operator:
        i. Hot line (company-side) and dead bus (project-side).
        ii. Hot line (company-side) and hot bus (project-side) [TBD—For Projects with self--energization]
            1. Active synchronization control (i.e., an active synchronizer) on the generation facility shall be used to limit the disturbance, caused by closing, to a minimum. If synchronization parameters, such as voltage magnitude, angle and frequency difference are used during this process, these parameters shall be reviewed and approved by Company.
        iii. Dead line (company-side) and hot bus (project-side), for black start provided by grid forming capabilities.

**Protection Notes**

4. Breaker failure of HECO 138kV breaker H2 or H3 shall trip a HECO lockout relay which will trip and block close Project 138kV breaker 138-1 via separate dedicated lockout relay.
5. Breaker failure of Project 138kV breaker 138-1 shall trip developer-owned dedicated lockout relay which will trip dedicated lockout relay in HECO substation. Dedicated lockout relay in HECO

substation will trip and block close HECO 138kV breakers H2 and H3.

**System Operations Notes**

6. HECO shall have SCADA trip control over Customer's 138 kV breaker CB-A (HECO# XXXX).
7. Customer to provide raw count (DNP 3.0) for analog and status points to HECO or other formats as specified in the following notes. Customer to provide hardwired dry contact pairs for status points to HECO, and accept hardwired and DNP 3.0 control points from HECO as categorized in the following notes.
8. HECO load dispatcher shall be enabled to issue the following Control signals to the Customer:
   a. Digital Controls - Hardwire Dry Contact Pair controls
      i. Trip control over Customer's 138kV breaker
      ii. Reset control of remotely-resettable lockouts
      iii. Inverter On/Off control signal
      iv. Isochronous Mode Enable/Disable control signal
   b. Analog Controls - DNP 3.0 – Customer is not allowed to override HECO's control
      i. Maximum Power Import Limit
      ii. Maximum Power Export Limit
      iii. Power Reference Limit (dispatch setpoint; can be -/+ value for grid-charging capable batteries);
      iv. Line to Line Voltage Target (analog kV);
      v. Normal Operating Day Limit
      vi. Normal Operating Night Limit.
9. All control values must be retained in non-volatile memory such that they will be restored immediately upon return from a systems restart, power outage, loss of communication, etc.
10. The following signals provided by the Customer shall be telemetered to HECO load dispatch office:
    a. Analog Points – Hardwired
       i. 138kV line amps (B phase), 138kV voltage (A-B phase), NET MW, and NET MVAR at point of interconnection through use of HECO approved non-programmable analog transducers. Data to be provided in analog format (+/- 1mA) directly from the analog transducers;
    b. Analog Points – DNP 3.0
       i. 138kV line amps (A phase, B phase, and C phase), 138kV voltage (A phase L-N, B phase L-N, and C phase L-N), frequency, NET MW, NET MVAR, and NET power factor at point of interconnection. Power factor to be a calculated value;
       ii. Latest received Maximum Power Import Limit, Maximum Power Export Limit, and Power Reference Limit Setpoints. Power Reference Limit can be +/- for grid-charging capable batteries;
       iii. Latest received Voltage Setpoint;
       iv. PV MW and MVAR output;
       v. BESS MW and MVAR output/charge;

vi. KW output for each inverter;
vii. PV Inverters Available
viii. BESS Inverters Available
ix. Ramp Rate;
x. Ramp Rate Limit Up;
xi. Ramp Rate Limit Down;
xii. Plant Power Possible (MW);
xiii. PV Power Possible (MW);
xiv. BESS Power Possible (MW);
xv. Frequency Droop percent and deadband settings;
xvi. BESS State of Charge (%), Minimum Usable MWh Capacity, and Maximum Usable MWh Capacity, and BESS Usable Energy Remaining (MWh), must account for derates, outages, and battery degredation;
- Where, BESS State of Charge % = BESS Energy Remaining / Contract Capacity

xvii. Time Remaining at Current MW Output (hh:mm);
xviii. Year to Date BESS Usage Counter (cycles and/or MWh)
xix. Year to Date Daily Average BESS Usage Counter (MWh)
xx. Wind Speed in Miles per Hour and Wind Direction;
xxi. Barometric Pressure;
xxii. Temperature in Celsius;
xxiii. Plane of Array Irradiance on same axis as array (Watts/m2);
xxiv. Back of Panel temperature at array height (Celsius);
xxv. Normal Operating Day Limit Control Feedback
xxvi. Normal Operating Night Limit Control Feedback
xxvii. Normal Operating Limit In Effect (MW)

c. Accumulator Points
   i. Total KWh From HECO
   ii. Total KWh To HECO
   iii. Total KVARh From HECO
   iv. Total KVARh To HECO
d. Indication Points – Hardwired Dry Contact Pairs
   i. Status of Customer's 138kV breaker CB-A (HECO# XXXX);
   ii. Status of remotely-resettable lockouts;
   iii. DTT and RTU Loss of Communication;
   iv. 48VDC and/or 125VDC Charger Trouble. Specific alarms to be determined by HECO at a later date;
   v. Trouble alarm for loss of VDC source(s); and
   vi. Operation of HECO-owned SCADA re-settable lockout relays;
e. Indication Points – DNP 3.0
   i. Status of Customer's medium voltage feeder breakers;
   ii. Violation of Maximum Ramp Rate Upward (Performance Standard); and
   iii. Violation of Maximum Ramp Rate Downward (Performance Standard).

iv. Status Indicating when Maximum Power Import Limit is in effect - Normal or Alarm;
v. Status Indicating when Maximum Power Export Limit is in effect – Normal or Alarm;
vi. EMS Control Status indicating who has control over dispatch and voltage (Local vs HECO);
vii. Voltage Regulation Status – Normal or Alarm (regular On or Off)
viii. Frequency Response Status – Normal or Alarm (On or Off);
ix. Status for each inverter;
x. Grid Following/Grid Forming Status;
xi. Inverter Enable / Disable Feedback Status;
xii. Isochronous Mode Enable / Disable Status;
xiii. PPC Heartbeat Status – Normal or Alarm (On or Off).

11. HECO requires 24 hour access to HECO-owned SCADA/RTU, communication, and HECO-owned relaying and monitoring equipment.

12. HECO shall own a high-speed power quality device (i.e., Tesla Model No. 4000) near the point of interconnection, which shall be in continuous service and on a rolling window basis, monitoring sub-cycle voltages and currents, as well as disturbance events, and capable of remote interrogation following an event. HECO requires 24 hour access to this equipment. Customer to provide the following hard wired inputs to HECO's power quality device:
    a. Status of Customer's 138kV breaker CB-A (HECO# XXXX);
    b. Status of Customer's medium or low voltage breakers that will be used to sequence plant connection to prevent voltage issues upon energization/connection to the grid (as needed per IRS);
    c. Status of remotely-resettable lockouts;
    d. 138kV line amps (3 phase and neutral); and
    138kV line-to-neutral voltage (3 phase).

**Design Notes**

13. All 138kV CT's are to be MRCT's with relaying accuracy class C800 unless noted otherwise. MRCT's are to have full distributed windings on all taps and a minimum thermal rating factor of 2.0. (Provide the Protection Department with CT saturation, ratio correction factor curves, and continuous thermal rating factors.)
14. All microprocessor relays, instruments, CT's, and PT's are to have test switches.