APPENDIX I: Description and Functional Specifications for Transmission Facilities Eligible for Competitive Solicitation

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Overview

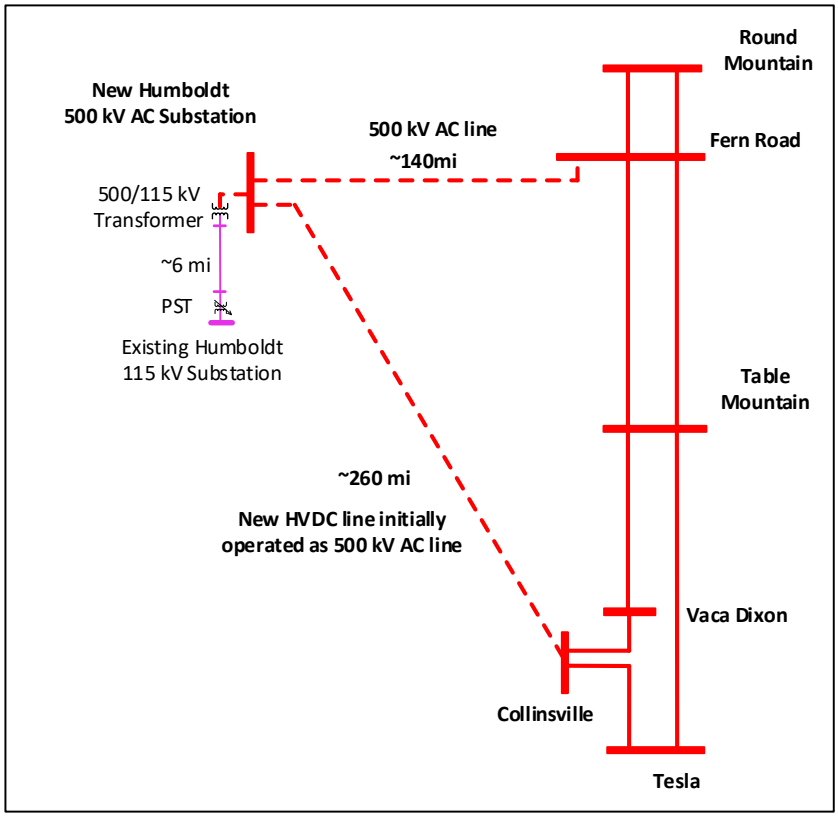
The ISO has recommended the following policy-driven projects for approval that are eligible for competitive solicitation:

- New Humboldt 500 kV Substation, with a 500/115 kV transformer, and 500 kV line to Collinsville [HVDC operated as AC]
- New Humboldt to Fern Road 500 kV Line

These projects are part of the overall transmission plan to integrate the offshore wind resources in the north coast to the rest of the CAISO system. More information on these projects are provided in Chapter 3 and Appendix F.

The CEC has posted under its AB525 Reports webpage [1] a high-level corridor assessment related to the development of potential electric transmission infrastructure needed to access wind energy in federal waters offshore Humboldt County.

Figure I.1-1: Overall Plan to Interconnect Humboldt 500 kV to CAISO System



[1] https://www.energy.ca.gov/data-reports/reports/ab-525-reports-offshore-renewable-energy

The components of the overall plan that are eligible for competitive solicitation process are divided into two projects. The following sections contain detailed descriptions and functional specifications for these two projects.

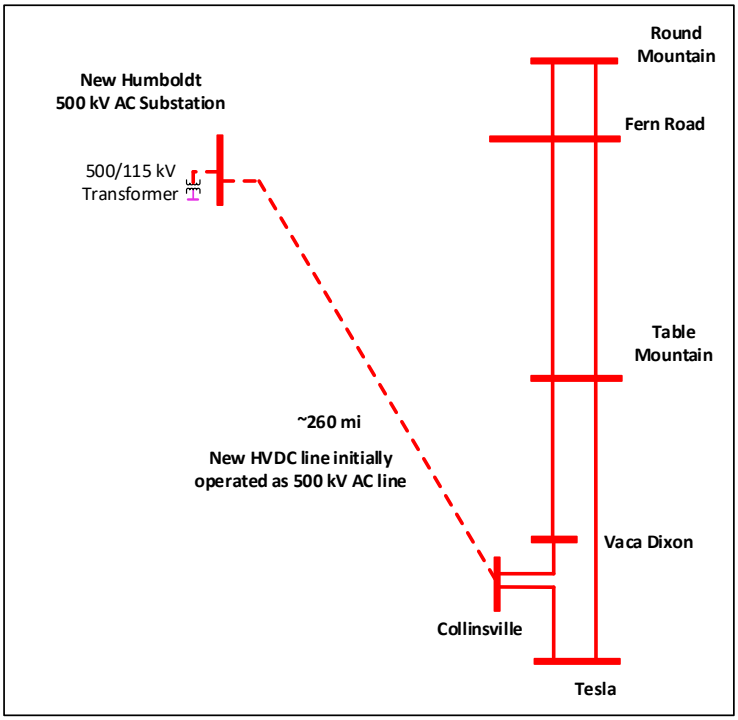
I.1 Description and Functional Specifications for Proposed Policy-Driven New Humboldt 500 kV Substation, with 500/115 kV transformer, and a 500 kV line to Collinsville [HVDC operated as AC] Project

I.1.1 Description

In the 2023-2024 Transmission Plan, the ISO has identified a policy-driven need for the New Humboldt 500 kV Substation with 500 kV line to Collinsville project as part of the overall transmission plan to integrate the offshore wind resources in the north coast to the rest of the CAISO system. Figure I.1-1 provides a schematic diagram of the transmission system in the area. As shown in the figure, the project scope includes the following:

- New 500/115 kV substation in Humboldt with one 500/115 kV transformer
- New Humboldt – Collinsville HVDC line, estimated at 260 miles. This line will initially operate at 500 kV AC with 75% series compensation. No converter station will be installed at intial phase of the implementation. However the project sponsor shall acquire the land for future addition of the converter station at both Humboldt and Collinsvile end of the line.

Figure I.1-1: Schematic Diagram of the New Humboldt 500 kV Substation with 500 kV line to Collinsville project



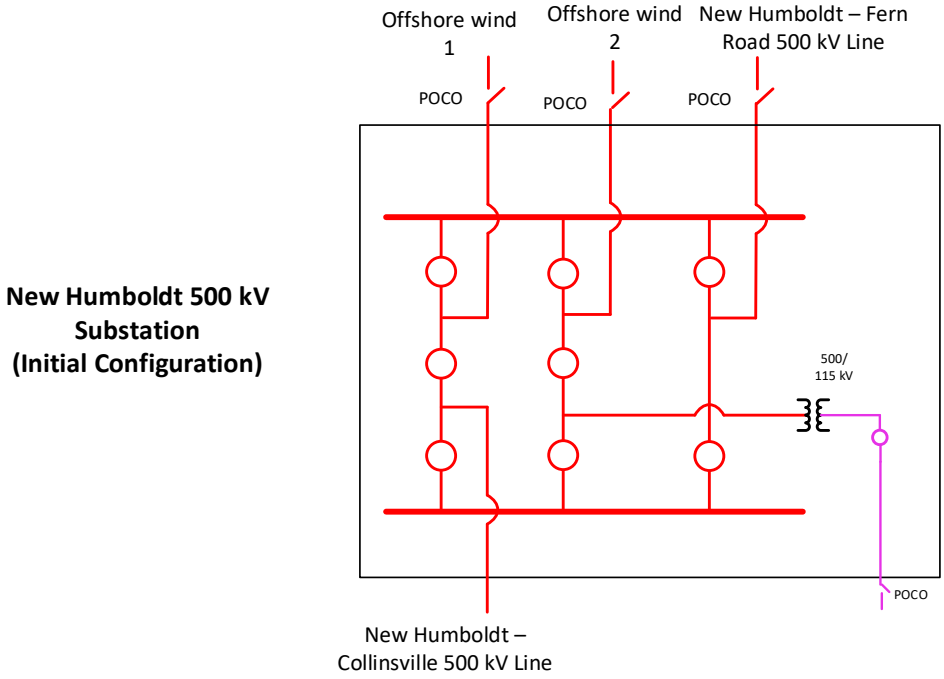
The ISO estimates that the proposed project will approximately cost $1,913 - $2,740 million. The ISO recognizes there may be some uncertainty regarding routing and siting of the 500 kV

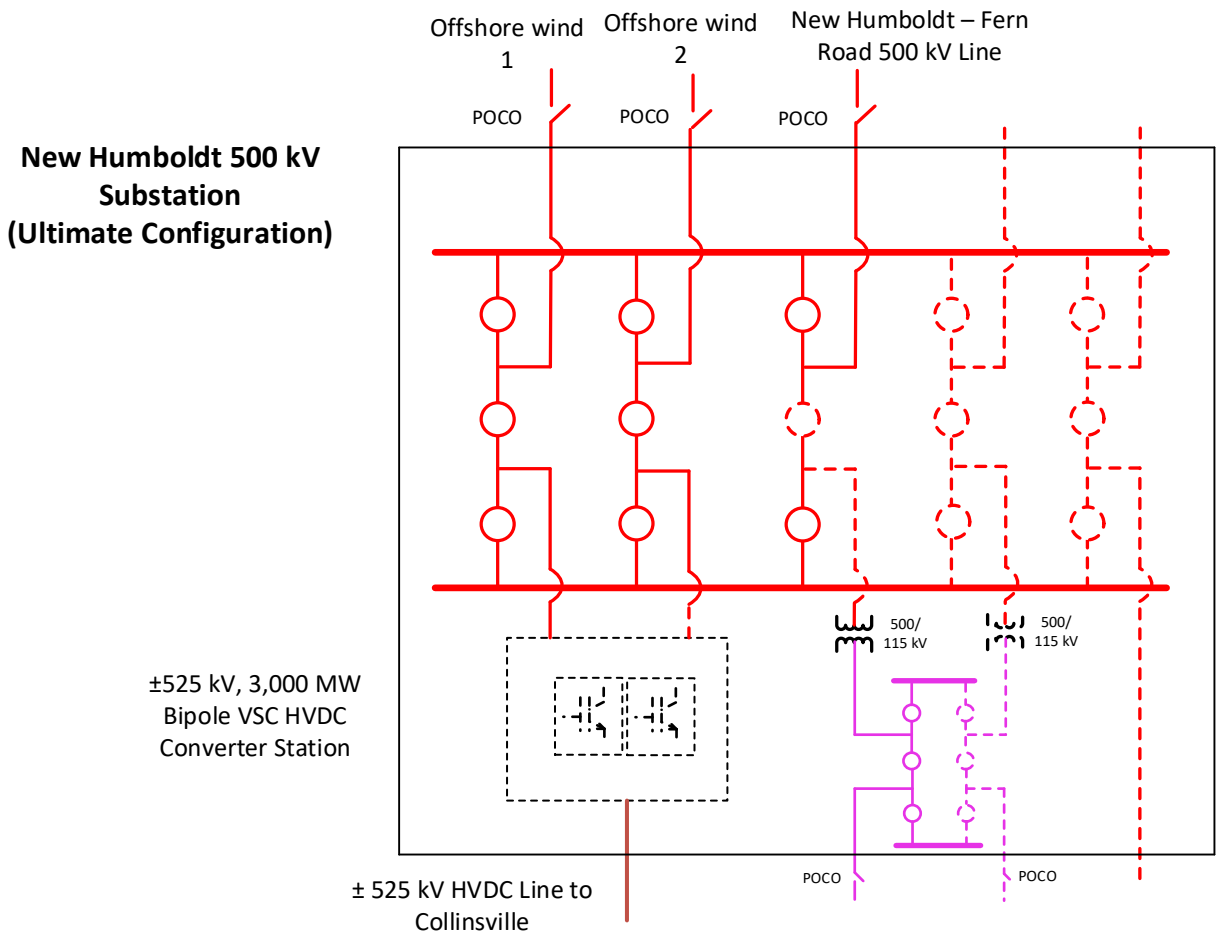
AC transmission line during the siting and permitting process for this project. As such, the ISO will seek cost and risk mitigation strategies from project sponsors' in their bid applications in the competitive solicitation process along with potential alternatives and mitigation measures. The required in-service date for the project is June 1st, 2034.

Beginning with the 2023-2024 Transmission Planning Process, CAISO is now requiring all project sponsors to propose an In Service Date that matches the CAISO requested In Service Date. CAISO will not attribute any value to an In Service Date earlier than the Requested In Service Date.

Figure I.1-2 provides a schematic diagram of the new Humboldt 500/115 kV substation with the initial and the ultimate plan.

Figure I.1-2: Schematic Diagram of the Humboldt 500/115 kV Substation

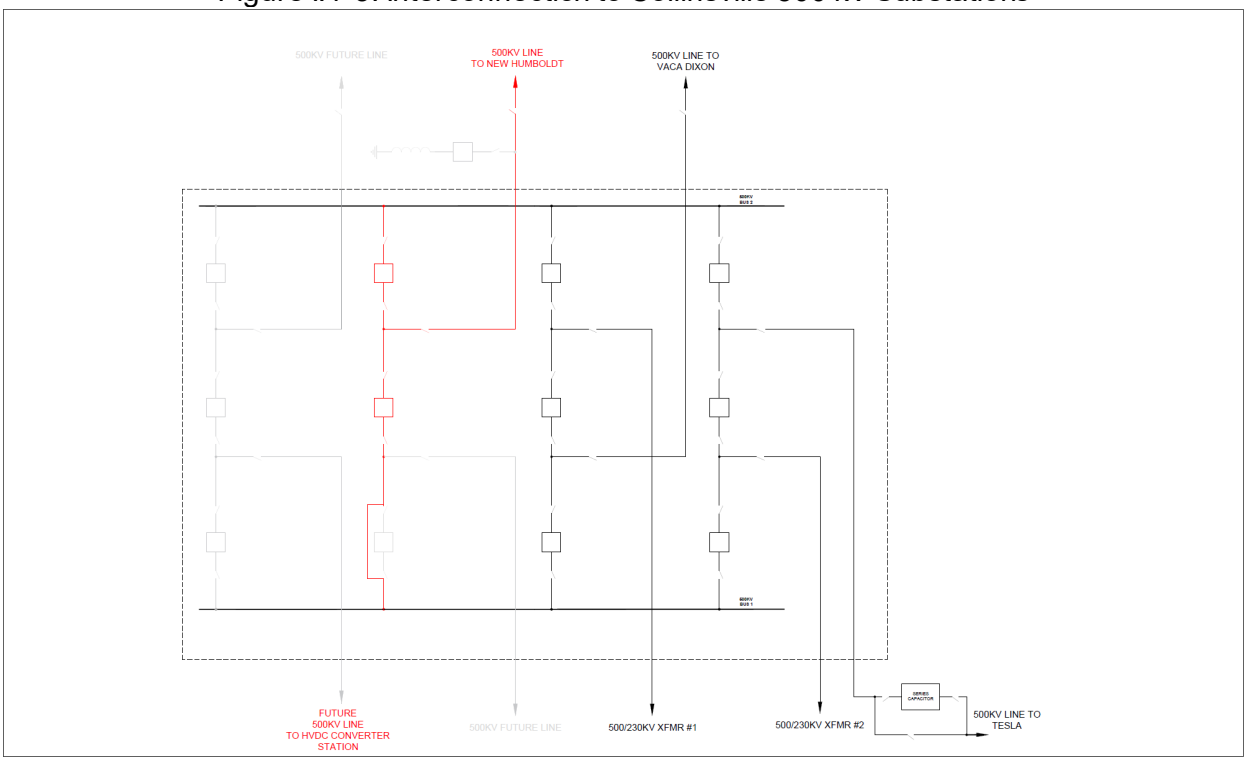




The location of the Humboldt 500/115 kV substation is expected to be within a boundary that is along the existing Humboldt Bay - Humboldt 115 kV line and approximately within 3 miles of the existing 115 kV line corridor.

Figure I.1-3 provides a high level diagram of line terminations and interconnection to the Collinsville 500/230 kV substations. As shown in Figure I.1-3, in the initial phase with 500 kV AC operation, the Humboldt – Collinsville 500 kV line will terminate on a bay position in Collinsville substation. In the ultimate configuration, there would be two 500 kV lines between the future Collinsville HVDC converter station built by the project sponsor and the LSPGC's Collinsville substation. Both two single circuit 500 kV lines or a double circuit 500 kV line between future Collinsville HVDC converter station and planned Collinsville 500/230 kV substation are acceptable.

Figure I.1-3: Interconnection to Collinsville 500 kV Substations



The facilities in the new Humboldt 500 kV Substation with 500 kV line to Collinsville project that are eligible for competitive solicitation are

- The new 500/115 kV Humboldt substation with the 500 kV and 115 kV bus-work and termination equipment
- The 500/115 kV transformer at Humboldt 500 kV Substation
- The new 260-mile 525 kV HVDC line from the new Humboldt 500 kV substation to planned Collinsville 500/230 kV Substation. The line will initially operate as 500 kV AC line.
- The required 500 kV series capacitors and line reactors

For the interconnection of the new Humboldt 500 kV Substation with 500 kV line to Collinsville, the incumbent PTO (LSPGC) will be responsible for installing the new transmission line segment from the Collinsville 500 kV bus up to a point within 100 feet of the Collinsville substation property line. The new line segment will terminate on a dead end structure, to be owned by LSPGC. The approved project sponsor will be responsible for (and will own and maintain) the facilities from this last dead end structure(s) back to the new Humboldt 500 kV Substation.

For the 115 kV interconnection to PG&E system, the project sponsor will be responsible for installing the new 115 kV line segment from the new Humboldt substation 115 kV bus up to a point within 100 feet of the new Humboldt substation property line. The new line segment will terminate on a deadend structure to be owned by the project sponsor. PG&E will be responsible for the facilities from this last deadend structure back to PG&E's existing Humboldt 115 kV substation.

The approved project sponsor, who will own the Humboldt 500 kV substation, will be responsible for owning, operating and maintaining the protection equipment located within the substation that is designated for the protection of the incoming transmission lines.

The approved project sponsor will coordinate with LSPGC and PG&E regarding the specifications and the details of the associated line protection (*e.g.* current differential, directional comparison) etc. and will work with LSPGC and PG&E to develop relay logic and detailed relay settings.

The project sponsor shall provided the details on what design features they are considering to facilitate the transition from AC operation to HVDC operation. The project sponsor shall acquire the land needed for the implementation of the ultimate configuration with HVDC converter stations at Humboldt and Collinsville. The project sponsor shall provide the details of their plan for the implementation of the ultimate configuration including commissioning and testing and how the operation of the line will switch from AC to HVDC with minimum outage requirements.

As the project includes building new transmission facility with voltage level over 200 kV, the approved project sponsor will be responsible for completing the WECC Progress Report and other processes required for this project.

Due to the inherent uncertainty with the development of new technologies such as floating offshore wind off the California coast, the ISO will be taking additional steps to balance the need to engage promptly on long lead time transmission with the need to remain in step with the numerous other parallel development paths needed to enable offshore wind to develop. The ISO is committed to both seeking to prudently manage expenditures that could be the subject of cost recovery processes, as well as providing industry transparency on the pace of transmission development activities and associated cost exposure. Accordingly, the approved project sponsor will be required to provide non-confidential cost tracking information and anticipated major cost commitment decision points through the project development cycle, which the ISO would approve. Further, the ISO is clarifying that consideration of cost containment provisions in the project sponsor selection process can include not only the management of total costs, but the management of costs through the project development lifecycle.

I.1.2 Functional Specification for New Humboldt 500 kV Substation, with 500/115 kV transformer, and a 500 kV line to Collinsville [HVDC operated as AC] Project

Humboldt Substation:

Nominal Phase to Phase AC Voltage: 525/115 kV

500 kV and 115 kV Initial Bus Configuration: Breaker and a half (BAAH)

500 kV and 115 kV Ultimate Bus Configuration: BAAH

Initial Number of 500 kV terminations: 5

Ultimate Number of 500 kV terminations: 10

Initial Number of 500 kV CBs: 8

Ultimate Number of 500 kV CBs: 15

Initial Number of 115 kV terminations: 2

Ultimate Number of 115 kV terminations: 4

Initial Number of 115 kV CBs: 3

Ultimate Number of 115 kV CBs: 6

Initial Minimum 500 kV Continuous Bus Ampacity: _5400 A_ Ultimate Bus Ampacity: _5400 A

Initial Minimum 4 hour 500 kV Bus Ampacity: _7350 A_ Ultimate Bus Ampacity: _7350 A_

Initial Minimum Continuous 115 kV Bus Ampacity: _4000 A_ Ultimate Bus Ampacity: _4000 A_

Initial Minimum 4 hour 115 kV Bus Ampacity: _4000 A_ Ultimate Bus Ampacity: _4000 A_

Minimum 500 kV CB Continuous Ampacity: _4000 A_ Minimum 500 kV CB Interrupting Capability: _63 kA_

Minimum 500 kV CB 4 hour Ampacity: _4400 A_

Minimum 500 kV CB 30 minute Ampacity: _5130 A_

Minimum 115 kV CB Continuous Ampacity: _4000 A_ Minimum CB Interrupting Capability: _63 kA_

Minimum 115 kV CB 4 hour Ampacity: _4000 A_

Transfer Bus Required (SBSB only): N/A

Station Minimum BIL: 550 kV for 115 kV and 1800 kV for 500 kV

Initial Reactive Power Requirements: None

Ultimate Reactive Power Requirements: None

Telemetering Requirements: Install necessary equipment, including RTUs to monitor the typical bulk power elements such as MW, MVAr, and phase currents (Amps) at each line and also voltages (kV) at lines and buses and all circuit breaker (CB) status/control, protection relays statuses and alarms. The installed equipment must be capable of transmitting information to the appropriate Control Center.

In Service Date: The required in-service date is June 1st, 2034.

Low Profile Required: Subject to local permitting requirements

Gas Insulation Required: No, but if proposed shall be enclosed

Initial Number of Transformers: One 3–phase bank with an installed spare. Single phase units are permissible with one single phase spare

Ultimate Number of Transformers: Two 3–phase banks with an installed spare. Single phase units are permissible with one single phase spare

Transformer Nominal High Winding Phase to Phase Voltage: 525 kV

Transformer Nominal Low Winding Phase to Phase Voltage: 115 kV

Tertiary Winding Required: __Yes__ Nominal Voltage Rating: _13.8 kV_

Primary Voltage Winding (wye, grounded wye, delta, etc): Grounded Wye

Secondary Voltage Winding: Grounded Wye; Tertiary Voltage Winding: Corner Grounded Delta

Maximum Transformer % IZ: _17%_ Minimum Transformer %IZ: _13%_

Minimum Transformer Normal Rating: ___ 300 MVA ____ Minimum Transformer 4-hour Emergency Rating: ___300 MVA_____ LTC Required: ___Yes_____

No Load Taps Required: 5 NLTs with two 2.5% taps above & below nominal voltage of 115 kV

CIP 14 requirement: The substation perimeter shall be fenced by a wall

Location of Series Compensation and Line Reactors :

The project sponsor shall specify the locations of the line reactors. Each line reactor shall be at least 100 Mvar. The series compensation at each end of the line shall be 37.5% of the line. At each location, the series capacitor shall be in two equal blocks and each block shall have a bypass breaker so that the operator can bypass the block. The cost of the series compensation and line reactors are within the scope of this project and will be the responsibility of the approved project sponsor.

525 kV HVDC Transmission Line Functional Specifications

Overhead Line Construction

Line Terminus 1: Humboldt Substation 500 kV Bus

Line Terminus 2: Collinsville Substation 500 kV Bus

DC Voltage at Humboldt end: ±525 kV DC

DC Power measured at Humboldt end: 3,000 MW

Functional Specifications for Initial 500 kV AC Operation

Overhead Line Construction

Nominal Phase to Phase Voltage: 525 kV

Minimum Line Continuous Ampacity - Summer: 3800 Amps

Minimum Line Continuous Ampacity – Winter: 3800 Amps

Minimum Line 4 Hour Emergency Ampacity – Summer: 4400 Amps

Minimum Line 4 Hour Emergency Ampacity – Winter: 4400 Amps

Minimum Line 30 Minute Emergency Ampacity: 5130 Amps

Minimum Series Capacitor Continuous Ampacity - Summer: 3800 Amps

Minimum Series Capacitor Continuous Ampacity – Winter: 3800 Amps

Minimum Series Capacitor 4 Hour Continuous Ampacity - Summer: 4400 Amps

Minimum Series Capacitor 4 Hour Continuous Ampacity – Winter: 4400 Amps

Minimum Series Capacitor 30 Minute Emergency Ampacity: 5130 Amps

Approximate Line Impedance: 0.00000728 + j0.000264 pu/mile (500 kV, 100 MVA base), ±20%.

Approximate level of series compensation required: 75%

Approximate Line Length: 260 miles

Requested In Service Date: June 1st, 2034

Support Structures: Single circuit structure

Shield Wire Required: Optical ground wire (minimum 24 pairs of fibers)

Failure Containment Loading Mitigation (anti-cascade structures, etc.): Per applicable codes

Shield Wire Ground Fault Withstand Ampacity: Coordinate with interconnecting entities

Aeolian Vibration Control (Conductor and Shield Wire): Vibration dampers must be installed on all conductors and overhead shield wires, with the exception of slack spans.

Transmission Line Minimum BIL: 1800 kV for 500 kV, with solidly grounded systems

Minimum ROW Width: Per applicable codes

Governing Design and Construction Standards: (GO 95, Known Local Conditions to be compliant with GO 95's High Fire-Threat District maps, facilities that traverse the HFTD will require a Wildfire Mitigation Plan under PUC code 8386, NESC Code, applicable municipal codes)

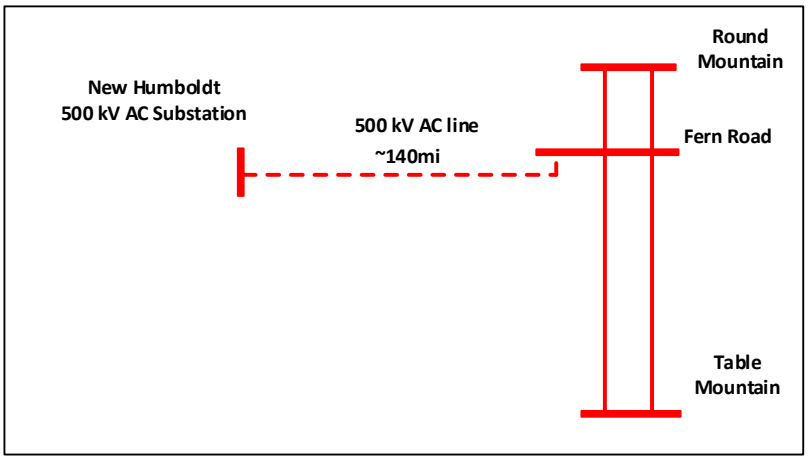
Design Temperature: 50°C

I.2 Description and Functional Specifications of Proposed Policy-Driven New Humboldt to Fern Road 500 kV Line Project

I.1.1 Description

In the 2023-2024 Transmission Plan, the ISO has identified a policy-driven need for the New Humboldt to Fern Road 500 kV Line project as part of the overall transmission plan to integrate the offshore wind resources in the north coast to the rest of the CAISO system. Figure I.2-1 provides a schematic diagram of the transmission system in the area. As shown in Figure I.2-1, the project scope includes the new Humboldt – Fern Road 500 kV line, estimated at 140 miles.

Figure I.2-1: Schematic Diagram of the New Humboldt to Fern Road 500 kV Line Project

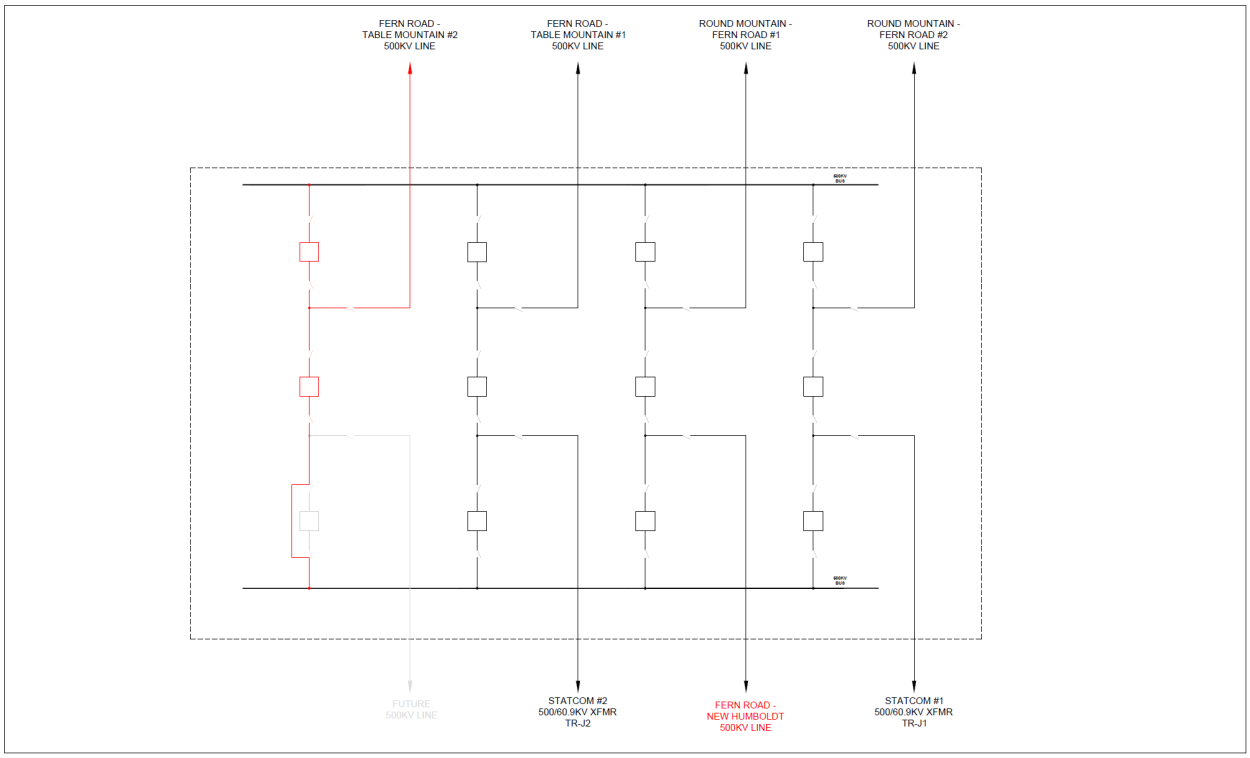


The ISO estimates that the proposed project will approximately cost $980 - $1,400 million. The ISO recognizes there may be some uncertainty regarding routing and siting of the 500 kV AC transmission line during the siting and permitting process for this project. As such, the ISO will seek cost and risk mitigation strategies from project sponsors' in their bid applications in the competitive solicitation process along with potential alternatives and mitigation measures if significant undergrounding of the line is required. The required in-service date for the project is June 1st 2034.

Beginning with the 2023-2024 Transmission Planning Process, CAISO is now requiring all project sponsors to propose an In Service Date that matches the CAISO requested In Service Date. CAISO will not attribute any value to an In Service Date earlier than the Requested In Service Date.

Figure I.2-2 provides a high level diagram of line terminations and interconnection to the Fern Road 500 kV substation, and Figure I.1-2 (in the previous section above) provides a high level diagram of line terminations and interconnection to the new Humboldt substation.

Figure I.2-2: Interconnection to Fern Road 500 kV Substation



The facilities in the New Humboldt to Fern Road 500 kV Line project that are eligible for competitive solicitation is the new 140-mile 500 kV line from New Humboldt 500 kV to Fern Road 500 kV Substation.

For the interconnection of the New Humboldt to Fern Road 500 kV Line, the incumbent PTO (LSPGC) will be responsible for installing the new transmission line segments from the Fern Road 500 kV bus up to a point within 100 feet of the Fern Road substation property line. The new line segment will terminate on a deadend structure, to be owned by LSPGC. The approved project sponsor will be responsible for (and will own and maintain) the facilities from this last deadend structure back to the New Humboldt 500 kV Substation.

For the interconnection of the New Humboldt to Fern Road 500 kV Line to the New Humboldt 500 kV substation, the project sponsor for the New Humboldt 500 kV Substation, with 500/115 kV transformer, and a 500 kV line to Collinsville [HVDC operated as AC] Project will be responsible for installing the new transmission line segment from the New Humboldt 500 kV bus up to a point within 100 feet of the New Humboldt substation property line. The new line segment will terminate on a deadend structure(s), to be owned by the project sponsor for New Humboldt 500 kV Substation with 500 kV line to Collinsville Project. The approved project sponsor will be responsible for (and will own and maintain) the facilities from this last deadend structure(s) back to the Fern Road Substation.

The approved project sponsor will coordinate with LSPGC and the project sponsor for the New Humboldt 500 kV Substation, with 500/115 kV transformer, and a 500 kV line to Collinsville [HVDC operated as AC] Project regarding the specifications and the details of the associated

line protection (*e.g*. current differential, directional comparison) etc. and will work with LSPGC and the project sponsor for the New Humboldt 500 kV Substation with 500 kV line to Collinsville Project to develop relay logic and detailed relay settings.

As the project includes building new transmission facility with voltage level over 200 kV, the approved project sponsor will be responsible for completing the WECC Progress Report and other processes required for this project.

Due to the inherent uncertainty with the development of new technologies such as floating offshore wind off the California coast, the ISO will be taking additional steps to balance the need to engage promptly on long lead time transmission with the need to remain in step with the numerous other parallel development paths needed to enable offshore wind to develop. The ISO is committed to both seeking to prudently manage expenditures that could be the subject of cost recovery processes, as well as providing industry transparency on the pace of transmission development activities and associated cost exposure. Accordingly, the approved project sponsor will be required to provide non-confidential cost tracking information and anticipated major cost commitment decision points through the project development cycle, which the ISO would approve. Further, the ISO is clarifying that consideration of cost containment provisions in the project sponsor selection process can include not only the management of total costs, but the management of costs through the project development lifecycle.

I2.1 Functional Specification for New Humboldt – Fern Road 500 kV Line Project

500 kV Transmission Line Functional Specifications

Overhead Line Construction

Line Terminus 1: New Humboldt Substation 500 kV Bus

Line Terminus 2: Fern Road Substation 500 kV Bus

Nominal Phase to Phase Voltage: 525 kV

Minimum Line Continuous Ampacity - Summer: 3800 Amps

Minimum Line Continuous Ampacity – Winter: 3800 Amps

Minimum Line 4 Hour Emergency Ampacity – Summer: 4400 Amps

Minimum Line 4 Hour Emergency Ampacity – Winter: 4400 Amps

Minimum Line 30 Minute Emergency Ampacity: 5130 Amps

Minimum Series Capacitor Continuous Ampacity - Summer: 3800 Amps

Minimum Series Capacitor Continuous Ampacity – Winter: 3800 Amps

Minimum Series Capacitor 4 Hour Continuous Ampacity - Summer: 4400 Amps

Minimum Series Capacitor 4 Hour Continuous Ampacity – Winter: 4400 Amps

Minimum Series Capacitor 30 Minute Emergency Ampacity: 5130 Amps

Approximate Line Impedance: 0.00000728 + j0.000264 pu/mile (500 kV, 100 MVA base), ±20%.

Approximate level of series compensation required: 75%

Approximate Line Length: 140 miles

Requested Service Date: June 1st, 2034.

Support Structures: Single circuit structure

Shield Wire Required: Optical ground wire (minimum 24 pairs of fibers)

Failure Containment Loading Mitigation (anti-cascade structures, etc.): Per applicable codes

Shield Wire Ground Fault Withstand Ampacity: Coordinate with interconnecting entities

Aeolian Vibration Control (Conductor and Shield Wire): Vibration dampers must be installed on all conductors and overhead shield wires, with the exception of slack spans.

Transmission Line Minimum BIL: 1800 kV with solidly grounded systems

Minimum ROW Width: Per applicable codes

Governing Design and Construction Standards: (GO 95, Known Local Conditions to be compliant with GO 95's High Fire-Threat District maps, facilities that traverse the HFTD will require a Wildfire Mitigation Plan under PUC code 8386, NESC Code, applicable municipal codes)

Design Temperature: 50°C

Location of Series Compensation and Line Reactors :

The project sponsor shall specify the locations of the line reactors. Each line reactor shall be at least 100 Mvar. The series compensation at each end of the line shall be 37.5% of the line. At each location, the series capacitor shall be in two equal blocks and each block shall have a bypass breaker so that the operator can bypass the block. The cost of the series compensation and line reactors are within the scope of this project and will be the responsibility of the approved project sponsor.