Delaware Basin Load Integration Study – Final Update

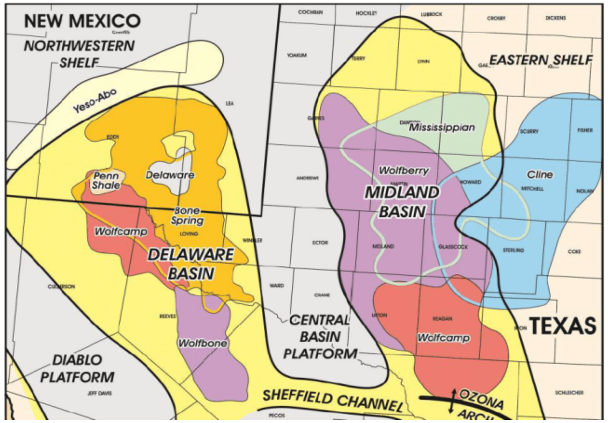
ERCOT Transmission Planning

Regional Planning Group
December 17, 2019

Outline

- Motivation and Purpose
- Study Assumptions and Methodology
- Study Results and Recommendation

Motivation and Purpose of Delaware Basin Study



- Motivation:
  - The Far West Weather Zone, especially in the Delaware Basin area with significant oil and natural gas load, has had the highest peak demand growth rate percentage in the ERCOT region in recent years
  - Ensuring that the transmission improvements are in place in time to serve the load has been a challenge
  - Oil and gas customers do not typically provide financial commitment for new load additions more than one to two years in advance. However, major transmission improvements (e.g. new 345-kV lines) can take more than five years to complete

Motivation and Purpose of Delaware Basin Study

- Purpose:
  - To perform higher-than-committed load growth studies to identify cost-effective bulk power system upgrades that may be necessary if load in the Delaware Basin continues to increase at rapid pace through 2024
  - To identify long lead time transmission improvements to reliably serve the assumed load

Study Progress Overview

ERCOT worked with stakeholders to develop the study scope
(January 2019)

TSPs provided higher-than-committed load addition
(May 2019 RPG)

ERCOT conducted reliability study and provided status updates to TSPs and RPG
(May ~ December 2019)

Delaware Basin Load Projection for Year 2024	
2019 Regional Transmission Plan (based on Planning Guide Section 3.1.7)	2,688 MW
Delaware Basin Study (include higher than committed load)	5,372 MW

Study Assumptions

- Solar generation resources were assumed to be offline in the Delaware Basin area
- TSPs provided upgrades and new circuits (if there were no existing transmission facilities in the area) to interconnect the projected load additions
- The focus of the study was on steady state analysis to identify long lead time transmission improvements needed to reliably serve the assumed load

Study Methodology

Types of Upgrades Considered	Comment
Long lead time Extra High Voltage circuits (e.g. new 345-kV lines)	**This was the focus of the analysis**
Existing 345-kV line upgrades	Included in the analysis
New 138-kV lines	Included in the analysis, but not optimized
Existing 138-kV and 69-kV line upgrades	Included in the analysis, but not optimized
Voltages support devices, static and dynamic	Included in the analysis, but stability analysis was not performed to optimize

Study Methodology

Identify reliability criteria violations

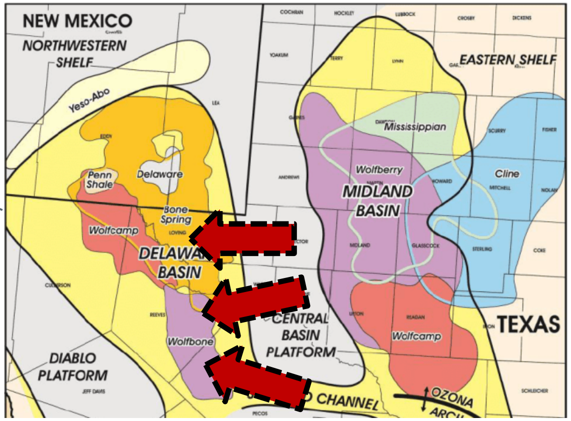
Develop upgrade options

Short-list upgrade options

Finalize results

Common HV and voltage support upgrades

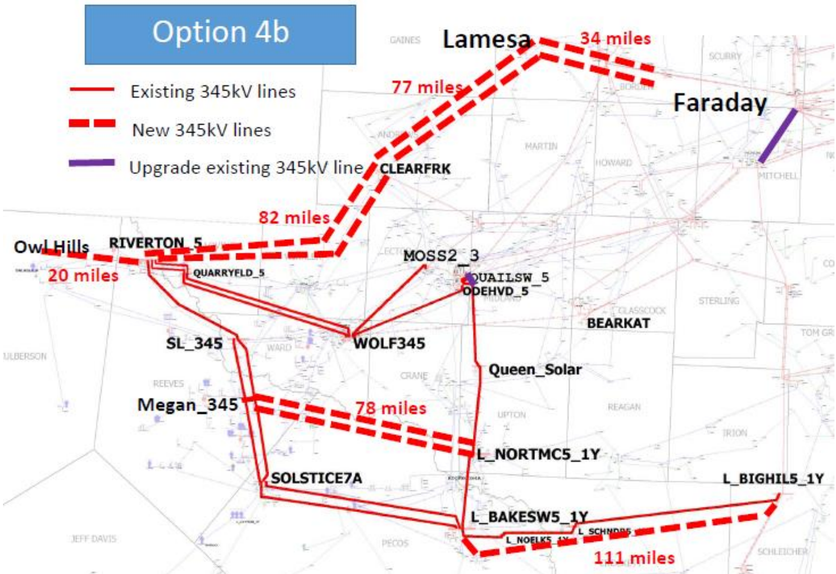
Unique EHV import options

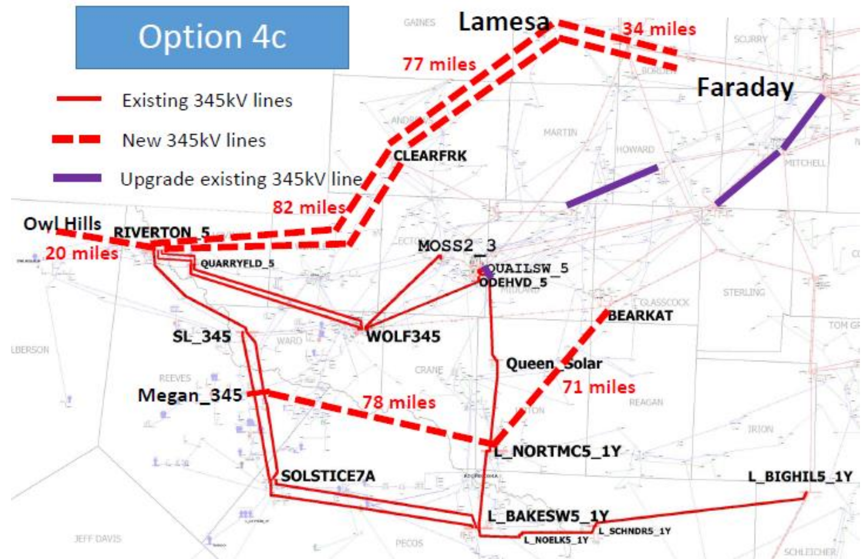


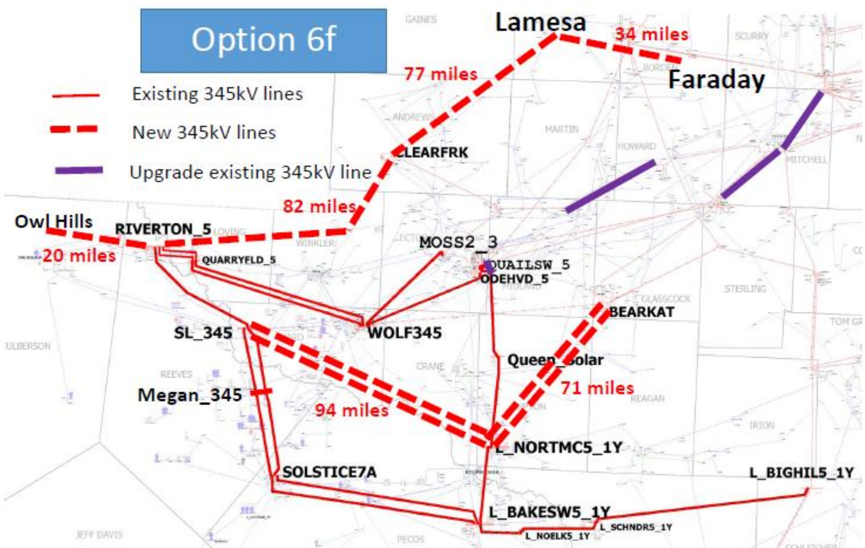
Summary of the Import Options

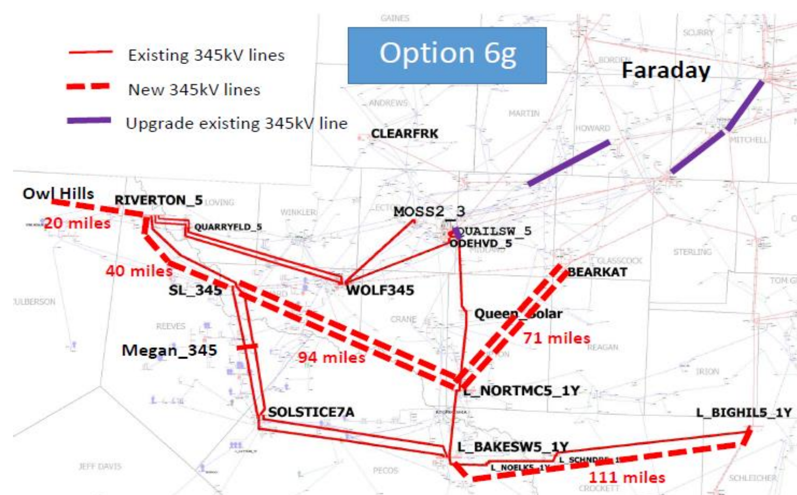
- More than ten import options were initially identified to reliably serve the projected Delaware Basin load under normal and tested N-1 conditions. These options are mainly composed of the following components:
  - New 345-kV, 765-kV, or HVDC circuits
  - Upgrade existing 345-kV circuits
  - Add 2nd circuit on the existing tower structure
- Four short-listed import options were selected based on G-1+N-1, X-1+N-1, and N-1-1 reliability tests
- Options Maps were provided in the Appendix

Four short-listed import options









Four short-listed import options

- 345-kV transmission improvement details

Import Options	4b	4c	6f	6g
	Miles	Miles	Miles	Miles
Upgrade Existing 345-kV Ckts	22	107	107	107
Add 2nd 345-kV Ckts on the existing structures	111	--	--	151
New 345-kV Double Ckts	271	193	164	164
New 345-kV Single Ckt (on double circuit structures)	20	169	213	20
Total	425	469	485	443

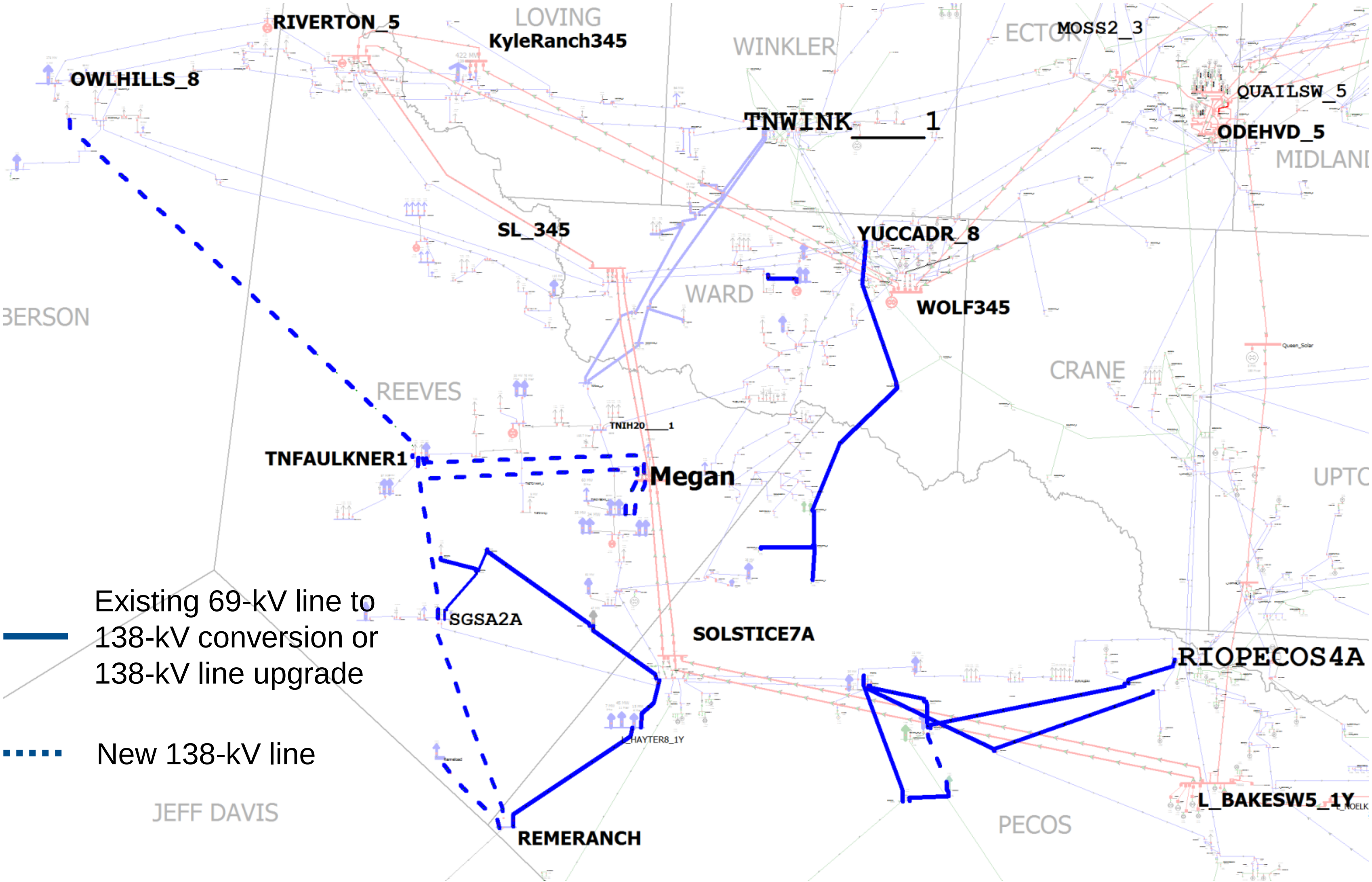
Common Upgrades

- Common upgrades were identified to reliably support the load additions and were included in all four short listed import options

Common Upgrade	Unit
New 345/138-kV transformer	8
Add new circuits (138-kV)	120 miles
Circuit Conversion and Upgrade (69-kV and 138-kV)	196 miles
Reactive Support Needs (1)	~1800 MVAR

(1) A stability analysis will be needed to determine the actual reactive support needs in terms of size, location, and technology.

Map of the Common 69-kV and 138-kV Upgrades



Options Comparison: Load Serving Capability, Congestion Analysis, and Cost Estimates

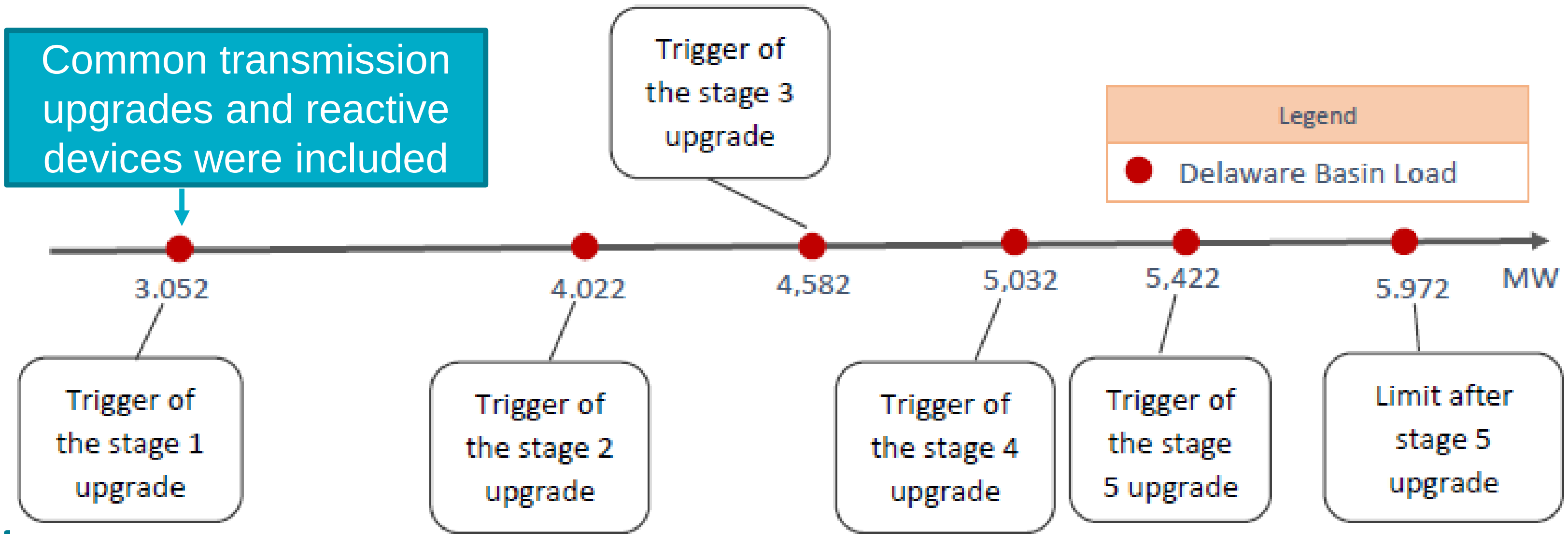
Option	New ROW (miles)	Delaware Basin Load Serving Capability (1) (MW)	Production Cost Difference (2) ($M)	Cost Estimates (3) ($M)
4b	291	5,982	0.4	753 (4)
4c	362	6,062	3.1	816 (4)
6f	378	6,042	3.1	873 (4)
6g	185	5,722	Reference	618

1) Performed under N-1 from a steady-state voltage stability perspective. Does not include G-1+N-1, X-1+N-1, or N-1-1 limitations. Common upgrades were included in the study cases.
2) Using 2019 RTP 2024 economic case.
3) These cost estimates are based on TSP's preliminary estimate and subject to further review and updates. These cost estimates only include the 345-kV transmission upgrades/additions.
4) Riverton station may not be feasible to accommodate the new 345-kV line from Clearfork. A new 345-kV station nearby Riverton may be needed, which will increase the cost estimates.

Roadmap Consideration

- A roadmap was developed that includes the long lead time transmission improvements and the associated triggers in terms of load growth in the Delaware Basin

Roadmap



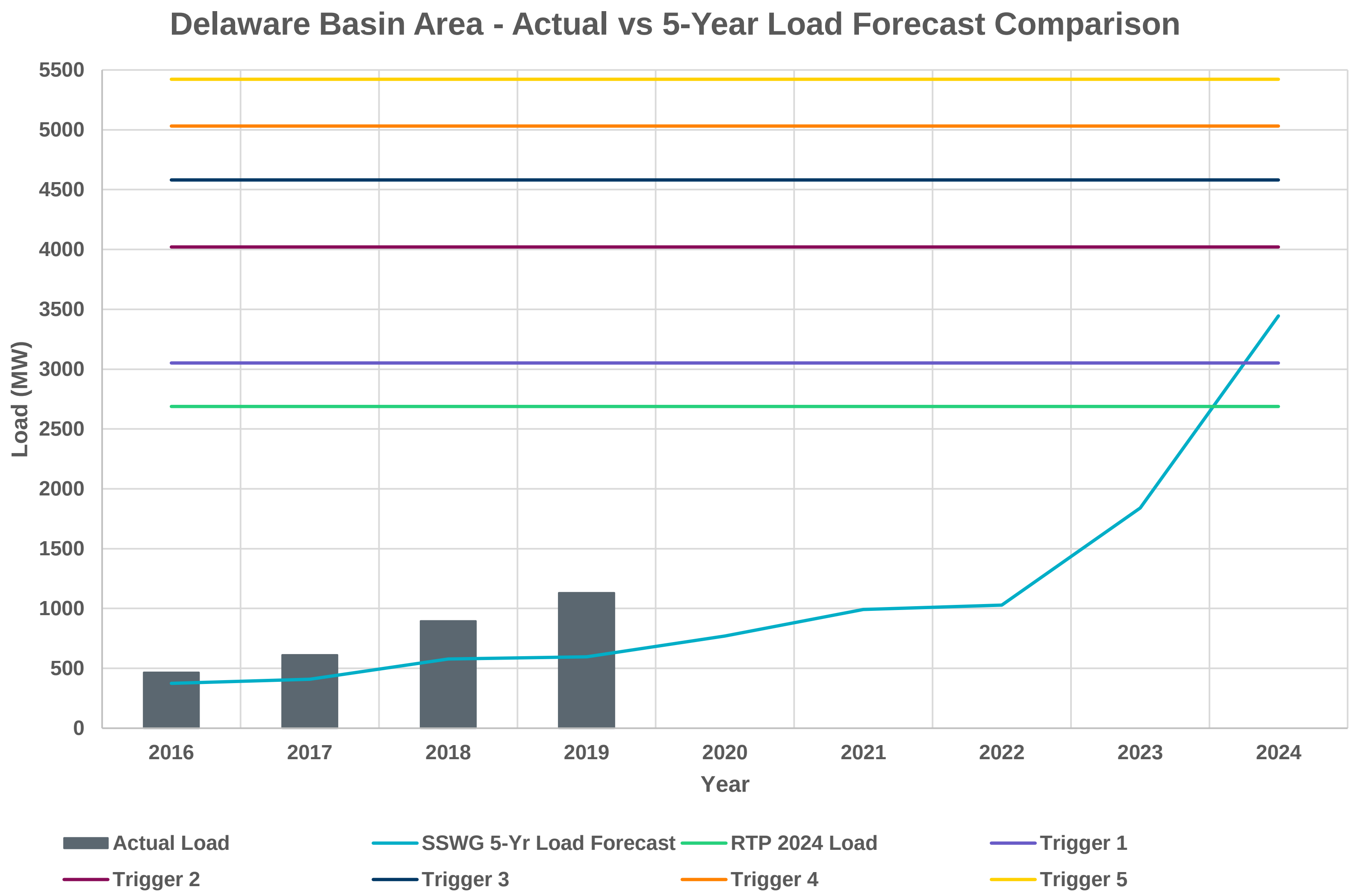
The trigger and limit are based on thermal and steady-state voltage stability under N-1, G-1+N-1, X-1+N-1, and N-1-1 contingency conditions.

Stage	Delaware Basin Load Level (MW)	Upgrade Element	Estimated Upgrade Cost ($M)	Trigger
1	3,052	Big Hill – Bakersfield 2nd 345-kV circuit	69	Import Needs
2	4,022	Bearkat – North McCamey – Sand Lake 345-kV double circuit	371	Import Needs
3	4,582	Riverton - Owl Hills 345-kV single circuit	41	Culberson Loop Needs
4	5,032	Riverton – Sand Lake 138-kV to 345-kV conversion and new Riverton - Sand Lake 138-kV	56	Culberson Loop Needs
5	5,422	Faraday - Lamesa - Clearfork - Riverton 345-kV double circuit	444	Import Needs

Disclaimer

- The identified long lead time transmission improvements are based on the assumptions used in this study. Assumptions that could change the results of this analysis include but are not limited to the following: actual load addition size, timing, and location; common transmission upgrade implementation; availability and dispatch of the generation in the study area; impedance of the new conductors; and transmission upgrade cost estimates.
- ERCOT performed steady-state analyses using the updated case and identified both long-lead time transmission improvements and a set of common transmission upgrades to reliably serve the assumed load in this study. The common transmission upgrades include upgrading existing transmission facilities , adding new 138-kV transmission lines, and adding new reactive power devices. These common upgrades are assumed in-service in the import path evaluation and the development of transmission upgrade roadmap.
- The trigger points of each long lead time transmission improvement were identified in terms of the load level in the Delaware Basin area. As the upgrades of existing 345-kV lines are expected to be implemented in a relatively shorter time frame than constructing new 345-kV lines, the existing 345 kV line upgrades were not included in the roadmap development.

Delaware Basin Area - Actual vs 5-Year Load Forecast Comparison



Next Step

- ERCOT will complete the report and post it on the ERCOT website in December

Status Updates

- ERCOT presented the study scope at the Nov 2018 RPG
  http://www.ercot.com/content/wcm/key_documents_lists/138710/Delaware_Basin_Load_Integration_Study_Scope_-_Nov2019_RPG.pdf

- ERCOT presented status updates at the May, July, September, and November 2019 RPG meetings
  – http://www.ercot.com/content/wcm/key_documents_lists/165286/Delaware_Basin_Load_Integration_Study_Update_-_May2019_RPG.pdf
  – http://www.ercot.com/content/wcm/key_documents_lists/165294/Delaware_Basin_Load_Integration_Study_Update_-_July2019_RPG.pdf
  – http://www.ercot.com/content/wcm/key_documents_lists/165302/Delaware_Basin_Load_Integration_Study_Update_-_Sept2019_RPG.pdf
  – http://www.ercot.com/content/wcm/key_documents_lists/165311/Delaware_Basin_Load_Integration_Study_Update_-_Nov12-2019_RPG.PDF

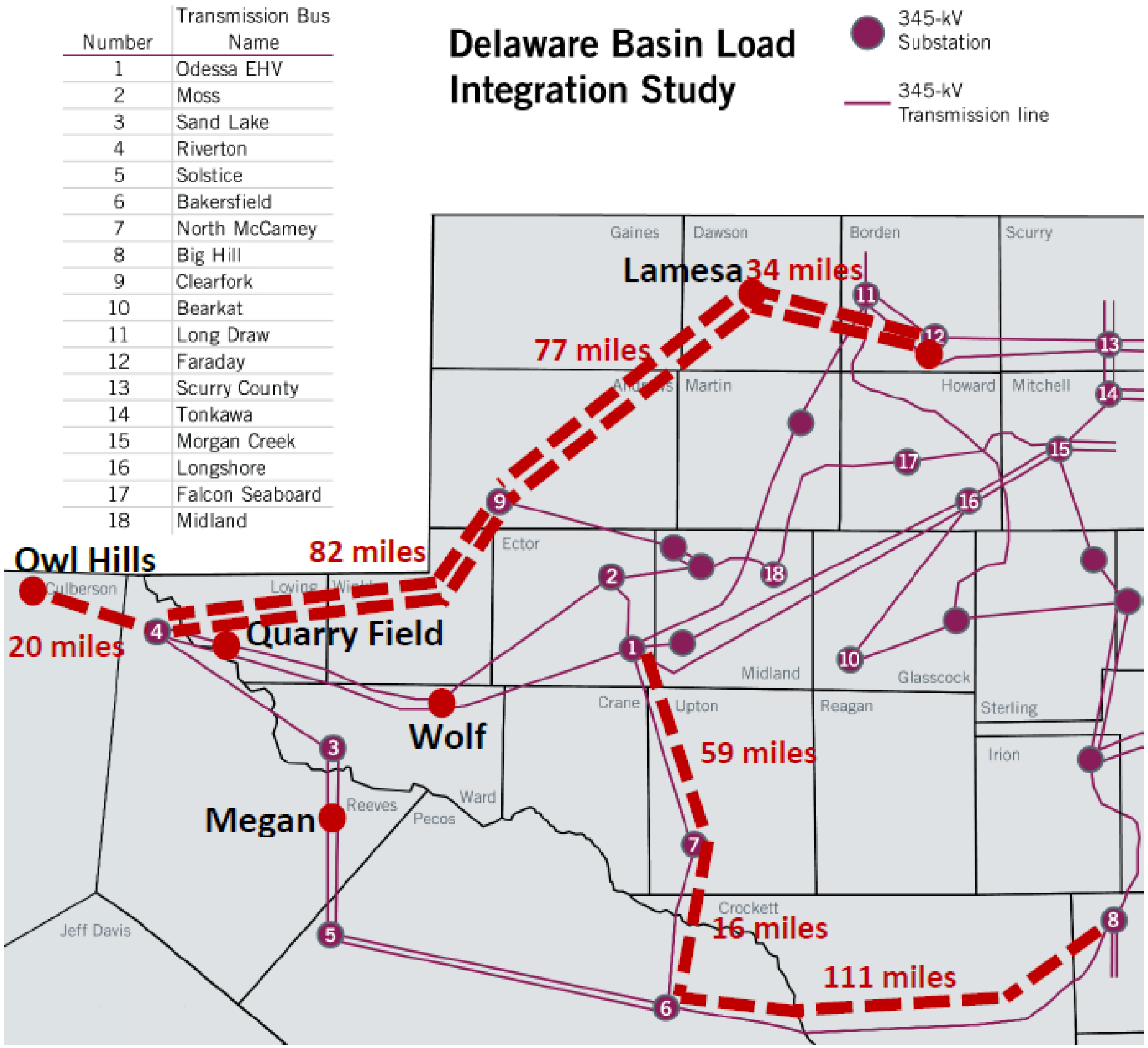
Appendix – List of the Common transmission upgrades

- Added seven reactive devices (5 placeholder synchronous condensers, 1 DRD and 1 capacitor bank)
- Tapped the new 345-kV Wolf station to the Odessa/Moss – Riverton 345-kV double circuit lines (TPIT 46094, Tier 3, Dec 2020)
- Tapped Tap the Wolf - Riverton 345-kV double circuit at Quarry Field, and add two 345/138-kV autotransformer at Quarry Field
- Built a new Owl Hills 345-kV substation with two 345/138-kV transformers, and added a new single-circuit 345-kV line from Riverton to 345-kV Owl Hills station
- Tapped a new Megan 345-kV substation on the Solstice to Sand Lake 345-kV double-circuit line, and install two new 345/138-kV transformers at the new Megan station
- Converted AEP 69-kV line Barrilla - Hoefs Road - Verhalen - Saragosa to 138-kV
- Converted ONCOR 69-kV line Yucca - Royalty - Coyanosa - Wolfcamp to 138-kV
- Built a new 138-kV double-circuit line from the new Megan station to Saddleback
- Built a new 138-kV double-circuit line from the new Megan station to Faulkner
- Built a new 138-kV line from Elcor to Faulkner
- Built a new 138-kV line from Saragosa to Faulkner
- Built a new 138-kV line from Remeranch to Saragosa
- Built a new 138-kV line from Conoco Rgec to TNMP 16th Street
- Converted the existing Fort Stockton - Conoco Comp station - Conoco Rgec 69-kV line to 138-kV
- Upgraded the existing 138-kV lines from Rio Pecos to Fort Stockton
- Upgraded the Gemsbok to Gemsbok Autonomous Crypto 138-kV line
- Upgraded the Solstice - Hayter - Remeranch138-kV line
- Upgraded the existing Quail Switch - Odessa EHV 345-kV line
- Upgraded the existing Morgan Creek - Tonkawa 345-kV line
- Upgraded the existing Midland East - Falcon Seaboard 345-kV line

Appendix – Import Option 4a

- Option 4a: Faraday – Lamesa - Clearfork – Riverton 345-kV double circuit; Big Hill – Bakersfield – Odessa 2nd circuit

Number	Transmission Bus Name
1	Odessa EHV
2	Moss
3	Sand Lake
4	Riverton
5	Solstice
6	Bakersfield
7	North McCamey
8	Big Hill
9	Clearfork
10	Bearkat
11	Long Draw
12	Faraday
13	Scurry County
14	Tonkawa
15	Morgan Creek
16	Longshore
17	Falcon Seaboard
18	Midland



Appendix – Import Option 4b

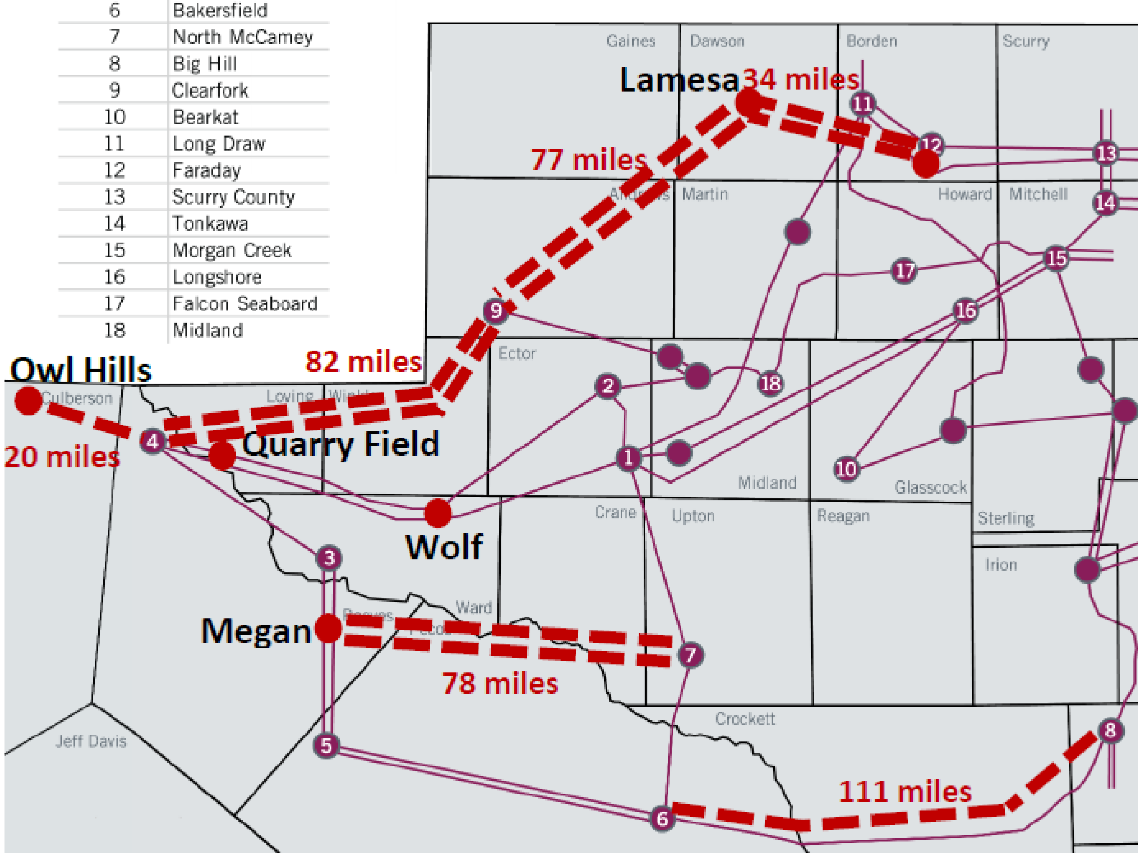
- Option 4b: Faraday – Lamesa - Clearfork – Riverton 345-kV double circuit; Big Hill – Bakersfield 2nd circuit plus North McCamey – Megan 345-kV double circuit

Number	Transmission Bus Name
1	Odessa EHV
2	Moss
3	Sand Lake
4	Riverton
5	Solstice
6	Bakersfield
7	North McCamey
8	Big Hill
9	Clearfork
10	Bearkat
11	Long Draw
12	Faraday
13	Scurry County
14	Tonkawa
15	Morgan Creek
16	Longshore
17	Falcon Seaboard
18	Midland

Delaware Basin Load Integration Study

345-kV Substation

345-kV Transmission line



Appendix – Import Option 4c

- Option 4c: Faraday – Lamesa - Clearfork – Riverton 345-kV double circuit; Bearkat - North McCamey – Megan 345-kV single circuit

Number	Transmission Bus Name
1	Odessa EHV
2	Moss
3	Sand Lake
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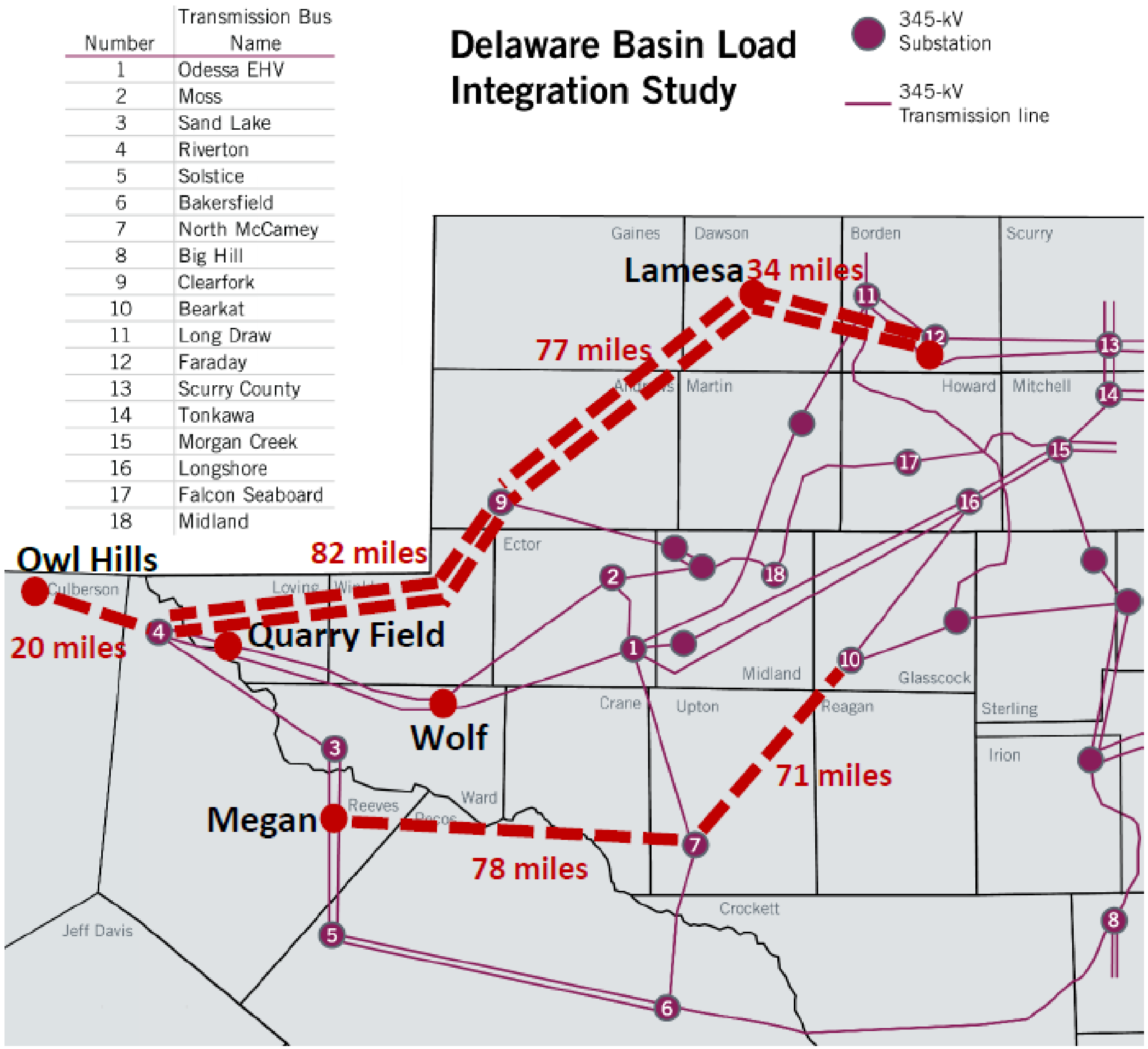

Appendix – Import Option 4g

- Option 4g: Faraday – Lamesa - Clearfork – Riverton 345-kV double circuit; Big Hill – Bakersfield 2nd circuit; Convert the Sand Lake – Riverton 138-kV to 345-kV and add a new 138-kV line from Sand Lake to Riverton

Number	Transmission Bus Name
1	Odessa EHV
2	Moss
3	Sand Lake
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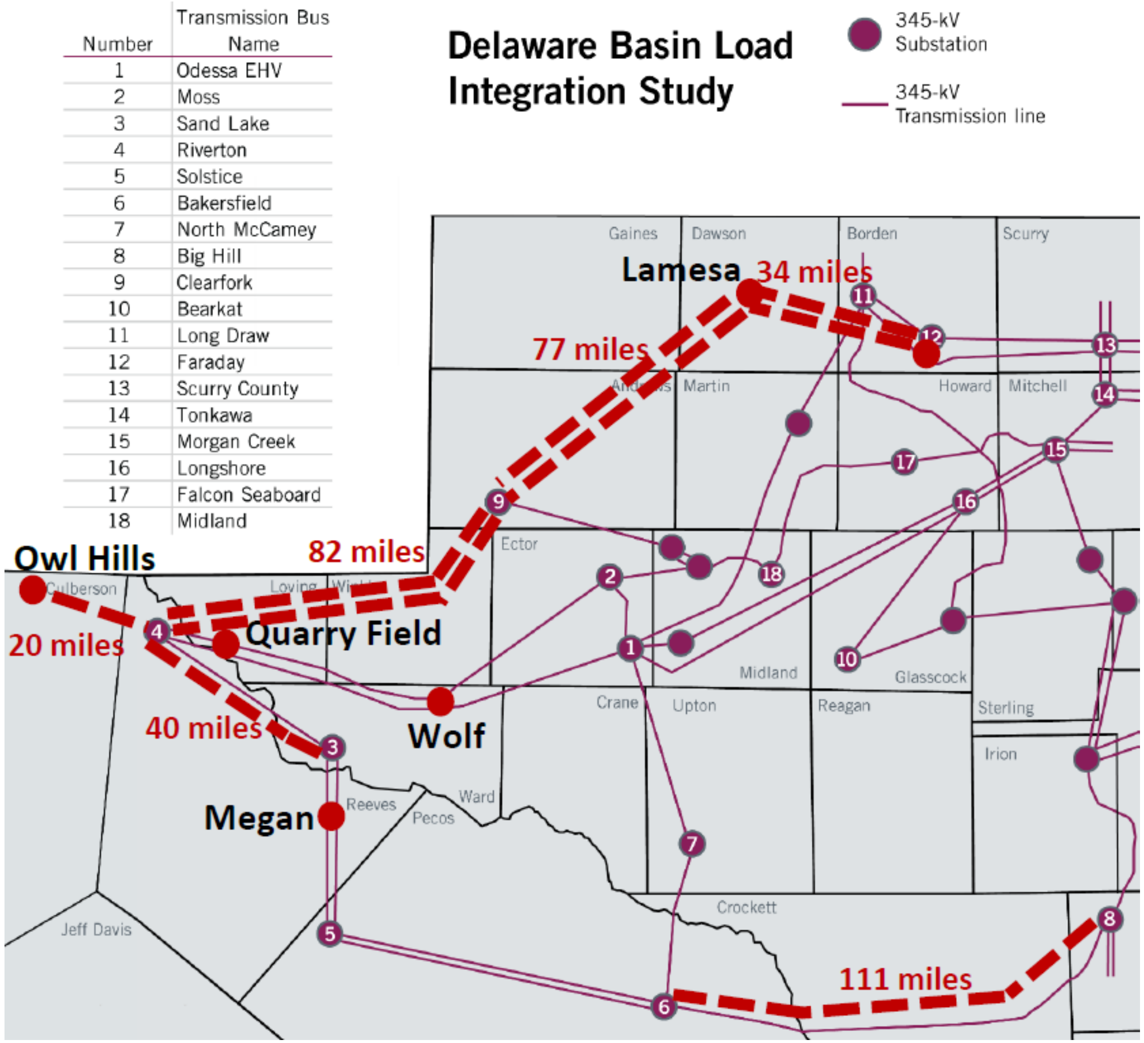

Appendix – Import Option 5d

- Option 5d: Bearkat - North McCamey – Megan 345-kV double circuit; Clearfork – Riverton 345-kV double circuit

Number	Transmission Bus Name
1	Odessa EHV
2	Moss
3	Sand Lake
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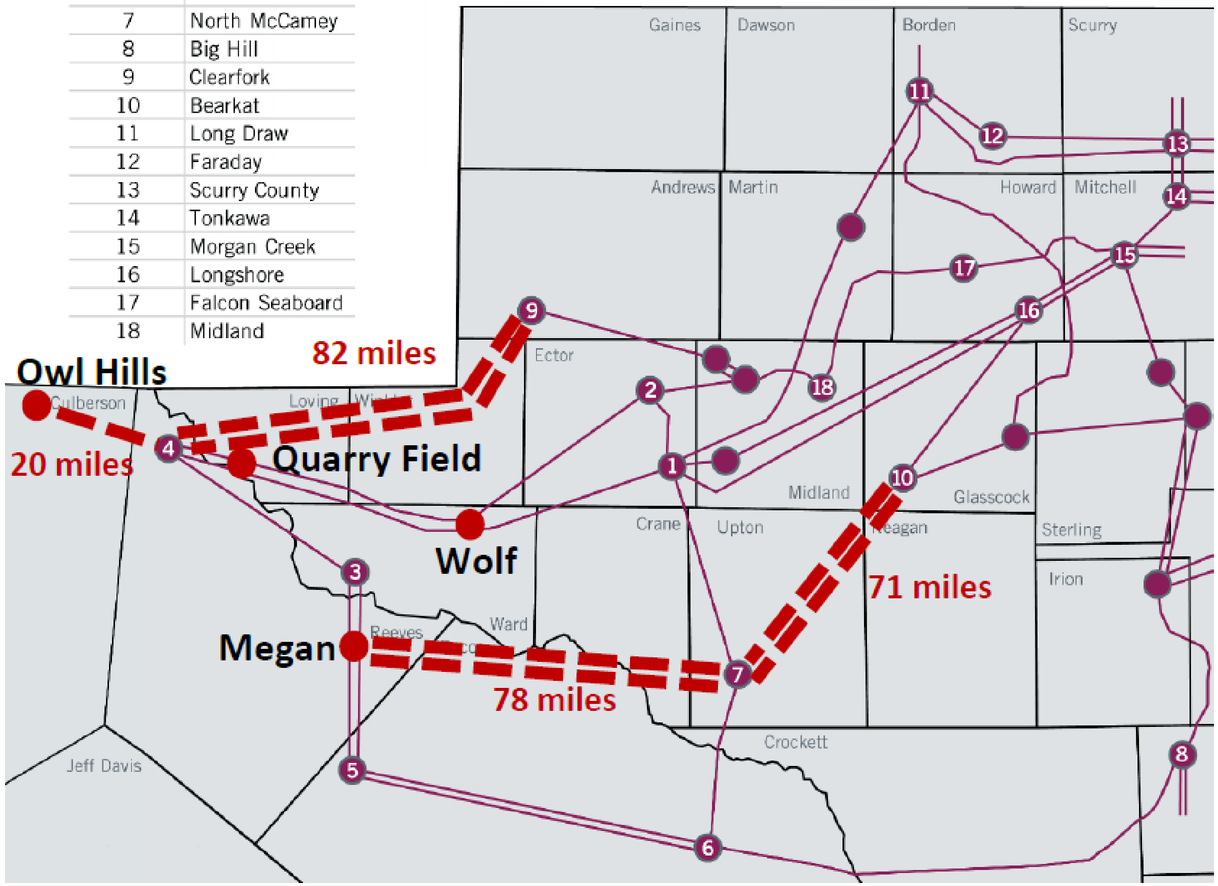
Delaware Basin Load Integration Study

345-kV Substation

345-kV Transmission line



Appendix – Import Option 5e

- Option 5e: Bearkat - North McCamey – Megan 345-kV double circuit; Big Hill – Bakersfield 2nd circuit plus Clearfork – Riverton 345-kV double circuit

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1	Odessa EHV
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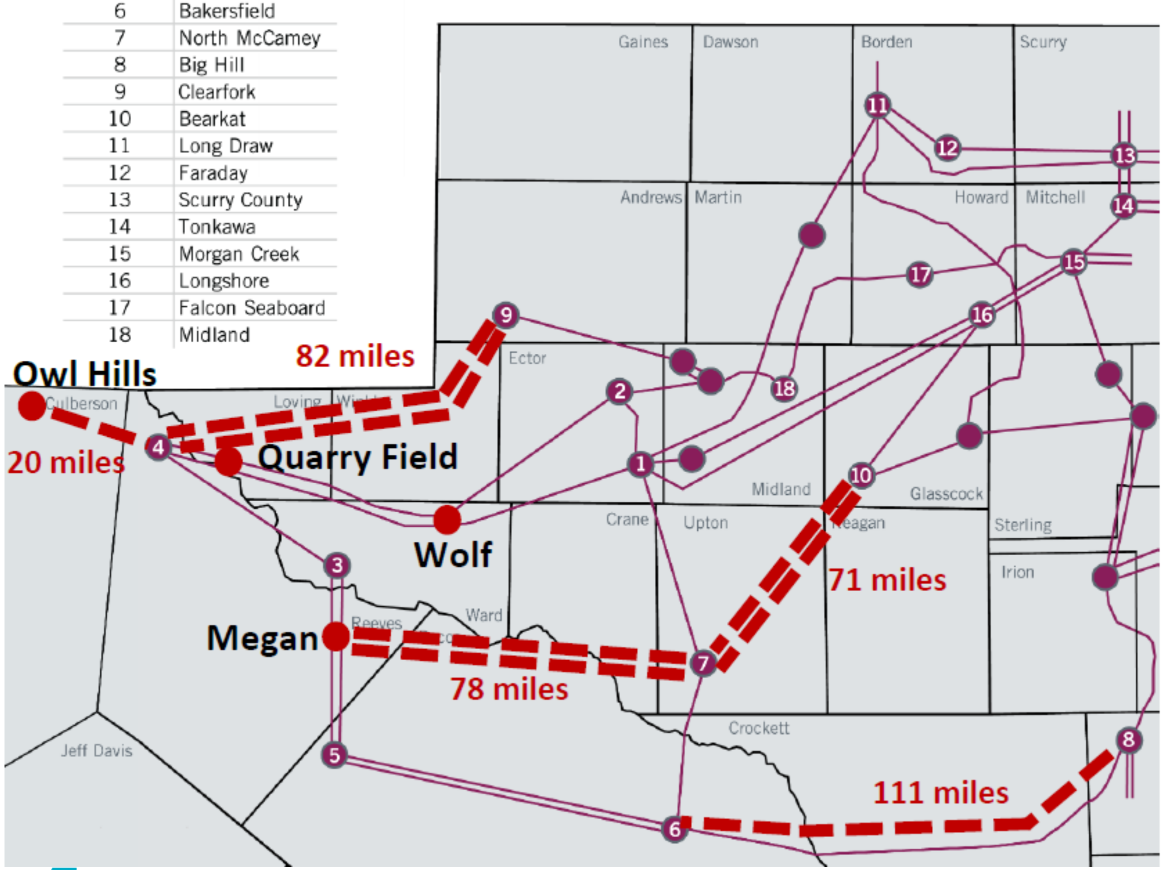
Delaware Basin Load Integration Study

345-kV Substation

345-kV Transmission line



Appendix – Import Option 5f

- Option 5f: Bearkat - North McCamey – Megan 345-kV double circuit; Faraday - Clearfork – Riverton 345-kV single circuit

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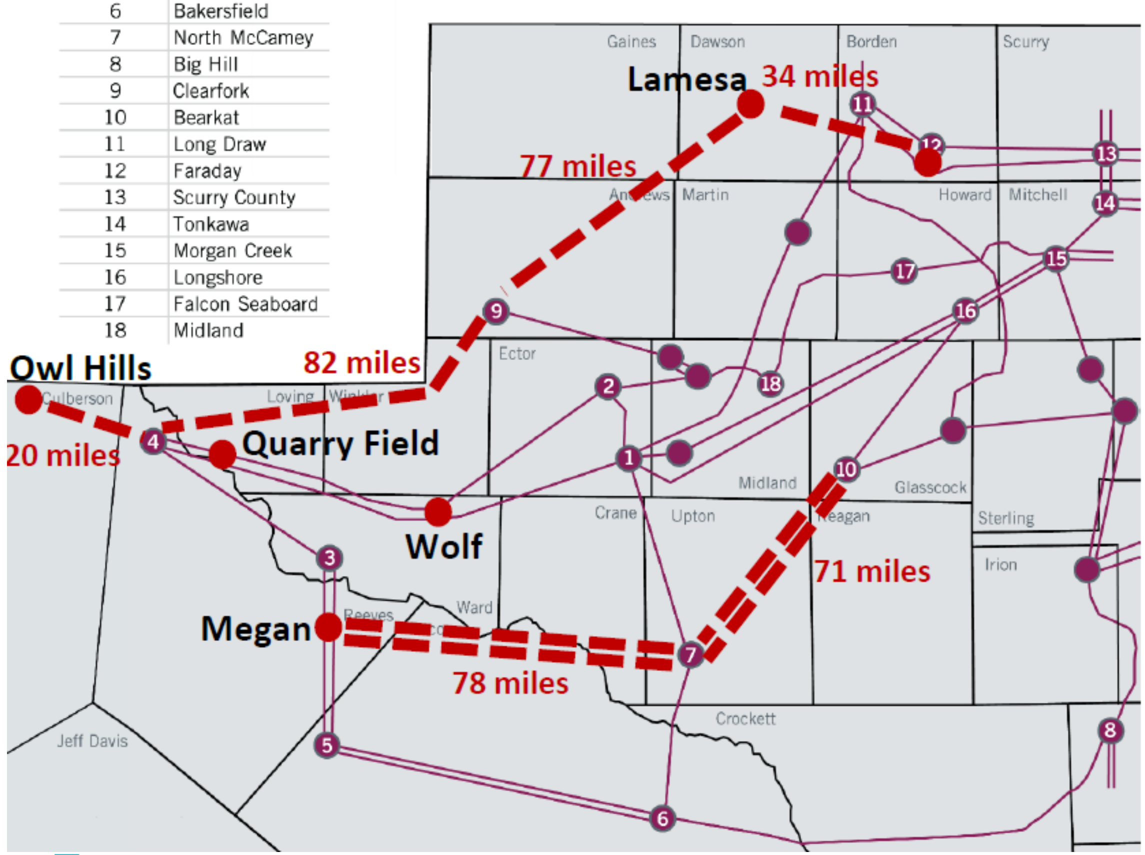
Delaware Basin Load Integration Study

345-kV Substation

345-kV Transmission line



Appendix – Import Option 6a

- Option 6a: Bearkat - North McCamey – Sand Lake 345-kV double circuit; Big Hill – Bakersfield – Odessa 2nd circuit

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1	Odessa EHV
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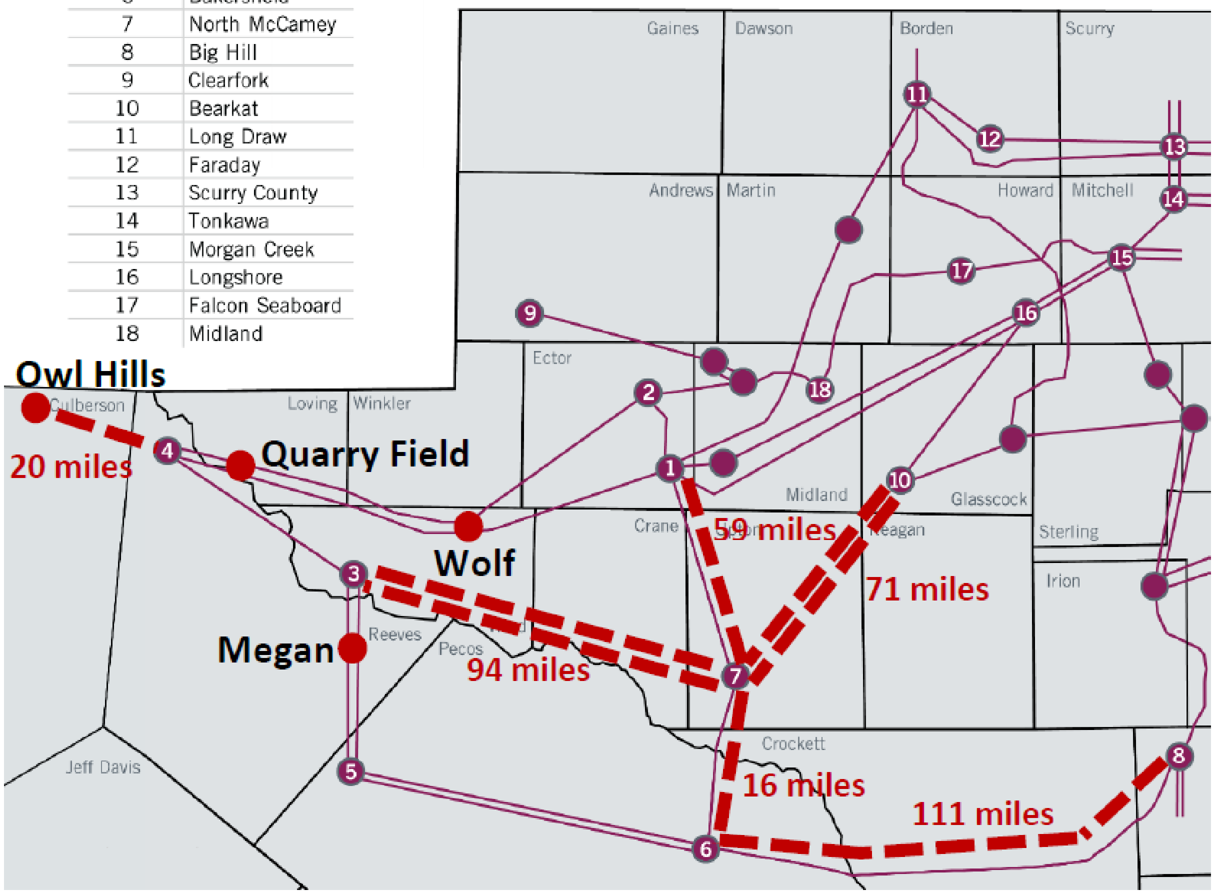
Delaware Basin Load Integration Study

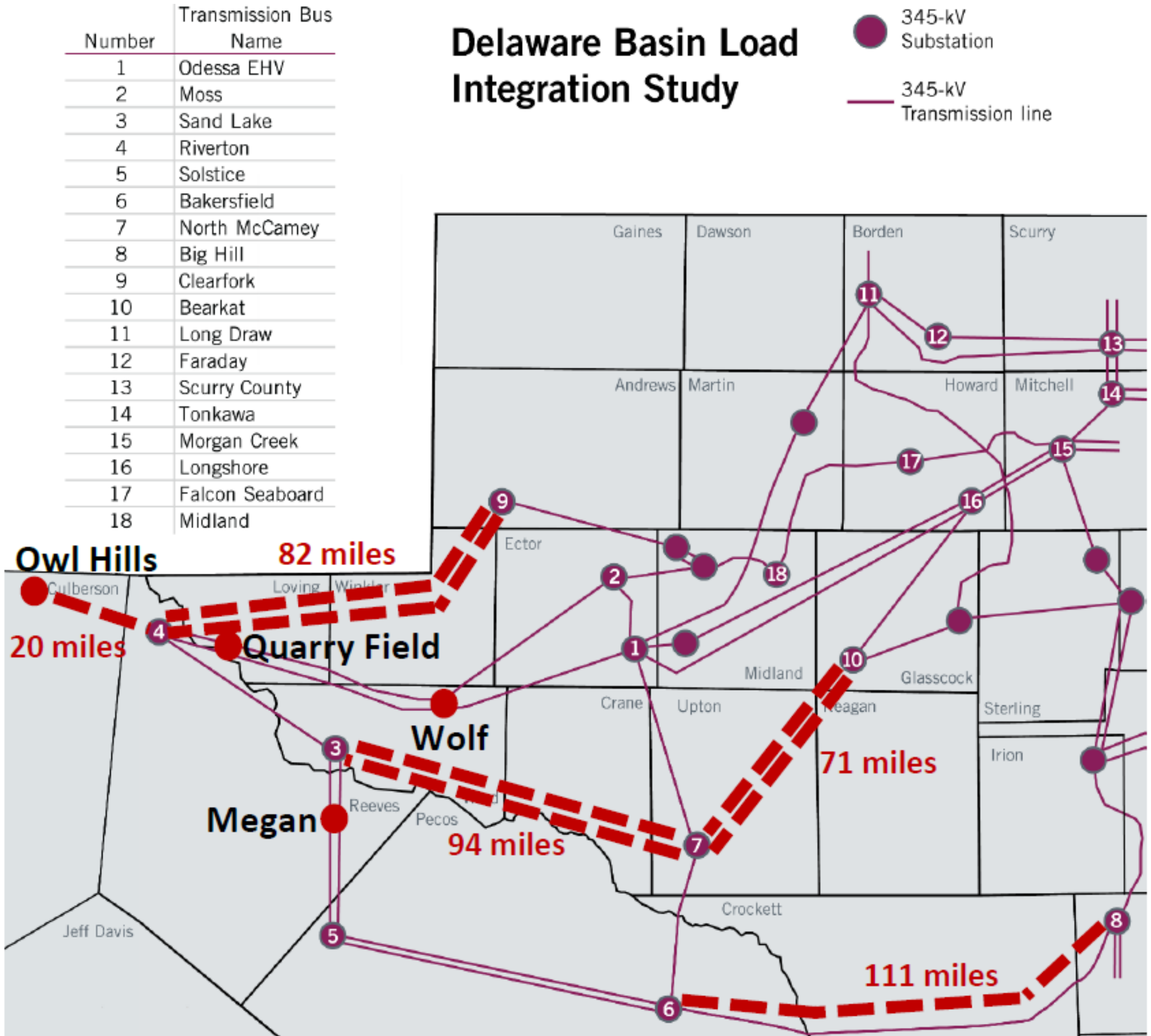
345-kV Substation

345-kV Transmission line



Appendix – Import Option 6e

- Option 6e: Bearkat - North McCamey – Sand Lake 345-kV double circuit; Big Hill – Bakersfield 2nd circuit plus Clearfork – Riverton 345-kV double circuit



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Appendix – Import Option 6f

- Option 6f: Bearkat - North McCamey – Sand Lake 345-kV double circuit; Faraday – Clearfork - Riverton 345-kV single circuit

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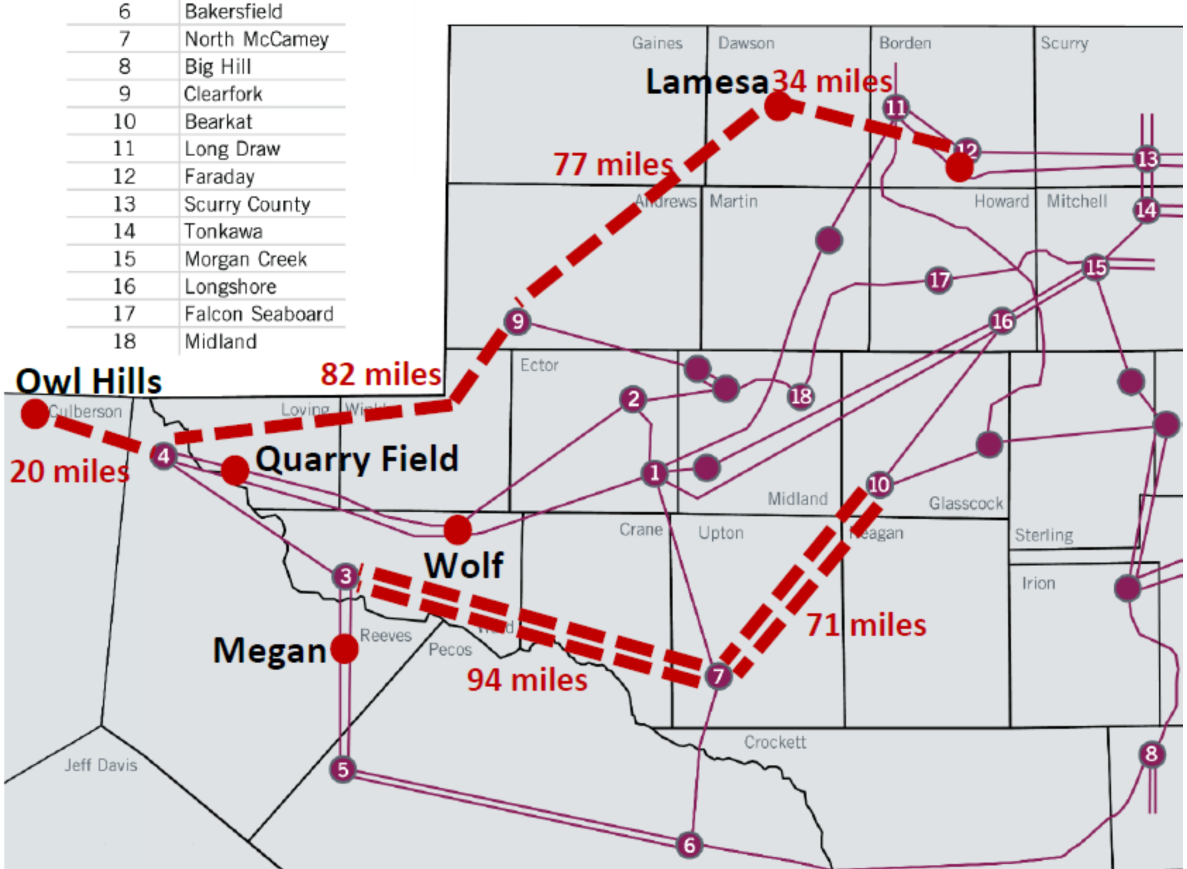

Appendix – Import Option 6g

- Option 6g: Bearkat - North McCamey – Sand Lake 345-kV double circuit; Big Hill – Bakersfield 2nd circuit; Convert the Sand Lake – Riverton 138-kV to 345-kV and add a new 138-kV line from Sand Lake to Riverton

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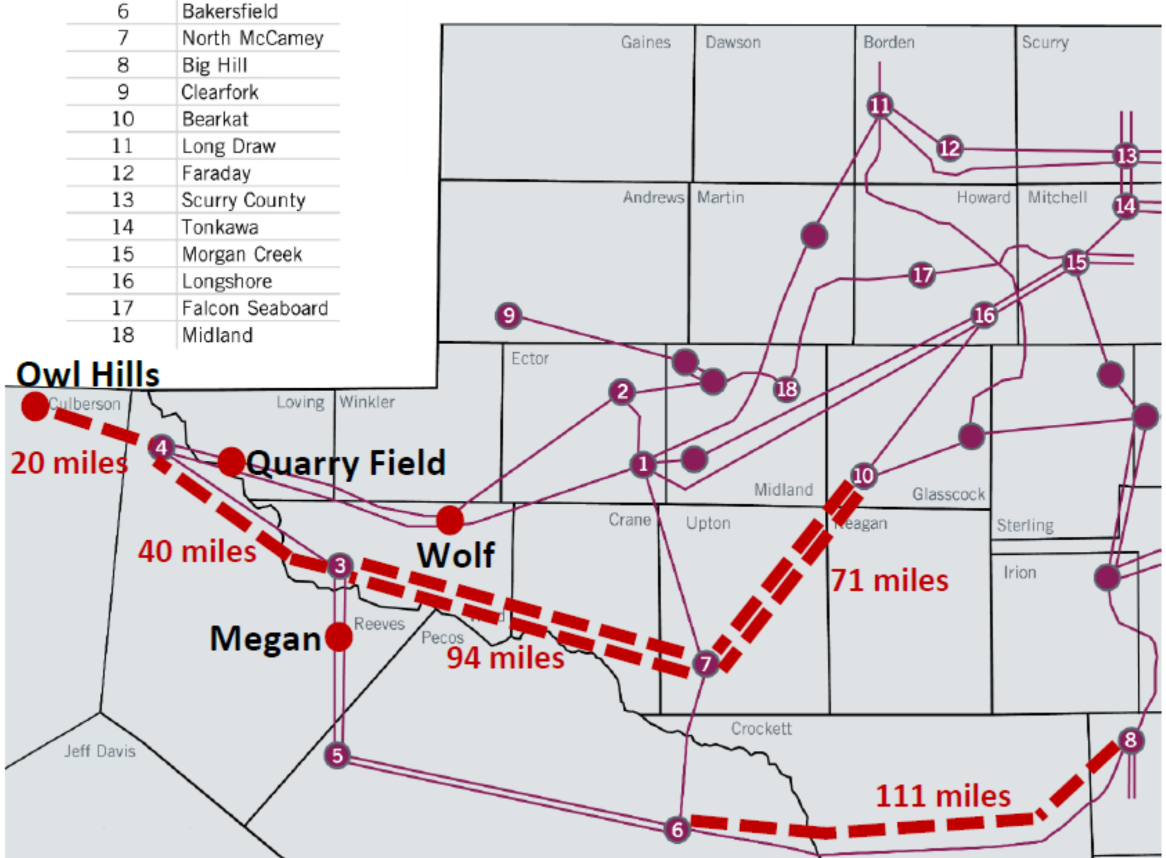
Delaware Basin Load Integration Study

345-kV Substation

345-kV Transmission line



Appendix – Import Option 9e

- Option 9e: 1,200 MW HVDC line (VSC) from Howard Road to Bakersfield and new 345-kV double-circuit line from North McCamey to Megan; Big Hill – Bakersfield 2nd circuit plus Clearfork – Riverton 345-kV double circuit

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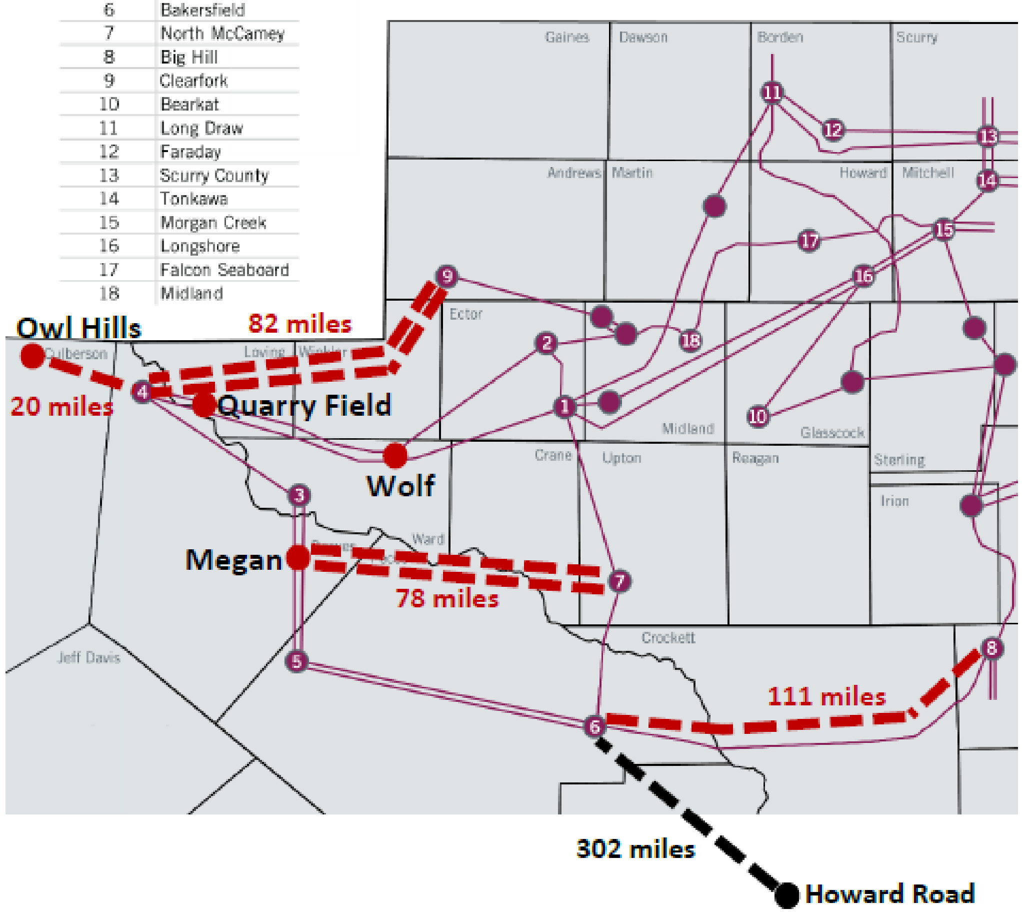
Delaware Basin Load Integration Study

345-kV Substation

345-kV Transmission line



Appendix - Load Summary

TSP	2018 RTP	2019 RTP	Feb 2019 SSWG	DBA Study
AEP	130	272	330	459
Golden Spread	8	6	7	9
LCRA	6	7	17	210
ONCOR	1,463	1,875	1,900	2,724
TNMP	507	527	1,254	1,969
Grand Total	**2,114**	**2,688**	**3,509**	**5,372**