PJM Feasibility Study Report

Long-Term Firm Transmission Service

OASIS Assignment Reference 4954950
Queue Project AE1-042

January 30, 2019

Network Impacts

The Queue Project AE1-042 (OASIS Request 4954950) was evaluated as a 180 MW injection from the Morgan Combined Cycle units in TVA to PJM. Project AE1-042 was evaluated for compliance with applicable reliability planning criteria (PJM, NERC, NERC Regional Reliability Councils, and Transmission Owners). Project AE1-042 was studied with a commercial probability of 100%. Potential network impacts were as follows:

Summer Peak Analysis - 2022

Generator Deliverability

(Single or N-1 contingencies for the Capacity portion only of the interconnection)

ID	FROM BUS#	FROM BUS	FROM BUS AREA	TO BUS#	TO BUS	TO BUS AREA	CKT ID	CONT NAME	Type	Rating MVA	PRE PROJECT LOADING %	POST PROJECT LOADING %	AC|DC	MW IMPACT
70833	314903	8CHCKAHM	DVP	314908	8ELMONT	DVP	1	DVP_P1-2: LN 208	single	2442.12	99.92	100.15	AC	5.46
72435	342838	7SPURLOCK	EKPC	253077	09STUART	DAY	1	Base Case	single	1240.0	98.18	100.73	AC	6.06

Multiple Facility Contingency

(Double Circuit Tower Line, Fault with a Stuck Breaker, and Bus Fault contingencies for the full energy output)

None

Contribution to Previously Identified Overloads

(This project contributes to the following contingency overloads, i.e. "Network Impacts", identified for earlier generation or transmission interconnection projects in the PJM Queue)

None

Contingency Definitions

Contingency Name	Contingency Definitions
Base Case	
DVP_P1-2: LN 208	CONTINGENCY 'DVP_P1-2: LN 208' OPEN BRANCH FROM BUS 314286 TO BUS 314309 CKT 1 /* 6CHESTF A 230.00 - 6IRON208 230.00 OPEN BRANCH FROM BUS 314309 TO BUS 314338 CKT 1 /* 6IRON208 230.00 - 6SOUWEST 230.00 OPEN BUS 314309 /* ISLAND: 6IRON208 230.00 END

System Reinforcements

ID	Appendix	Facility	Upgrade Description	Cost
72435	2	**7SPURLOCK 345.0 kV - 09STUART 345.0 kV Ckt 1**	Description : Dayton will upgrade the conductor on its section of the line with bundled 954 MCM 54x7 ACSS rated at 300F Time Estimate : 20.0 Months Cost : $8,000,000	$8,000,000
70833	1	**8CHCKAHM 500.0 kV - 8ELMONT 500.0 kV Ckt 1**	Description : Rebuild / Uprate Line 557 - 28 mi Va CPCN Time Estimate : 36-44 Months Cost : $84,000,000	$84,000,000
		TOTAL COST	**$92,000,000**	

Flow Gate Details

The following appendices contain additional information about each flowgate presented in the body of the report. For each appendix, a description of the flowgate and its contingency was included for convenience. However, the intent of the appendix section is to provide more information on which projects/generators have contributions to the flowgate in question. Although this information is not used "as is" for cost allocation purposes, it can be used to gage other generators impact. It should be noted the generator contributions presented in the appendices sections are full contributions, whereas in the body of the report, those contributions take into consideration the commercial probability of each project.

Appendix 1

ID	FROM BUS#	FROM BUS	FROM BUS AREA	TO BUS#	TO BUS	TO BUS AREA	CKT ID	CONT NAME	Type	Rating MVA	PRE PROJECT LOADING %	POST PROJECT LOADING %	AC|DC	MW IMPACT
70833	314903	8CHCKAHM	DVP	314908	8ELMONT	DVP	1	DVP_P1-2: LN 208	single	2442.12	99.92	100.15	AC	5.46

Bus #	Bus	MW Impact
314554	3BTLEBRO	0.8
314557	3BETHELC	1.03
314566	3CRESWEL	4.83
314572	3EMPORIA	0.29
314574	6EVERETS	7.19
314578	3HORNRTN	3.25
314582	3KELFORD	5.65
314594	6PLYMOTH	1.73
314603	3SCOT NK	4.62
314617	3TUNIS	1.17
314620	6CASHIE	1.77
314623	3WITAKRS	1.4
315131	1EDGECMA	9.42
315132	1EDGECMB	9.42
315136	1ROSEMG1	2.38
315137	1ROSEMS1	1.47
315139	1GASTONA	3.34
315141	1GASTONB	3.34
315292	1DOMTR78	2.84
315293	1DOMTR9	2.32
315294	1DOMTR10	4.21
900672	V4-068 E	0.31
917331	Z2-043 C	0.65
917332	Z2-043 E	1.61
917342	Z2-044 E	0.6
917511	Z2-088 C OP1	2.35
917512	Z2-088 E OP1	5.86
918491	AA1-063AC OP	1.9
918492	AA1-063AE OP	5.21
918511	AA1-065 C OP	3.36

Bus #	Bus	MW Impact
918512	AA1-065 E OP	9.61
918531	AA1-067 C	0.51
918532	AA1-067 E	1.27
918561	AA1-072 C	0.1
918562	AA1-072 E	0.27
919691	AA2-053 C	1.72
919692	AA2-053 E	4.29
919701	AA2-057 C	7.67
919702	AA2-057 E	3.83
920042	AA2-088 E OP	6.59
920592	AA2-165 E	0.51
920671	AA2-174 C	0.08
920672	AA2-174 E	0.5
920691	AA2-178 C	3.33
920692	AA2-178 E	8.29
923911	AB2-031 C O1	1.74
923912	AB2-031 E O1	0.86
923941	AB2-035 C	0.43
923942	AB2-035 E	0.19
923992	AB2-040 E O1	4.68
924152	AB2-059 E O1	5.43
924391	AB2-088 C	0.56
924392	AB2-088 E	0.27
924401	AB2-089 C	1.24
924402	AB2-089 E	0.64
924491	AB2-098 C	0.99
924492	AB2-098 E	0.42
924501	AB2-099 C	0.95
924502	AB2-099 E	0.41
924511	AB2-100 C	7.11
924512	AB2-100 E	3.5
925121	AB2-169 C	2.11
925122	AB2-169 E	11.02
925171	AB2-174 C O1	5.2
925172	AB2-174 E O1	4.71
925291	AB2-188 C O1	4.76
925292	AB2-188 E O1	2.14
925591	AC1-034 C	6.83

Bus #	Bus	MW Impact
925592	AC1-034 E	5.15
925781	AC1-054 C O1	4.49
925782	AC1-054 E O1	2.07
926071	AC1-086 C	21.85
926072	AC1-086 E	9.94
926201	AC1-098 C	7.82
926202	AC1-098 E	4.66
926211	AC1-099 C	2.62
926212	AC1-099 E	1.54
927021	AC1-189 C	13.69
927022	AC1-189 E	6.82
927141	AC1-208 C	10.09
927142	AC1-208 E	4.48
930402	AB1-081 E O1	3.83
930861	AB1-132 C O1	2.55
930862	AB1-132 E O1	6.36
931232	AB1-173 E	0.82
931242	AB1-173AE	0.82
932631	AC2-084 C	11.15
932632	AC2-084 E	5.49
933991	AD1-023 C	27.21
933992	AD1-023 E	14.81
934201	AD1-047 C	6.24
934202	AD1-047 E	4.16
934231	AD1-050 C	2.73
934232	AD1-050 E	1.49
934331	AD1-057 C O1	10.32
934332	AD1-057 E O1	5.51
934521	AD1-076 C	110.73
934522	AD1-076 E	56.38
936401	AD2-051 C O1	15.91
936402	AD2-051 E O1	6.83
936531	AD2-068 C	6.56
936532	AD2-068 E	3.38
936701	AD2-089 C	9.29
936702	AD2-089 E	6.19
937571	AD2-169 C	8.21
937572	AD2-169 E	5.47

Bus #	Bus	MW Impact
938171	AE1-026 C1 O	58.57
938172	AE1-026 C2 O	8.47
938173	AE1-026 E O1	17.69
938221	AE1-035 C	4.88
938222	AE1-035 E	2.4
AA2-074	AA2-074	2.73
CARR	CARR	0.19
CBM-S1	CBM-S1	6.01
CBM-S2	CBM-S2	7.07
CBM-W1	CBM-W1	6.24
CBM-W2	CBM-W2	39.71
CIN	CIN	2.8
CPLE	CPLE	4.01
G-007	G-007	0.68
IPL	IPL	1.75
LGEE	LGEE	0.81
MEC	MEC	6.17
MECS	MECS	2.73
O-066	O-066	2.26
RENSSELAER	RENSSELAER	0.15
WEC	WEC	0.75

Appendix 2

ID	FROM BUS#	FROM BUS	FROM BUS AREA	TO BUS#	TO BUS	TO BUS AREA	CKT ID	CONT NAME	Type	Rating MVA	PRE PROJECT LOADING %	POST PROJECT LOADING %	AC|DC	MW IMPACT
72435	342838	7SPURLOCK	EKPC	253077	09STUART	DAY	1	Base Case	single	1240.0	98.18	100.73	AC	6.06

Bus #	Bus	MW Impact
206271	28MCRC/REC	0.26
206325	28O C GEN	74.95
206327	28S RIV G1	8.97
206328	28S RIV G2	8.97
206329	28S RIV G3	11.83
206358	28PARLN1&2	1.9
206359	28PARLN3&4	2.27
206363	28RDOAKCT2	21.73
206364	28RDOAKCT3	21.73
206412	28R11	308.65
207204	28HOL_W1-112	0.05
207206	28TIN_W1-124	0.29
901912	W1-112E OP1	0.48
902032	W1-124E	2.76
903981	W3-079 C	0.07
903982	W3-079 E	0.68
907082	X1-037 E	1.56
912182	X4-031 E	0.38
914092	Y2-051 E	0.47
917682	Z2-109 E	14.03
919662	AA2-048 E	1.07
919672	AA2-049 E	0.67
920732	AA2-184 E	4.44
925541	AC1-029	2.42
930891	AB1-138 C	0.48
930892	AB1-138 E	0.8
931122	AB1-163 E	0.65
937261	AD2-165	28.06
938151	AE1-020 C O1	37.63
938152	AE1-020 E O1	96.28

Bus #	Bus	MW Impact
938211	AE1-034 C O1	45.29
938212	AE1-034 E O1	115.87
BAYOU	BAYOU	0.22
BIG_CAJUN1	BIG_CAJUN1	0.33
BIG_CAJUN2	BIG_CAJUN2	0.67
BLUEG	BLUEG	1.09
CALDERWOOD	CALDERWOOD	0.11
CANNELTON	CANNELTON	0.07
CARR	CARR	0.79
CATAWBA	CATAWBA	0.06
CHEOAH	CHEOAH	0.1
CHILHOWEE	CHILHOWEE	0.04
CHOCTAW	CHOCTAW	0.22
COFFEEN	COFFEEN	0.11
COTTONWOOD	COTTONWOOD	0.86
DEARBORN	DEARBORN	0.21
DUCKCREEK	DUCKCREEK	0.25
EDWARDS	EDWARDS	0.12
ELMERSMITH	ELMERSMITH	0.11
FARMERCITY	FARMERCITY	0.08
G-007	G-007	23.12
GIBSON	GIBSON	0.05
HAMLET	HAMLET	0.21
NEWTON	NEWTON	0.3
O-066	O-066	13.71
PRAIRIE	PRAIRIE	0.55
RENSSELAER	RENSSELAER	0.63
SANTEETLA	SANTEETLA	0.03
SMITHLAND	SMITHLAND	0.04
TATANKA	TATANKA	0.14
TILTON	TILTON	0.14
TRIMBLE	TRIMBLE	0.12
TVA	TVA	0.36
UNIONPOWER	UNIONPOWER	0.16

ATTACHMENT PP

Form of

Firm Transmission Feasibility Study Agreement

Company name: Calpine Energy Services, L.P.

OASIS Request	Start	Stop	Amount	Path	Date & Time of Request
4954950	06/01/2021	06/01/2026	180 MW	TVA-PJM	06/27/2018 15:31

PURPOSE

A Firm Transmission Feasibility Study is used to determine whether or not the Transmission System is adequate to accommodate all or part of a request for long-term firm transmission service under both Part II (POINT-TO-POINT TRANSMISSION SERVICE) or Part III (NETWORK INTEGRATION TRANSMISSION SERVICE) of the PJM Open Access Transmission Tariff (the "Tariff) (together referred to as "long-term firm transmission service"). The FERC comparability standard is applied in evaluating the impact of all requests.

SCOPE OF WORK

The Firm Transmission Feasibility Study will determine if the PJM network has sufficient capability to grant the transmission service.

The Firm Transmission Feasibility Study indicates whether or not the request for service can be granted based on expected system conditions and topology. Pursuant to Section 19.3 or Section 32.3 of the Tariff, upon completion of the Firm Transmission Feasibility Study, PJM will notify the transmission customer that (a) the transmission service request is accepted, or (b) additional analysis is required. Pursuant to Part VI of the Tariff, additional analysis will only commence if the customer elects to continue to the System Impact Study within 30 days of notification.

General

Firm Transmission Feasibility Studies are performed on transmission service requests in the order in which they are received. Multiple requests for overlapping periods and similar paths are evaluated until a limit is reached. Transmission service requests are held in "Study" status until requests received earlier have been confirmed or withdrawn. If the study demonstrates that the requested service can be accepted, the status of the request is changed to "Accepted" on the PJM OASIS. As soon as possible after notification of acceptance, the Transmission Customer should "Confirm" the transmission request. If accepted service is not confirmed within 15 days, the request is deemed "Withdrawn," and other requests waiting in the queue can then be studied.

Network Analysis and Deliverability Test

PJM evaluates requests for long-term firm transmission service using deliverability tests commensurate with the testing employed for evaluating generation interconnection requests. The energy from generating facilities or the energy delivered using long-term firm transmission service that is ultimately committed to meet resource requirements must be deliverable to where it is needed in the event of a system emergency. Therefore, there must be sufficient transmission network transfer capability within the control area. PJM determines the sufficiency of network transfer capability through a series of "deliverability tests." All generator interconnections and long-term firm transmission service in PJM are subjected to the same deliverability tests. The FERC comparability standard is applied in evaluating the impact of all requests.

Rollover Rights

Pursuant to section 2.2 of the PJM Tariff:

Existing firm service customers of any Transmission Owner (wholesale requirements and transmission-only, with a contract term of five-years or more), may request rollover/reservation priority rights at the end of the term of the service. However, rollover rights may be limited in some cases. For instance, if the System Impact Study identifies limits caused by reliability problems (unless Direct Assignment Facilities or Network Upgrades are constructed to provide the requested service), the Transmission Customer will be notified of the limitation. The Service Agreement will include language which will reserve to PJM the right to limit rollovers in such circumstances. Therefore, the Transmission Customer may not be able to exercise reservation/rollover priority rights, in whole or in part, which it may otherwise have pursuant to Section 2.2 of the Tariff upon the initial termination date of the Transmission Service unless the Direct Assignment Facilities and/or Network Upgrades identified in the System Impact Study and/or Facilities Studies are completed pursuant to Part VI.

Reliability problems which may be identified by the System Impact Study and which may require additional Direct Assignment Facilities or Network Upgrades to provide the requested service include the following:

Limiting rollover rights for Deliverability.

If there is not enough system capability to accommodate rollover rights beyond the initial term PJM may explicitly state in the transmission service agreement that rollover rights for the requested service will be limited.

Limiting rollover rights for earlier queued transmission or generation interconnections.

As a part of the Firm Transmission Feasibility Study, the request is tested to verify that the service can co-exist with generators whose interconnection request predates the transmission service request. If the transmission service cannot co-exist with a planned generator whose interconnection request predates the transmission service request, and the original transmission service request does not conflict with the generator in service

date, the request will be approved. However, the transmission customer will be notified that the service has limited rollover rights. If the customer requests to renew the transmission service, another Firm Transmission Feasibility Study may be required.

Estimated Time and Cost to Complete the Firm Transmission Feasibility Study

In the event that the Transmission Provider is unable to complete the Firm Transmission Feasibility Study within the timeframe prescribed in Section 36.2 of the PJM Tariff, the Transmission Provider shall notify the Interconnection Customer and explain the reasons for the delay. The cost to complete the Firm Transmission Feasibility Study is estimated at $20,000.

ADDITIONAL TERMS AND CONDITIONS
FIRM TRANSMISSION FEASIBILITY STUDY AGREEMENT
FOR LONG-TERM FIRM TRANSMISSION SERVICE REQUESTS

1.0 This Agreement for a Firm Transmission Feasibility Study for Long-Term Firm Transmission Service Requests ("Firm Transmission Feasibility Study Agreement") is entered into, by and between PJM Interconnection, L.L.C. ("PJM") and **Calpine Energy Services, L.P.** ("Customer").

2.0 PJM has determined that the Transmission Customer has completed the Application for Firm Point-To-Point Transmission Service or Network Service under the PJM Open Access Transmission Tariff ("Tariff") and has provided an Application deposit in accordance with the provisions of the Tariff. The Tariff is accessible through the PJM OASIS.

3.0 PJM has determined that a Firm Transmission Feasibility Study for Transmission Service needs to be conducted to evaluate the request.

4.0 PJM will conduct the Firm Transmission Feasibility Study in accordance with the procedures described in the PJM Manuals, the Tariff and this Firm Transmission Feasibility Study Agreement.

5.0 This Firm Transmission Feasibility Study Agreement indicates the Scope of the Work required to evaluate the request and provides an estimated cost and schedule for completing the subject Firm Transmission Feasibility Study for Transmission Service. The Customer shall be responsible for actual charges associated with the Firm Transmission Feasibility Study.

6.0 Any notice or request made to or by either PJM or the Transmission Customer, regarding this Firm Transmission Feasibility Study Agreement shall be made to the representatives listed below.

7.0 This Firm Transmission Feasibility Study Agreement **must be executed** by the Transmission Customer **and returned to PJM within (fifteen) 15 days** of the Date stated below, or this Agreement will be void.

8.0 In accordance with Part II, (POINT-TO-POINT TRANSMISSION SERVICE), Section 19 (Firm Transmission Feasibility Study Procedures For Long-Term Firm Point-To-Point Transmission Service Requests) Section 19.1 (Notice of Need for Firm Transmission Feasibility Study) and Part III, (NETWORK INTEGRATION TRANSMISSION SERVICE), Section 32 (Firm Transmission Feasibility Study Procedures for Network Integration Transmission Service Requests), and Section 32.1 (Notice of Need for Firm Transmission Feasibility Study) of the Tariff, the Eligible Customer shall agree to reimburse the Transmission Provider for performing the required Firm Transmission Feasibility Study.

In some cases, the requested service cannot be granted upon completion of the Firm Transmission Feasibility Study. If the Customer has withdrawn its New Service Request or has not requested completion of a System Impact Study within 30 days of completion of the Firm Transmission Feasibility Study, its New Service Request will be deemed to be withdrawn and terminated.

Transmission Provider
PJM Interconnection, L.L.C.
2750 Monroe Blvd.
Audubon, PA 19403

Agent: DocuSigned by: David M Egan 961A5286D8214D8...

Date: 7/18/2018

Transmission Customer
Calpine Energy Services, L.P.
717 Texas Avenue, Suite 1000
Houston, TX 77002

Agent: DocuSigned by: Seth Berend 44384A6DF8D64D4...

Date: 7/9/2018