

Oklahoma Electric Power Transmission Task Force (OEPTTF) Study

SPP Engineering Department, Planning Section

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Updated

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1. Executive Summary

Expansion planning at Southwest Power Pool (SPP) has evolved significantly in recent years to move beyond the development of comprehensive reliability plans to the identification of economic expansion opportunities as part of the SPP Transmission Expansion Plan (STEP). More importantly, SPP through its Transmission Working Group has prepared visionary, conceptual plans to identify potential long range planning needs for SPP and neighboring regions as a blueprint for future development. These SPP resulting EHV Overlay Studies have provided a framework for dialogue on significant issues, e.g., effective seams agreements with fair and simple cost allocations, which must be addressed if inter-regional long range collaborative bulk transmission planning will result in transmission expansion. The STEP 2008-2017 formed a foundation for a special study to identify the transmission expansion needs in and around Oklahoma. The Oklahoma Electric Power Transmission Task Force (OEPTTF) created by the Oklahoma legislature in 2007, directed this study, which considered the impact of 4 – 15 GW of wind development in the central and south plains in the SPP region. The scope of this study was approved in late 2007; SPP performed its analysis and provides this report in early 2008 to identify transmission expansion needs in and around Oklahoma.

This analysis identifies approximately \$4.5 billion of transmission expansion needs for approximately 3,500 circuit miles and 1,700 pole miles (Rights-of-Way) of 345 kV transmission lines, and 5,500 MVA of EHV autotransformer capacity in the SPP region to reliably integrate and deliver 4 – 15 GW of wind development in the central and south plains based on 2010 and 2020 scenarios targeted by the OEPTTF. SPP has prepared alternative expansion plans that leverage the Updated EHV Overlay Study results published in March 2008 by Quanta Technologies and provide an alternative plan that includes 1,255 and 287 circuit (or pole) miles of new 765 and 345 kV transmission lines, respectively, and up to 30,000 MVA of EHV autotransformer capacity that should be considered in lieu of 345 kV expansion alone. The installed cost for 765 kV alternative expansion plan is approximately \$3.4 billion. The benefits of a 765 kV build out as compared to a 345 kV build out have been demonstrated by American Electric Power (AEP) and others in terms of costs, capability, and environmental impacts for Rights-of-Way (ROW) requirements. This is particularly true given the targeted wind development scenarios evaluated as part of this OEPTTF study.

This study provides a reasonable EHV build out for the OEPTTF. This study did not consider the impacts associated with substantial wind development in terms of system stability assessments, reactive compensations requirements to manage voltages, and other issues. This study also did not evaluate the impacts to underlying 230 kV + facilities within and around the SPP region that could be expected as a result of these EHV Overlays. For an EHV Overlay to be effective in the SPP region, it cannot simply be interconnected to the existing transmission network. It would be prudent to access potential reconfiguration of existing transmission facilities (including islanding weak segments of the existing network and incorporating special protection schemes and other smart grid applications) to manage the flows on existing facilities and proactively address potential operational issues and overloads.

SPP must resolve outstanding issues regarding the timing, scope and capability of major EHV facilities in the STEP 2008-2017. SPP has been working with stakeholders to determine what will be built and by whom regarding the proposed ICT Great Plains Spearville – Comanche Co – Wichita and Spearville – Knoll - Axtell sponsored projects, which are in the STEP 2008-2017 with 2012 in-service dates assuming 345 kV construction. SPP studies continue to show that the Spearville – Comanche Co – Wichita and Spearville – Knoll sections of these lines need to be built at 765 kV design standards and initially operated at 345 kV. These facilities will start the development of a 765 kV backbone in the western portion of the SPP region. This OEPTTF Study shows 765 kV extensions from Comanche to Woodward/Mooreland and on to Lawton Eastside, with a major 765 kV feeder from Woodward/Mooreland into the panhandle of OK near the existing Hitchland substation in Texas along the Texas/Oklahoma border at the intersection of the existing Finney – Potter 345 kV line. Southwestern Public Service is proceeding with development of the Hitchland substation. SPP would request that the Hitchland – Pringle and Hitchland – Perryton North 230 kV lines be assessed for large capacity and potentially 345 kV design to facilitate wind farm collector system development and integration into an EHV backbone long-term.

SPP looks forward to working with the OEPTTF, and affected stakeholders on the development of effective long range expansion plans to address future needs in and around Oklahoma in a timely manner. The development of a robust plan and continual reassessments to verify the validity of conclusions and recommendations is warranted. SPP has taken the results from the OEPTTF Study to develop a construction and recommendation plan for the build out of the grid. This plan uses the EHV Overlay study as the template for the ultimate build out and combines the findings from the OEPTTF analysis into a recommendation. This OEPTTF Study provides a blueprint for long-range transmission expansion planning that creates significant value to SPP and neighboring regions while facilitating major wind development in the central and south plains with firm deliveries to the market.

2. Introduction

SPP performed a long-range, comprehensive transmission expansion study at the request of the Oklahoma Electric Power Transmission Task Force (OEPTTF). Although the primary focus of the OEPTTF is transmission expansion in the state of Oklahoma to facilitate wind development in the state, a more regional assessment was necessary given the dynamic nature and interdependencies of the bulk power transmission network. The study's primary focus was to identify the bulk power transmission expansion needs to integrate and deliver wind resources to customers based on approved projects in the SPP Transmission Expansion Plan 2008-2017 and current projections for wind development in the central and south plains of the SPP region.

The study was divided into analyses for 2010 and 2020. The study considered nominal wind and high wind injection scenarios for both years of study. The level of wind development ranged from a 2010 base level of 4 GW (nameplate) to a 2020 high wind level of 15 GW (nameplate).

The majority of the wind development was assumed to occur in the Oklahoma panhandle, western Oklahoma, western Kansas, the Texas panhandle and portions of New Mexico. Wind generation in each state would be used to serve retail customers within the SPP region up to 10% of native load requirements. The excess wind energy was assumed to be transferred to major markets in the Eastern Interconnection.

Analysis for the study was conducted in two phases. The first phase of the study, was performed to determine what upgrades were necessary to provide firm deliveries based on the specified wind development scenarios. Economic analyses were subsequently performed on these scenarios to determine the adjusted production cost savings for the respective scenarios.

Important Note

Absent a special agreement, SPP must follow its FERC-approved Open Access Transmission Tariff for the provision of transmission service. While SPP will work with stakeholders on studies to evaluate and identify potential beneficial transmission expansion projects, SPP can not guarantee the availability of transmission capability to provide firm deliverability of resources without a specific request being evaluated and approved as a part of the aggregate study process for long-term transmission service requests.

3. Study Methodology

The study was conducted in two phases: transfer analysis and economic analysis. Modeling assumptions for these phases were consistent. Wind assumptions used as input are shown in the following section. Subsequent sections of the report document and detail the study’s transfer analysis and economic analysis phases.

A. Wind Assumptions

Table 1 details the study’s base wind assumptions (MWs), which were provided by the OEPTTF. These wind amounts were considered to be in place and operational beginning in 2010 of the study period. Details are listed by state and source. These three source categories were taken from the SPP Generation Interconnection (GI) queue.

The first category is “in-service”, which pertains to wind that is operational today. “On schedule” is wind in the GI queue that is scheduled to be in-service by the targeted in-service date. Wind designated as “suspension” has a signed Interconnection Agreement (IA) which has been suspended. Since a generator can stay in suspension up to three years, the OEPTTF Study only considered 50% of the generation with this status.

Table 1 - Base Wind Assumptions

Wind Type	Base Wind
	2010
Kansas	1,648
In-Service	460
On Schedule	750
Suspension (50%)	438
Oklahoma	903
In-Service	698
On Schedule	20
Suspension (50%)	185
N. Mexico/Texas	1,499
In-Service	605
On Schedule	654
Suspension (50%)	240
Grand Total	4,050

In addition to the base wind detailed above, the study injected additional wind to meet targeted wind penetration levels agreed to in the approved OEPTTF Study scope. These generic wind injection locations were placed on the 345 kV system, as detailed below.

Table 2 documents wind injections (MWs) in 2010 and 2020, as well as the nominal and high wind scenarios in each of those years. The last column demonstrates what percentage of each state’s wind was introduced at each of the injection locations.

Table 2 - Wind Injection Locations

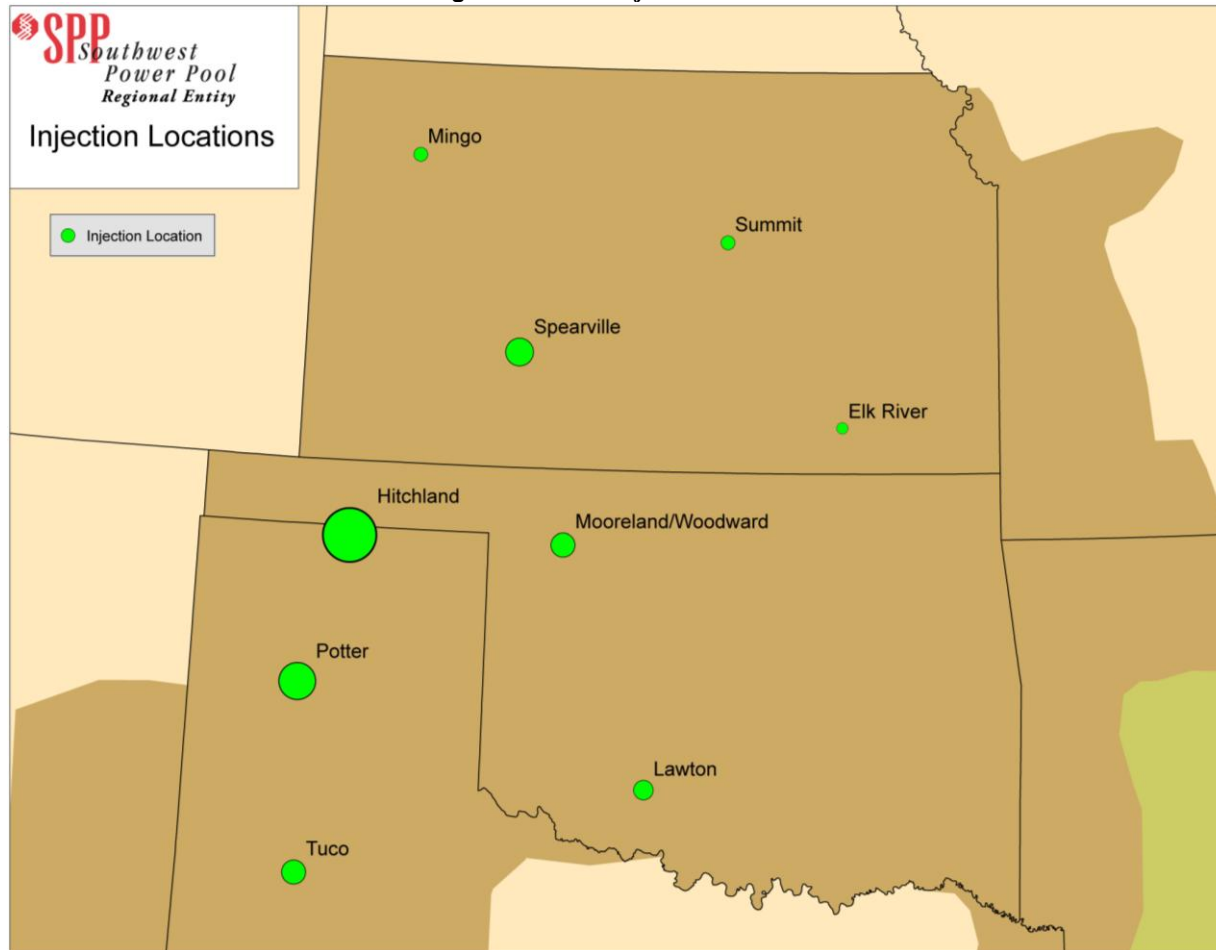
Injection Location	Nominal Wind Scenario		High Wind Scenario		Percent of State Inj
	2010	2020	2010	2020	
Kansas	1,000	2,000	Same	Same	
Spearville	600	1,200	600	1,200	60%
Mingo	150	300	150	300	15%
Elk River	100	200	100	200	10%
Summit	150	300	150	300	15%
Oklahoma	1,000	2,000	2,000	6,000	
Hitchland (Panhandle)	750	1,500	1,500	4,500	75%
Lawton	100	200	200	600	10%
Mooreland/Woodward	150	300	300	900	15%
N. Mexico/Texas	1,500	3,000	Same	Same	
Potter	1,050	2,100	1,050	2,100	70%
Tolk	450	900	450	900	30%
Total	3,500	7,000	4,500	11,000	

Table 3 shows the total amount of wind (MWs) in each of the scenarios and years. This is base level wind, plus additional injections at each location.

Table 3 - Total Wind in Study

	Nominal Scenario		High Wind Scenario	
	2010	2020	2010	2020
Grand Total Nameplate Wind	7,550	11,050	8,550	15,050

Figure 1 – Wind Injection Locations



B. Transfer Analysis

The transfer analysis was conducted for spring and summer seasons only. The analysis was performed using snapshot hours for 2010 and 2020. Powerflow models were developed from the SPP 2007 Model Development Working Group model set.

Powerflow models were developed using Siemens/PTI PSS/E v.30 software. Because there were no available 2010 or 2020 models, these were created by taking existing models and scaling-up generation and load within the SPP region. A load growth rate of 1.8% per year was used, which is the average annual load growth projected for the SPP region from 2007 to 2017.

The 2010 spring case was created by scaling-up load and generation in a 2008 spring case. The 2010 summer case was created by scaling-up a 2009 summer case. The 2020 summer case was created from the 2017 summer case. The 2020 spring case was created similarly using the 2008 spring case. See Table 4 for an illustrative explanation.

Table 4 – Models

Load Growth				
Starting Model	Ending Model	Annual Rate	Years	Load Change
08G	10G	1.8%	2	3.6%
09SP	10SP	1.8%	1	1.8%
17SP	20SP	1.8%	3	5.4%
08G	20G	1.8%	12	21.6%

The majority of the wind development was to be provided by the Oklahoma panhandle, western Oklahoma, western Kansas, the Texas panhandle, and portions of New Mexico. Wind generation in each state would be used to serve retail customers in the region at 10% of native load. Excess wind energy would be sold off-system. Table 5 details the wind injection amounts for each scenario.

The power kept in-state versus that sold off-system is calculated based on peak demand. For example, 10% of Oklahoma’s peak summer demand is the amount of wind power used in Oklahoma in the summer case. 10% of the spring load would be used in the spring case.

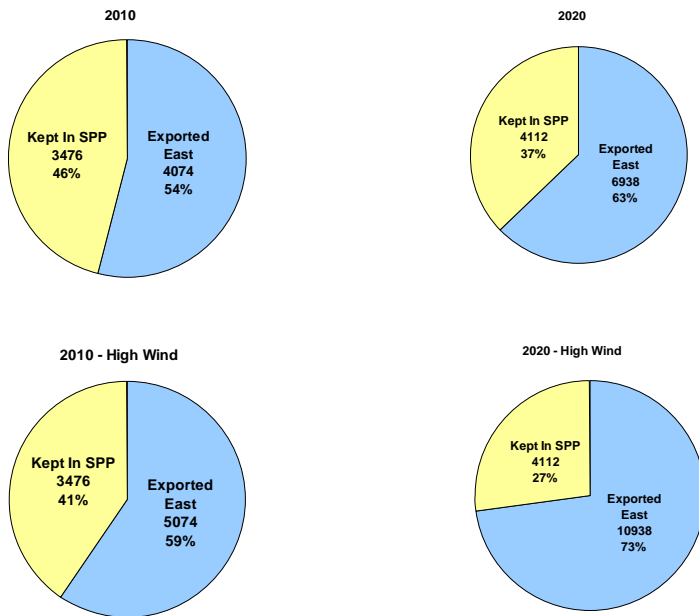
Transfer analysis conducted for the study is detailed in Table 5. The table refers to nameplate installed capacity for wind, not energy. For this study, 40% of nameplate wind was considered for the summer cases; the spring case injected the wind at 100% of nameplate.

Table 5 – Wind Transfer Amounts

Case & Location	Nominal Scenario			High Wind Scenario		
	Total Wind (MW)	Kept In-State (MW)	Exported Out of SPP (MW)	Total Wind (MW)	Kept In-State (MW)	Exported Out of SPP (MW)
2010 Summer	3,020	2,819	201	3,420	3,219	201
Kansas	1,059	978	81	1,059	978	81
Oklahoma	761	761	-	1,161	1,161	-
NM/TX	1,200	1,079	120	1,200	1,079	120
2010 Spring	7,550	3,476	4,074	8,550	3,476	5,074
Kansas	2,648	978	1,670	2,648	978	1,670
Oklahoma	1,903	1,418	485	2,903	1,418	1,485
NM/TX	2,999	1,079	1,920	2,999	1,079	1,920
2020 Summer	4,420	3,614	806	6,020	4,112	1,908
Kansas	1,459	1,138	321	1,459	1,138	321
Oklahoma	1,161	1,161	-	2,761	1,659	1,102
NM/TX	1,800	1,315	485	1,800	1,315	485
2020 Spring	11,050	4,112	6,938	15,050	4,112	10,938
Kansas	3,648	1,138	2,510	3,648	1,138	2,510
Oklahoma	2,903	1,659	1,244	6,903	1,659	5,244
NM/TX	4,499	1,315	3,185	4,499	1,315	3,185

The graphs in Figure 2 represent the ratios of wind power retained in-state and sold off-system in the spring cases.

Figure 2 – Wind Transfers



Siemens/PTI MUST v.6 was used to perform the transfer analysis. First Contingent Incremental Transfer Capability (FCITC) analysis was used to determine the system upgrades needed to support the wind development. Analysis was performed on 230+ kV facilities; only facilities greater than 230 kV were monitored, and contingencies were only taken on those facilities.

Transfer analysis was used to time projects appropriately. Project interaction was determined by multiple iterations of MUST analysis. Transmission upgrades outside the SPP region, with the exception of certain seams, were not recommended in the study. SPP intends to address these integration issues in the Joint Coordination System Planning (JCSP) Study currently being conducted with SPP, the Midwest ISO, PJM Interconnection, and the Tennessee Valley Authority.

See Appendix B for further details on MUST solution parameters.

C. Economic Analysis

Economic analysis was performed using New Energy Associates/Ventyx Powerbase and PROMOD software packages. Model development was performed using Siemens/PTI PSS/E v.30.

Where applicable, SPP's Economic Modeling and Methods Task Force (EMMTF) assumptions were added to the economic models (see EMMTF report on the SPP website). Additionally, key assumptions (such as adjusted production cost savings) were taken from the Concepts Paper on Economic Upgrades (see Cost Allocation Working Group background materials on SPP.org). Flowgate definitions were taken from NERC's [Book of Flowgates](#).

SPP economic models were used as the starting point of the analysis. Results from the transfer analysis were put into the economic model set. A 2010 base model was developed to represent the base wind modeling assumption of 4,000 MW of wind. Incremental models were developed to represent the 2010 nominal, 2010 high wind, 2020 base, 2020 nominal and 2020 high wind scenarios. The 2020 base was assumed to be the same level of wind injection and topology upgrades needed for the 2010 nominal case. The remaining cases followed the wind assumptions detailed in Section A. The topology upgrades found in the transfer analysis were added to the appropriate scenarios.

Simulations were conducted to determine the optimal dispatch for each upgrade proposal in each scenario. The modeling footprint is detailed in Appendix C.1 of this report. The simulation took into account only existing flowgates for modeling of system constraints.

Simulations were conducted using two techniques. The first technique was to determine the impact on the system by considering all constraints in the modeling footprint. Hurdle rates were modeled between Tier 1 neighboring systems, and wind was modeled as a 'must take' energy resource. Wind energy was modeled using wind energy profiles (see Appendix C.5). The model was then given permission to dispatch these profiles down, according to system congestion and optimal pricing. The price of wind was modeled at \$-35MW/hr to facilitate this curtailment.

The second economic analysis technique considered the system with only constraints in the SPP region. Constraints beyond the SPP region were eliminated due to the lack of upgrades outside of the study's proposed footprint. This technique assumes that such upgrades would occur, and attempts to analyze the societal impact of the wind with full deliverability beyond the SPP region.

Some drawbacks and limitations to both of the analysis techniques became evident. Because the process models all flowgates, and the study only recommends 345 kV solutions, many flowgates become heavily loaded requiring the program to dispatch and commit around them. Additionally, the first technique tends to over-optimize the base solution due to the removal of constraints beyond the SPP region.

Unlike in the transfer analysis, the wind is modeled economically. The models will dispatch the wind to areas that have higher costs over areas that have lower marginal costs.

Adjusted production cost savings were calculated for each of the above scenarios. Adjusted production cost savings represent the value of expected savings for a more efficient dispatch after an upgrade has facilitated a reduction in system congestion. The equation used to calculate these values is in Appendix C.

The adjusted production cost savings were used to calculate an estimated 10-year return using an 8% discount rate. These results are detailed in the next section of the report.

4. Results of Analysis

This section details the results of both the transfer analysis and economic analysis.

A. Transfer Analysis Results

2010 Nominal Scenario

The 2010 configuration provides the foundation for the ultimate build out of the OEPTTF upgrades. This foundation establishes strong paths from the new wind injection points to loads in the SPP region and beyond. The Oklahoma panhandle region is expected to generate a significant portion of this new wind energy. The 2010 plan shows two separate 345 kV lines leading east out of the Oklahoma panhandle into Oklahoma and Kansas. These two lines coordinate with and attach to two substations that are proposed under original SPP X-Plan analysis. From here, one double circuit 345 kV line moves power into the Oklahoma City load center. Another double circuit 345 kV line moves power into the Wichita, Kansas load center.

The northwest leg of the X-Plan serves a dual purpose. It helps move wind energy generated in west Kansas into the Wichita area. It also provides a strong south-to-north connection into Nebraska's EHV system, which will help transport power from the SPP region to loads in the eastern United States. For this line into Nebraska, the section from Spearville to Knoll needs a second circuit to prevent overloading of the nearby 230 kV lines.

The southwest leg of the X-Plan moves wind generation out of Southwestern Public Service (SPS), while a triangle of 345 kV lines connecting Potter, Tolk and Tuco significantly improves reliability in the heart of SPS.

With so much wind generation being pushed east, generation outlet problems occur around Jeffery Energy Center (JEC) in northeast Kansas. To alleviate this and other problems around Kansas City, new lines were added from JEC to Cooper, and from Fairport to Thomas Hill, along with a second circuit to Hoyt.

In addition to these major line upgrades, several 345/230 kV transformers have been paralleled with second or third transformers. These are at Potter, Tuco, Hitchland and Knoll.

2010 High Wind Scenario

The 2010 high wind scenario adds a modest 1,000 MW of generation to the nominal scenario. Therefore, few additional upgrades are needed.

Most significant is the addition of second circuits to the lines leading out of Hitchland and the addition of a second circuit from Spearville to Comanche. These lines improve the west-east paths moving generation from Hitchland and Spearville east to Oklahoma City and Wichita.

Smaller upgrades were added in Oklahoma City and Kansas City to help power flow through these areas.

2020 Nominal Scenario

The 2020 nominal scenario adds 2,500 MW of generation above the 2010 high wind scenario. To facilitate the transfer of this additional power, several upgrades are required.

In western Oklahoma, a third circuit is added east into Oklahoma City, and a second north-south circuit is added between Comanche and Mooreland/Woodward. Additional reinforcements were needed in Oklahoma City and around Wichita to accept this additional transfer.

Lines from Red Willow to Axtell, and from Knoll to Summit, were added to allow more power to be sent eastward through Nebraska and Kansas. The addition of the Sooner to Cleveland line adds another path to move power eastward through Oklahoma.

Generation outlet problems occur again around JEC and Wolf Creek in east Kansas. Second and third circuits are added between JEC and Kansas City, while a second circuit is added from Wolf Creek to LaCygne.

2020 High Wind Scenario

The 2020 high wind scenario adds 4,000 MW of generation above the 2020 nominal scenario. Significant upgrades are needed to transport this additional power across the SPP region.

Additional circuits are added to move the additional generation eastward. Third circuits are added to both of the lines out of Hitchland. A third circuit is added into Wichita, and a fourth circuit is added into Oklahoma City.

Central SPS is further strengthened with a second circuit from Potter to Tuco. A second circuit moves power from SPS toward Oklaunion. Second and third circuits from here to Lawton Eastside (LES) complete this path into south Oklahoma.

Several reinforcements were needed in southern Oklahoma, near Texarkana and near northwest Arkansas, to move this power into Arkansas. Additional reinforcement was needed at Wolf Creek to further address the increasing problem of generation outlet.

Issues

These results do not fully address issues that occur outside of the SPP region. Issues were seen in Nebraska, Associated Electric Cooperative, Inc. (AECI), and Entergy when this generation was moved across their systems. Entergy’s ICT Strategic Transmission Expansion Plan (ISTEP) was included in the analysis for Arkansas. This plan helps relieve some of the issues, but leaves some in eastern Arkansas unresolved. Low impedance paths out of the SPP region are needed. It is expected that these would resolve most issues. The EHV Overlay Study proposes such a path, which includes a 765 kV path northeast across Missouri and another 765 kV path across Arkansas.

Tables and Maps

Table 6 lists all of the 345kV upgrades proposed in the study. The four columns denote the year the upgrade takes place: 2010, 2010 high wind (HW), 2020, and 2020 HW.

Table 6 – Upgrades

Proposed Upgrades					
	Scenario:	2010	2010-HW	2020	2020-HW
	Total Wind (MW):	7550	8550	11050	15050
Upgrade Name					
Spearville-Comanche 345 kV		√	√	√	√
Comanche-Mooreland 345 kV		√	√	√	√
Hitchland-Mooreland 345 kV		√	√	√	√
Mooreland-Tuco 345 kV		√	√	√	√
Potter-Tuco 345 kV		√	√	√	√
Tuco 345/230 kV Ckt 2		√	√	√	√
Axtell-Knoll-Spearville 345 kV		√	√	√	√
Hitchland 345/230 kV Ckt 2		√	√	√	√
Tuco 345/230 kV Ckt 3		√	√	√	√
Comanche-Wichita 345 kV		√	√	√	√
Potter-Tolk 345 kV		√	√	√	√
Tolk-Tuco 345 kV		√	√	√	√
Mooreland-Northwest 345 kV		√	√	√	√
Hitchland-Comanche 345 kV		√	√	√	√
Potter 345/230 kV Ckt 2		√	√	√	√
Knoll 345/230 kV Ckt 2		√	√	√	√
Hitchland 345/230 Ckt 3		√	√	√	√
Spearville 345/230 Ckt 3		√	√	√	√
JEC - Cooper 345kV		√	√	√	√
Fairport - Thomas Hill 345kV		√	√	√	√
Hoyt – JEC Ckt 2		√	√	√	√
Mooreland-Northwest 345 kV Ckt 2		√	√	√	√
Comanche - Wichita 345kV Ckt2		√	√	√	√
Spearville – Knoll 345kV Ckt 2		√	√	√	√
Iatan-Nashua 345 kV			√	√	√
Hitchland-Comanche 345 Ckt 2			√	√	√

Proposed Upgrades				
Scenario:	2010	2010-HW	2020	2020-HW
Total Wind (MW):	7550	8550	11050	15050
Upgrade Name				
Hitchland-Mooreland 345 Ckt 2		√	√	√
Northwest – Arcadia 345kV Ckt 2		√	√	√
Commanche – Spearville Ckt 2		√	√	√
Comanche-Mooreland 345 kV Ckt 2			√	√
Swissvale – W. Gardner – Stilwell 345kV Rebuild/Rerate			√	√
Northwest – Cimarron Rebuild/Rerate			√	√
Mooreland-Northwest 345 kV ckt 3			√	√
Redwillow-Axtell 345kV			√	√
Ft Smith 500/345kV Ckt 2			√	√
Sooner-Cleveland 345 kV			√	√
Wolf Creek – LaCygne 345kV Ckt 2			√	√
Wichita – Rose Hill 345kV			√	√
Hoyt – Stranger Ckt 2			√	√
Hoyt – JEC Ckt 3			√	√
Knoll - Summit 345kV			√	√
Lawton Eastside (LES) – Seminole 345kV				√
Chamber Springs - Flint Creek 345kV				√
Mooreland - Hitchland 345kV Ckt3				√
Commanche - Wichita 345kV Ckt3				√
Commanche - Hitchland 345kV Ckt3				√
Lacygne - WolfCreek 345kV Ckt3				√
Lawton Eastside (LES)- Sunnyside 345kV Replace Terminals				√
Northwest - Mooreland 345kV Ckt4				√
Potter - Tuco 345kVCkt2				√
Muskogee - FtSmith 345kV Ckt2				√
Lawton Eastside (LES) - Oklaunion 345kV Ckt2				√
Oklaunion - Tuco 345kV Ckt2				√
Pittsburg-Valliant 345kV Replace Switch at Pittsburg				√
Cimarron - Draper 345kV Replace WT and CTs				√
Pittsburg-Seminole 345kV Replace Switch at Pittsburg				√
Lawton Eastside (LES) - Oklaunion 345kV Ckt 3				√
Pittsburg-Seminole 345kVCkt 2				√
Lydia - NW Texarkana 345kV Ckt 2				√

Figure 3 details the proposed upgrades for the study scenarios. Yellow lines are recommended in the study. Dashed yellow lines denote upgrades approved by the SPP Board of Directors and included in the SPP Transmission Expansion Plan (STEP).

Figure 3 – 2010 Nominal Wind

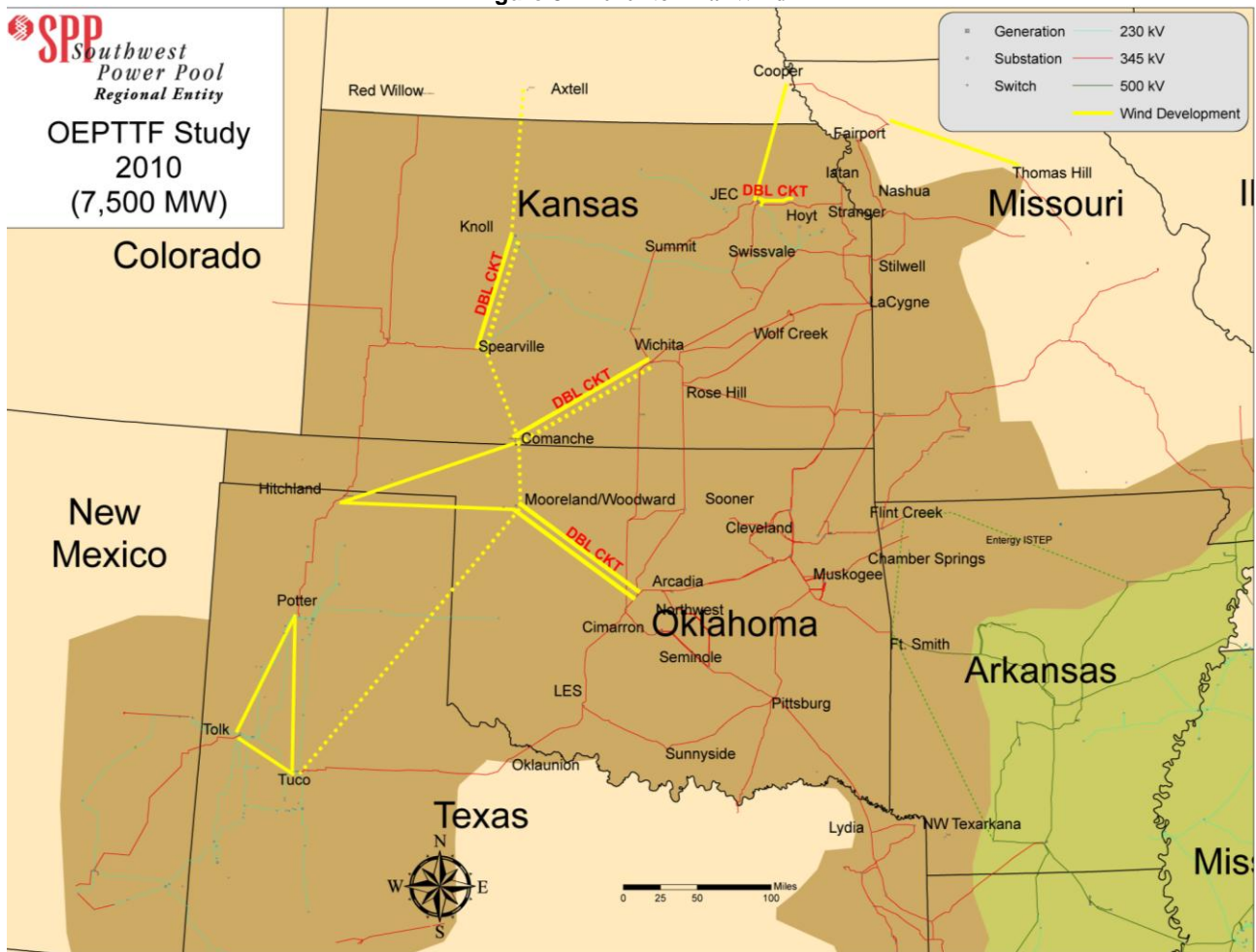
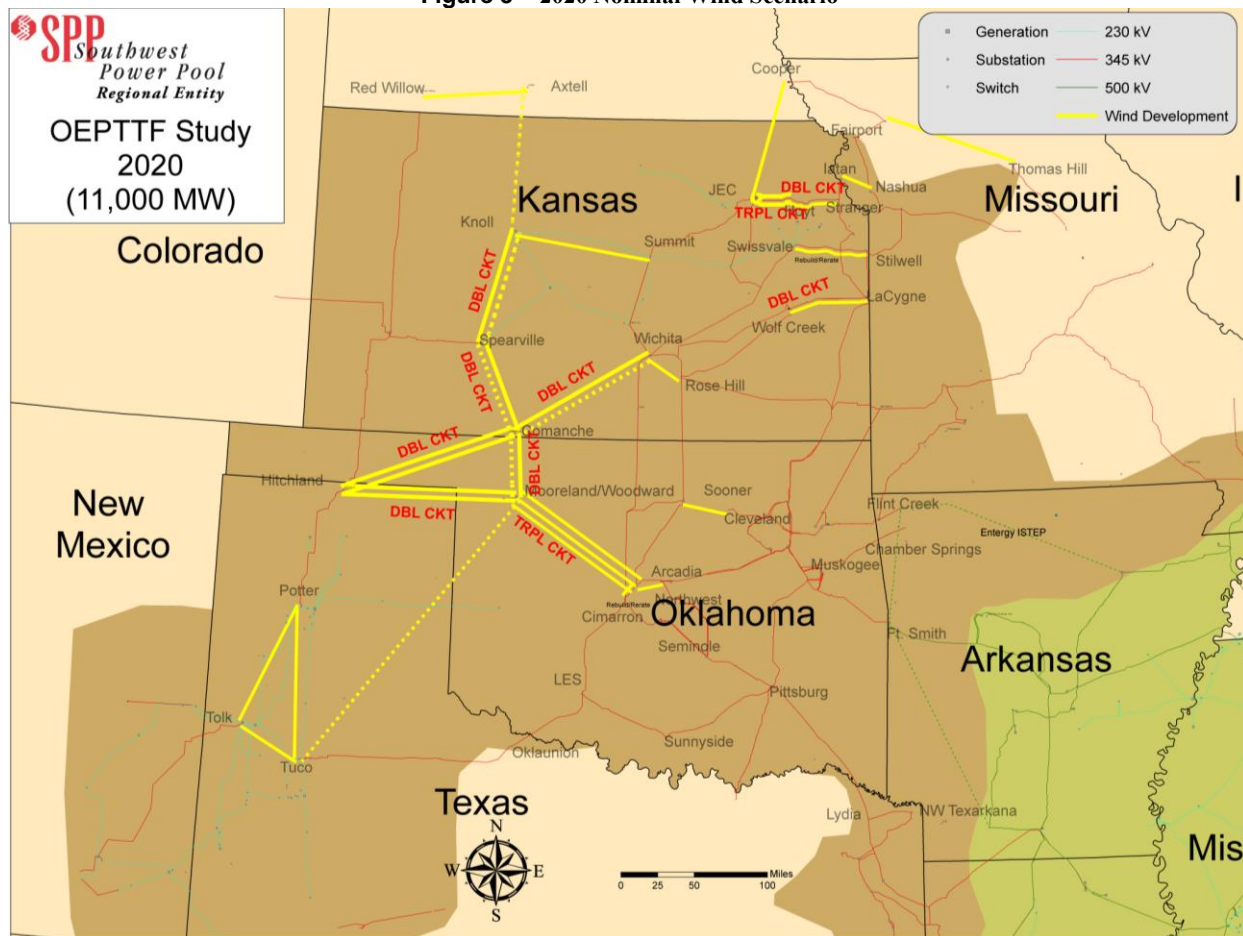


Figure 4 – 2010 High Wind Scenario



Figure 5 – 2020 Nominal Wind Scenario



B. Economic Analysis Results

This section includes the economic analysis, and is divided into two analysis techniques as described in the methodology section of this report.

Technique 1

The first technique was to determine the impact on the system by all constraints in the modeling footprint. Hurdle rates were modeled between Tier 1 neighboring systems, and wind was modeled as a “must take” energy resource. Wind energy was modeled using wind energy profiles (see Appendix C.5). The model was then given permissions to dispatch these profiles down, according to system congestion and optimal pricing. The price of wind was modeled at \$-35MW/hr to facilitate this curtailment.

Analysis for the 2020 study phase began with the 2010 nominal wind results as the base for comparison. Results for both the incremental benefits and the estimated cumulative benefits are shown in Tables 7 and 8. A negative adjusted production cost savings is denoted by parenthesis. Negative changes to adjusted production cost savings represent a cost reduction; positive changes represent an increase in costs.

Table 7 – Incremental Adjusted Production Cost Savings by Regions

Project	Total Adjusted Production Cost	SPP	TIER1
OEPTTF_Nominal_2010	(\$345,184,000)	(\$533,735,000)	\$188,552,000
OEPTTF_High_2010	(\$414,342,000)	(\$617,022,000)	\$202,681,000
OEPTTF 2020 Nominal Wind	(\$14,395,000)	(\$18,144,000)	\$3,749,000
OEPTTF 2020 High Wind	(\$73,771,000)	(\$128,618,000)	\$54,847,000

Table 8 – Cumulative Adjusted Production Cost Savings by Regions

Project	Total Adjusted Production Cost	SPP	TIER1
OEPTTF_Nominal_2010	(\$345,184,000)	(\$533,735,000)	\$188,552,000
OEPTTF_High_2010	(\$414,342,000)	(\$617,022,000)	\$202,681,000
OEPTTF 2020 Nominal Wind	(\$359,579,000)	(\$551,879,000)	\$192,301,000
OEPTTF 2020 High Wind	(\$418,955,000)	(\$662,353,000)	\$243,399,000

Table 9 demonstrates the expected benefit-cost ratio for each upgrade. The carrying charge rate for the projects is assumed to be 20%. Benefits to cost are compared on a yearly basis.

Table 9 – Estimated Benefit to Cost Ratios

Project	Total Project E&C	Estimated Revenue Requirements (20% FCR)	Estimated Yearly Benefit	B/C Ratio
OEPTTF_Nominal_2010	\$ 2,075,300,000	\$ 415,060,000	\$ 345,184,000	0.832
OEPTTF_High_2010	\$ 2,496,700,000	\$ 499,340,000	\$ 414,342,000	0.830
OEPTTF 2020 Nominal Wind	\$ 3,170,700,000	\$ 634,140,000	\$ 359,579,000	0.567
OEPTTF 2020 High Wind	\$ 4,541,350,000	\$ 908,270,000	\$ 418,955,000	0.461

Technique 1 attempted to represent a more open system for power transfers between the SPP region and other regions by removing all external flowgates, assuming that upgrades to facilitate these transfers would be studied at a later date. This method tends to over-optimize the base power exchange.

Once the upgrades are applied to the SPP system, more economic power transactions internal to the SPP region are enabled as well as more export capability. In addition, prices in the SPP region on a marginal and average basis will be lower as congestion is relieved and wind is added to the footprint. Thus in the upgrade scenarios, the SPP region will rely more on internal resources than base. This can be considered as a cost to areas outside of the SPP region.

Technique 2

The second economic analysis technique considered the system with only constraints within the SPP region. Constraints beyond the SPP region were eliminated due to the lack of upgrades outside of the study’s proposed footprint. This technique assumes that such upgrades were to occur, and attempts to analyze the societal impact of the wind with full deliverability beyond the SPP region.

Table 10 – Incremental Adjusted Production Cost Savings by Regions

Project	Total Adjusted Production Cost	SPP	TIER1
OEPTTF_Nominal_2010	(\$142,597,000)	(\$147,827,000)	\$5,230,000
OEPTTF_High_2010	(\$180,652,000)	(\$186,506,000)	\$5,854,000
OEPTTF 2020 Nominal Wind	(\$196,174,000)	(\$198,515,000)	\$2,341,000
OEPTTF 2020 High Wind	(\$121,162,000)	(\$119,649,000)	(\$1,514,000)

Table 11 – Cumulative Adjusted Production Cost Savings by Regions

Project	Total Adjusted Production Cost	SPP	TIER1
OEPTTF_Nominal_2010	(\$142,597,000)	(\$147,827,000)	\$5,230,000
OEPTTF_High_2010	(\$180,652,000)	(\$186,506,000)	\$5,854,000
OEPTTF 2020 Nominal Wind	(\$338,771,000)	(\$346,342,000)	\$7,571,000
OEPTTF 2020 High Wind	(\$263,759,000)	(\$267,476,000)	\$3,716,000

Table 12 – Estimated Benefit to Cost Ratios

Project	Total Project E&C	Estimated Revenue Requirements (20% FCR)	Estimated Yearly Benefit	B/C Ratio
OEPTTF_Nominal_2010	\$ 2,075,300,000	\$ 415,060,000	\$ 142,597,000	0.34
OEPTTF_High_2010	\$ 2,496,700,000	\$ 499,340,000	\$ 180,652,000	0.36
OEPTTF 2020 Nominal Wind	\$ 3,170,700,000	\$ 634,140,000	\$ 338,771,000	0.53
OEPTTF 2020 High Wind	\$ 4,541,350,000	\$ 908,270,000	\$ 263,759,000	0.29

This analysis technique was a more standard analysis process since it considered all existing flowgates. Because upgrades were added to the SPP system, yet the Tier 1 topology was a 2008 scheme, the analysis tended to restrain transfers out of the SPP region. This is why Tier 1 had a very low cost associated with the benefits.

Each bar in Graph 1 represents an adjusted production cost savings for the modeled footprint (SPP and neighboring systems) for the respective scenarios.

Graph 1 – Adjusted Production Cost Savings by Scenario and Technique

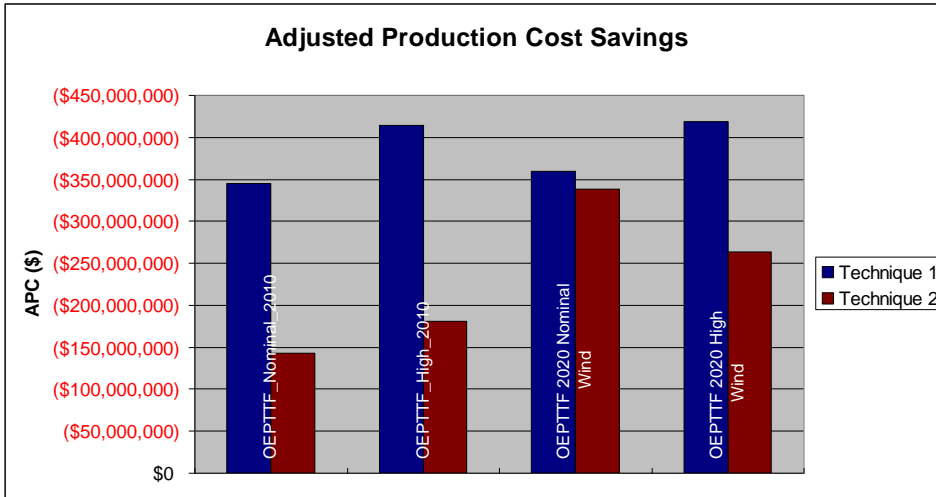


Table 13 lists the estimated annual wind revenues for the respective techniques and scenarios. It is noteworthy that Technique 1 dispatched far less wind than Technique 2. This is because the analysis did not use wind as “must take”, but as dispatchable. Due to certain underlying key constraints remaining after the EHV upgrades, the models are backing the wind down appropriately. Additionally, wind in both techniques was dispatched below the expected 35-40% capacity factor. These tables take wind revenue to be \$40/MWh. This does not consider any renewable energy credits or other subsidies. Actual wind revenues may be significantly higher than stated below. The table below reflects only modeling output for the techniques applied in the study.

Table 13 – Estimated Wind Revenues

Scenario	Installed Wind Nameplate Capacity (MW)	Technique 1		Technique 2	
		Annual Energy Output (GW)	Wind Revenues per year at \$40/MWh (in \$M)	Annual Energy Output (GW)	Wind Revenues per year at \$40/MWh (in \$M)
2010 Base	4,000	5,474	\$ 218,971	6,540	\$ 261,585
2010 Nominal Wind	7,550	5,425	\$ 216,997	17,847	\$ 713,874
2010 High Wind	8,500	5,667	\$ 226,691	18,149	\$ 725,976
2020 Base Wind	7,550	5,427	\$ 217,100	12,838	\$ 513,535
2020 Nomial Wind	11,050	8,107	\$ 324,290	24,624	\$ 984,956
2020 High Wind	15,050	9,768	\$ 390,725	24,644	\$ 985,743

Economic Analysis Considerations

Neither Technique 1 nor Technique 2 is considered to be a better or more accurate analysis process. The full range of transmission impacts must be determined to arrive at a solid benefit number. This study's analysis pushes the economic modeling process to its limits. These models optimize production costs around existing flowgate constraints. The OEPTTF Study does not consider underlying upgrades, and only considers EHV facilities needed for the transfer of wind across and out of the SPP region. Because of these discrepancies between model optimization points and the lack of underlying upgrades, the results are skewed.

Tier 1 benefits become difficult to infer from either of these techniques. The 2008 topology, and the fact that no upgrades have been added to compensate, is a limiting factor in the analysis. Future analysis should be conducted as long-range plans converge into a final solution. At that point, analysis should be conducted that is not limited by process assumptions that hamper the precision and accuracy of the modeling programs.

High Fuel Sensitivity

High fuel price sensitivity was considered for the study. This analysis was conducted on the 2010 Base by raising the price of gas from an average of \$9 to \$12 (an increase of 33%). Such a price increase resulted in an estimated increase to adjusted production cost of around 60%.

5. Conclusions and Recommendations

Transmission expansion alternatives for the OEPTTF Study considered 345 kV connectivity and expansion. As higher wind levels were analyzed, that assumption shifted to consideration of a 765 kV network. OEPTTF Study results indicate that for wind levels of 15,000 MW, 345 kV expansion is costly and requires a significant amount of Rights-of-Way (ROW) acquisition. Typically, to provide the capability of one 765 kV transmission circuit, three or four 345 kV circuits must be installed. .

SPP is using OEPTTF Study results to develop a construction and recommendation plan for the build out of the grid. This plan uses the EHV Overlay study as the template for the ultimate build out, and combines findings from the OEPTTF analysis into a recommendation.

Both the EHV Overlay Study and the OEPTTF Study provided similar results. Both plans revealed the need for a strong EHV connection to the Oklahoma panhandle, the Texas panhandle, and western Kansas. In many cases, the results were one-for-one. In those instances, the transition plan reflects circuits along the same ROW that would initially be constructed at 765 kV with 345 kV initial operation.

Elements of the OEPTTF Study, typically in eastern Oklahoma and Kansas, share similar transmission paths with the EHV Overlay analysis. Future analysis will likely indicate that, with 765 kV expansion and a networked 765 kV grid, these upgrades are superfluous.

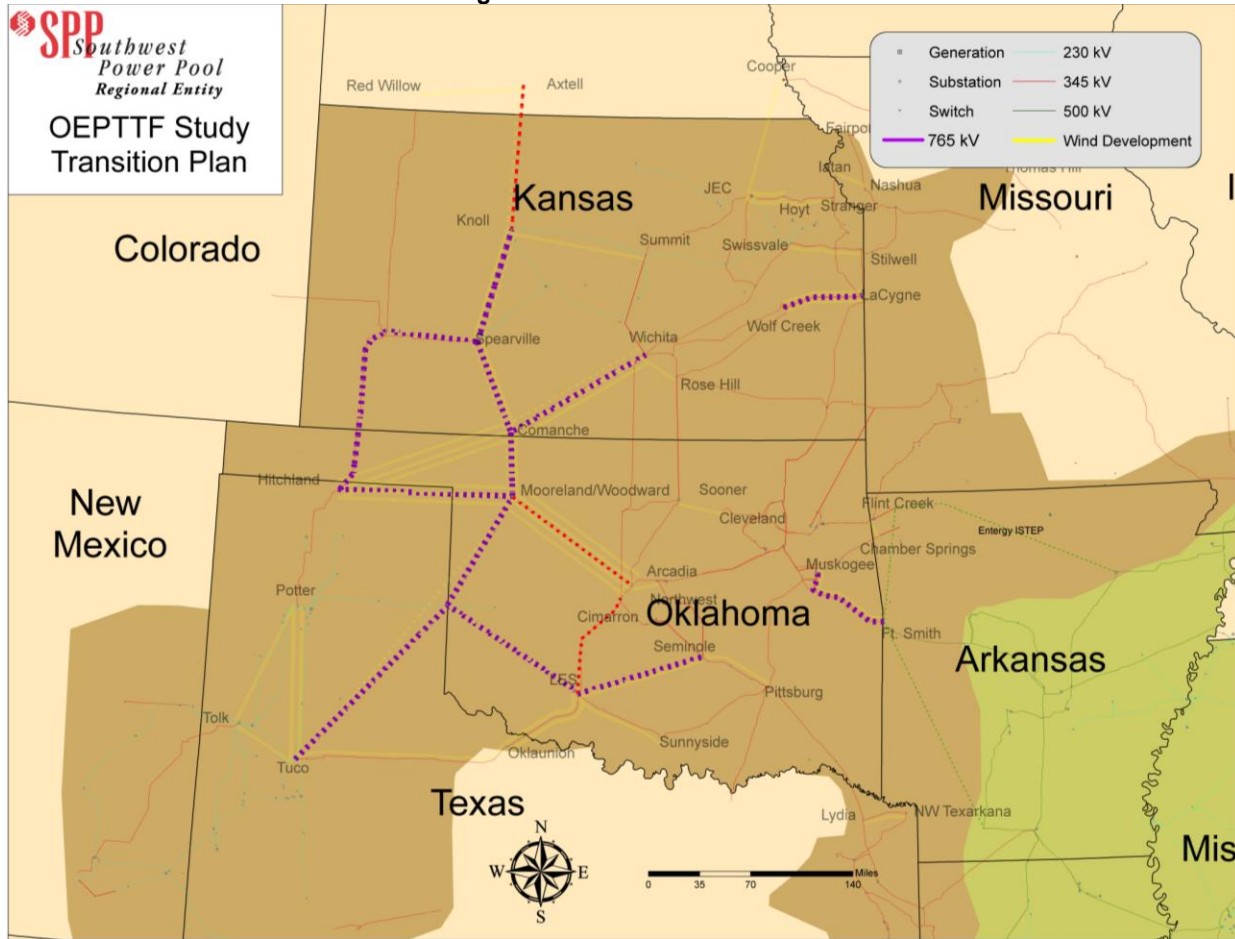
The recommendation is for a 765 kV grid starting in Spearville, with connections up to Knoll, Finney, and Comanche County. The transmission lines from Comanche County – Wichita, Comanche County – Mooreland/Woodward, Mooreland/Woodward – Hitchland, Hitchland – Finney are also recommended for 765 kV construction.

Circuits from Mooreland/Woodward – Stateline, Stateline – Tuco, Stateline – Lawton Eastside (LES), and Lawton Eastside (LES) – Seminole are recommended for 765 kV construction. Finally, Muskogee – Ft. Smith and Wolf Creek – LaCygne are common legs from the EHV Overlay study, and are in need of additional support. These portions of the plan are also recommended for 765 kV construction.

The circuit from Knoll – Axtell, a line from Mooreland/Woodward – Northwest, along with an additional circuit from Lawton Eastside (LES) – Cimarron are recommended for 345 kV construction.

Figures 7 and 8 detail both the final stage of the 765 kV expansion and the intermediate OETTF Study design point.

Figure 7 – Recommended Construction Plan



The transmission expansion approach SPP used in the OEPTTF Study focused on increased connectivity and capability between existing and potential EHV connection nodes. The location of injections within the SPP region is a key assumption that drives preliminary expansion plans. While this approach may simplify the determination of potential timing and location of large EHV corridors and capacity, it does not address diversity concerns or opportunities to create future collector system capabilities.

Prudent expansion planning should consider not only adequate EHV expansion needs, but also reliability considerations. SPP's approach scaled connectivity and capabilities between existing and potential EHV nodes, which may have created a tendency to bias recommendations toward 765 kV solutions. Balancing adequacy and reliability considerations against efficient and effective collection and delivery network designs is a challenge for future analysis.

Optimal expansion plans for substation siting selection should consider existing and planned transmission facilities at that location; land availability for substation development; access for transmission lines and congestion related to existing or planned developments in the area (such as wind farms); and the willingness and ability of project sponsors to build, operate, and maintain facilities

The hub of the original X Plan was at Mooreland, Oklahoma given Western Farmers Electric Cooperative's (WFEC) expected participation in Holcomb. The location of a major EHV substation in western Oklahoma was not critical in this OEPTTF Study. Mooreland versus Woodward are electrically equivalent for bulk power planning assessments. Decisions regarding which entity has the right and obligation to build transmission facilities within the SPP region are driven by governing documents and stakeholder input.

Planning and operations of existing transmission facilities that would interface with an EHV overlay in and around the SPP region will require substantial changes going forward. This paradigm shift is a critical success factor for demonstrating the value of an EHV transmission network across regions, interconnections, and beyond. The existing transmission network was not designed to support transfers and flows that can be expected in the near future, or that are desired long-term.

It is not necessarily prudent to upgrade all, or even a majority, of the constraints identified as the result of superimposing an EHV overlay onto the existing network. It may be more appropriate to reconfigure the existing network and island sections of existing transmission network to eliminate through flows. Long-range expansion planning must avoid unintended consequences.

It is not appropriate to negatively impact reliability for existing customers as a result of major EHV transmission expansion. Challenges provided by limitations to the existing network, and its incompatibility with EHV expansion, provide opportunities to apply new technology and approaches for system planning and operations. This may include special protection schemes, and smart grid applications.

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Consideration must be given to single phase operation of a 765 kV grid. Single phase operation can provide significant reliability benefits and change system planning and operations.

This analysis does not include many benefits that would be realized as a result of an EHV Overlay. While the economic benefits of EHV expansion can be quantified, an EHV Overlay's impact of reliability standards and margins can be substantial.

Treatment of Letters of Commitment

Several SPP members have indicated their desire to build major transmission facilities to support 345+ kV development in and around the SPP region. Multiple entities have indicated their desire to complete the southwest leg of the X-Plan into SPS, as well as the southeast leg of the X-Plan into Oklahoma City. At least two SPP members have made public pronouncements of their desire and willingness to build an EHV overlay in and around the SPP region.

SPP is currently processing letters of agreements and contracts and determining project designs. SPP continues to work with project sponsors and stakeholders on decisions regarding the Spearville – Comanche Co – Wichita and the Spearville – Knoll – Axtell EHV projects.

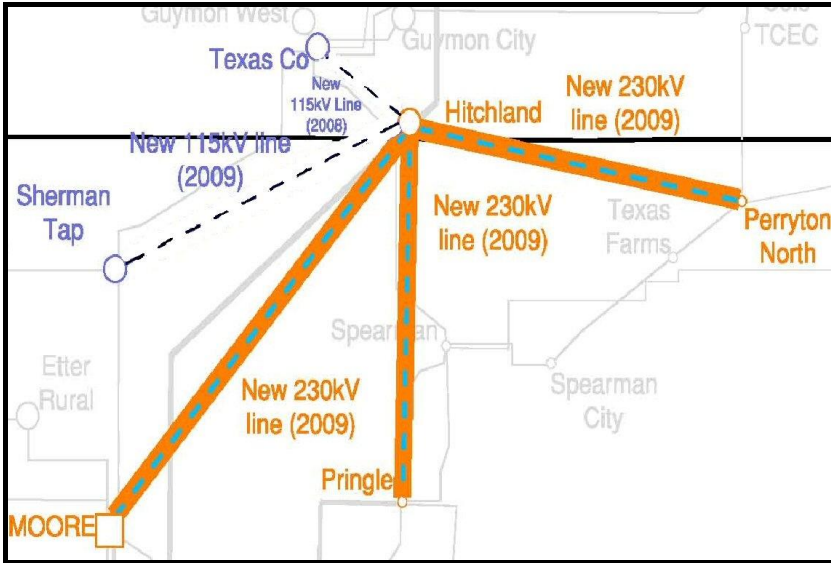
Fit with SPP Transmission Expansion Plan (STEP) 2008-2017

Significant transmission expansion projects in the STEP 2008-2017 could facilitate major wind development. The \$100+M Hitchland may provide a major opportunity to leverage an existing reliability based project in SPP to accommodate future needs. This is a large 345/230/115 kV substation being located where the existing Finney – Potter 345 kV line intersects the Texas and Oklahoma border. Figure 9 shows the Hitchland project and its 5 new transmission lines.

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Figure 9 –Hitchland Project



The proposed layout of the Hitchland substation by SPS is commendable. SPS has provided a preliminary layout of the Hitchland 345/230/115 kV substation (see Appendix E), which includes three additional 230 kV and six additional 345 kV, bus positions beyond the initial design. SPP has time to refine design and capabilities for Hitchland – Perryton North and Hitchland – Pringle 230 kV lines, since SPS does not plan to file CCNs for those lines until 2009.

SPS is proposing to string single conductor 795 ACSR on its new 230 kV lines at Hitchland. SPP would like to work with SPS and other TOs to assess the trade-offs between traditional use of 345 kV design and B-795 conductor (which increases costs by approximately one-third over 230 kV design) and composite core conductor with 2,000 amp load-carrying capability for 1024 ACCC/TW Aluminum Conductor Composite Core/Trapezoidal Wire, which has been used by SPP members in lieu of traditional 795 ACSR. The value versus cost of ACCC conductor or increased load-carrying capability needs to be assessed for new transmission lines that traverse prime wind development areas such as the Hitchland – Pringle and Hitchland –Perryton North lines in SPS.

Generation Interconnection Queue

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There are 25 GW of wind in the SPP generation interconnection (GI) queue. The existing system is saturated with approved GIs, many of which are on suspension, as allowed by the SPP Open Access Transmission Tariff (Tariff). The SPP GI queue in prime wind development areas is virtually at a standstill.

Study results are driven by assumptions and solution techniques used in the course of the study. Wind injection locations drive the major EHV nodes in the SPP expansion plans. Actual wind farm development may be significantly different than the existing GI queue since interconnection requests are limited to existing or approved transmission facilities, not planned or proposed lines or substations.

The most recent GI in the Hitchland area has direct assigned a 120 mile 345 kV line from Hitchland – Mooreland/Woodward to address stability needs for a new interconnection, notwithstanding transmission expansion that will be required to provide firm deliveries for related capacity and energy.

Generation interconnections and transmission delivery service are two distinct processes under SPP’s Tariff. Significant transmission expansion will require effective seams agreements with neighboring transmission providers and an unprecedented level of collaboration in power systems planning and operations.

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Benefits of EHV Expansion

Transmission expansion presented in this OEPTTF study has the potential to provide a number of benefits including:

- improve overall regional electric reliability and operating efficiencies;
- increase access to diverse resources, including renewables in the premier wind development regions of the central and south plains;
- increase import and export capabilities for the region; and
- reduce environmental impacts by sharing utility corridors where feasible.

Reliability concerns due to operational impacts of very large wind farms are valid (consider the wind events in ERCOT in February 2007 and February 2008). Aggregation of diverse wind resources and use of the EHV overlay can reduce the adverse impacts to host zones. Consolidating balancing authorities within the SPP region seems to be another step to mitigate difficulties in maintaining operating performance standards within individual zones. The geographic and physical diversity of wind resources in the SPP region provide benefits to wind development here relative to other regions with limited or condensed geographical separation between wind resources. There are ways to mitigate operational challenges associated with the intermittent and uncertainty/variability associated with wind resources that offset the incremental costs of better forecasts for planning and operations, as well as control schemes and protocols to implement operating directives.

The development of expansion plans is important, but actual physical transmission requires commitments and collaboration between affected parties, particularly for EHV expansion. Although SPP must adhere to its approved Tariff processes for generation interconnection and delivery services, innovative solutions to facilitate the implementation of effective long-range plans that provide a robust transmission network are needed. While multiple 345 kV lines in a common ROW may minimize environmental impacts for new transmission, and reductions in installed cost and maintenance expenses, the potential adverse consequences to system security for a common mode event could be devastating and present unacceptable levels of risk. It seems prudent to balance all objectives, including this study, given proper weight to key parameters, to achieve an optimal overall solution.

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6. Appendices

A. Fuel Pricing

The follow table details the average fuel prices used in the OEPTTF Study. Each fuel is referenced to the study's base year (2008). The fuel price is escalated to determine the appropriate price per study year. The escalation rate for all fuels used in the study is 1.83% per year.

Table – Fuel Price Assumptions

Fuel	2008 Avg Price
Gas	\$9
Oil - H	\$10.23
Oil - L	\$14.74
Coal	\$1.63

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B. MUST Solution Settings

MUST Choices in Running FCITC DC Analysis

Constraints/Contingency Input Options

1. AC Mismatch Tolerance – 2 MW
2. Base Case Rating – Rate A
3. Base Case % of Rating – 100%
4. Contingency Case Rating – Rate B
5. Contingency Case % of Rating – 100%
6. Base Case Load Flow – PSS/E
7. Convert branch ratings to estimated MW ratings – No
8. Contingency ID Reporting – Labels + Events
9. Maximum number of contingencies to process – 10000

MUST Calculation Options

1. Phase Shifters Model for DC Linear Analysis – Fixed Angle
2. Report Base Case Violations with FCITC – Yes
3. Maximum number of violations to report in FCITC table – 50000
4. Distribution Factor (OTDF and PTDF) Cutoff – 0.03
5. Maximum times to report the same elements – 3 {eliminate voluminous repeats}
6. Apply Distribution Factor to Contingency Analysis – Yes
7. Apply Distribution Factor to FCITC Reports – Yes
8. Minimum Contingency Case flow change – 0 MW
9. Minimum Contingency Case Distribution Factor change – 0.0
10. Minimum Distribution Factor for Transfer Sensitivity Analysis – 0.0

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C. Economic Model Options

1. Modeling Footprint

The diagram below reflects the economic modeling footprint. A checked box in the “Aggregate” column means the areas were combined into one simplified modeling area. Otherwise, the areas marked represent the actual areas modeled for the study.

Include	Market	Aggregate	Area
<input checked="" type="checkbox"/>		<input checked="" type="checkbox"/>	ALL
<input type="checkbox"/>		<input type="checkbox"/>	Eastern Canada
<input type="checkbox"/>		<input type="checkbox"/>	Florida
<input type="checkbox"/>		<input type="checkbox"/>	ISO (Ontario)
<input type="checkbox"/>		<input type="checkbox"/>	ISO New England
<input checked="" type="checkbox"/>		<input checked="" type="checkbox"/>	Midwest ISO
<input type="checkbox"/>		<input type="checkbox"/>	MISO [ECAR]
<input checked="" type="checkbox"/>		<input checked="" type="checkbox"/>	MISO [MAIN]
<input type="checkbox"/>		<input type="checkbox"/>	American Transmission Company - Wisconsin
<input checked="" type="checkbox"/>		<input checked="" type="checkbox"/>	Illinois
			AmerenCILCO
			AmerenCIPS
			AmerenIP
			City Water, Light & Power (Springfield, IL)
			Electric Energy, Inc.
			Southern Illinois Power Coop
<input checked="" type="checkbox"/>		<input checked="" type="checkbox"/>	Iowa & Missouri
			Alliant West
			AmerenUE
<input type="checkbox"/>		<input type="checkbox"/>	MISO [MRO]
<input checked="" type="checkbox"/>		<input checked="" type="checkbox"/>	MRO
<input checked="" type="checkbox"/>		<input checked="" type="checkbox"/>	Dakotas
<input checked="" type="checkbox"/>		<input checked="" type="checkbox"/>	Iowa
			MidAmerican Energy Co.
			Muscatine Power & Water
<input checked="" type="checkbox"/>		<input checked="" type="checkbox"/>	Minnesota & Wisconsin
<input checked="" type="checkbox"/>		<input checked="" type="checkbox"/>	Nebraska
			Lincoln Electric System
			Nebraska Public Power District
			Omaha Public Power District
			WAPA Billings East (UM-East) NEBRASKA & IOWA
			SaskPower
<input type="checkbox"/>		<input type="checkbox"/>	New York ISO
<input checked="" type="checkbox"/>		<input checked="" type="checkbox"/>	PJM Interconnect
<input checked="" type="checkbox"/>		<input checked="" type="checkbox"/>	Southeast
<input checked="" type="checkbox"/>		<input checked="" type="checkbox"/>	Carolinas
<input checked="" type="checkbox"/>		<input checked="" type="checkbox"/>	Energy Subregion
<input checked="" type="checkbox"/>		<input checked="" type="checkbox"/>	Northern Energy
			Associated Electric Coop, Inc.
			Entergy Corp. (Entergy Electric System) NORTH
<input checked="" type="checkbox"/>		<input checked="" type="checkbox"/>	Southern Entergy
			Kentucky
			Southern Subregion
			Alabama Electric Coop. Inc.
			Oglethorpe Power Corp.
			South Mississippi Electric Power Association
			Southern Company
			Tennessee Valley Authority
			Southwest Power Pool
			SPP Louisiana
			Cleco Utility Group, Inc.
			Lafayette Utilities System
			Louisiana Energy & Power Authority
			SPP North
			Aquila MISSOURI
			City Utilities of Springfield (Springfield, MO)
			Empire District Electric Co.
			Independence Power & Light Dept.
			Kansas City Board of Public Utilities
			Kansas City Power & Light Co.
			MidWest Energy, Inc.
			Sunflower Electric Power Corp., Inc.
			Westar Energy
			WestPlains Energy (KS)
			SPP South
			AEP West - SPP
			Arkansas Electric Coop Corp.
			Grand River Dam Authority
			Oklahoma Gas & Electric Co.
			Oklahoma Municipal Power Authority
			Southwestern Power Administration
			Southwestern Public Service Co.
			Western Farmers Electric Coop
			SPP Wind
			Kansas Wind
			Oklahoma Wind
			Texas/N Mexico Wind

3. Hurdle Rates

PROMOD applies a hurdle rate between different regions. For this analysis, a \$5/MW hurdle rate was applied for commitment and dispatch of units across regions. This hurdle rate was only applied to Technique 2.

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4. Adjusted Production Cost Equation

The adjusted production cost metric is calculated by estimating the unit commitment and economic dispatch of modeled generators within the context of a modeled transmission system and load delivery points. The commitment and dispatch of the generators is constrained to ensure that no overloads will occur on any monitored transmission element (typically including NERC's Book of Flowgates, but can also include additional potential future flowgates). The software produces a security constrained economic dispatch and unit commitment.

Program outputs are related to the production costs of the units modeled in the simulation. Production cost for each unit is based upon the fuel used, variable operating and maintenance costs, environmental costs, and both scheduled and forced outages.¹ The adjusted production cost considers the economics associated with purchases and sales between areas in the model.

Adjusted production cost would be calculated as follows:

$$\text{Adj Prod Cost} = \text{Production Cost} - \text{Revenue from Sales} + \text{Cost of Purchases}$$

Where

$$\text{Revenues from Sales} = \text{Net Export} \times \text{Zonal LMP}_{\text{Gen}} \text{ Weighted}$$

and

$$\text{Cost of Purchases} = \text{Net Import} \times \text{Zonal LMP}_{\text{Load}} \text{ Weighted}$$

The adjusted production cost metric is useful for comparing transmission expansion alternatives. This metric can also be used in the calculation of present value and net revenue requirements for regulatory justification.

¹ SPP is currently using probabilistic techniques to simulate a single draw of outages to simulate forced outages.

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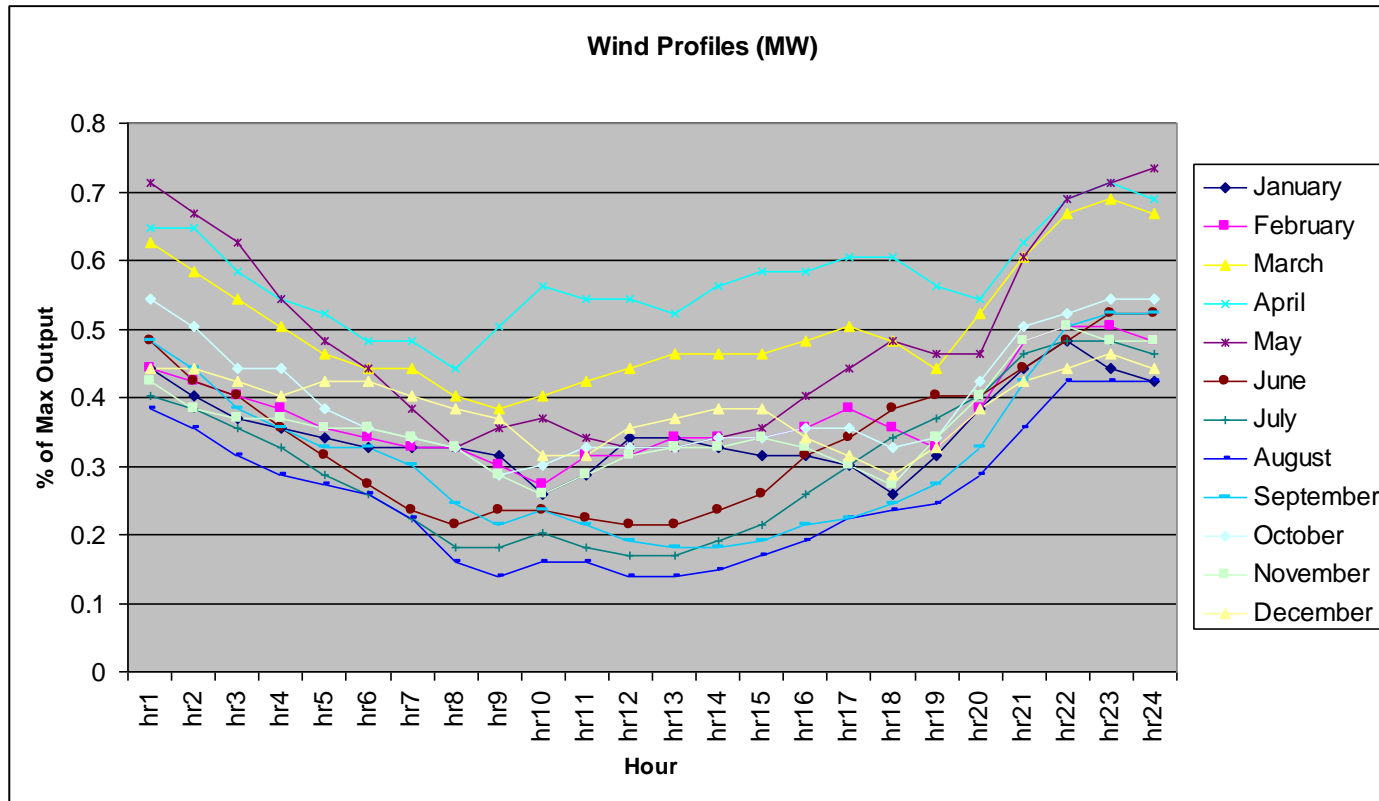
5. Wind Profiles

Wind profiles have been modeled as an expected energy output at each location. A generic profile has been applied to each location. This profile represents a typical week profile for each month.

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D. Project Cost Estimate

Upgrades					
Scenario:	2010	2010-HW	2020	2020-HW	Estimated Costs
Total Wind (MW):	7550	8550	11050	15050	
Upgrade Project					
Spearville-Commanche 345 kV	√	√	√	√	\$ 74,400,000
Comanche-Mooreland 345 kV	√	√	√	√	\$ 72,800,000
Hitchland-Mooreland 345 kV	√	√	√	√	\$ 168,000,000
Mooreland-Tuco 345 kV	√	√	√	√	\$ 263,800,000
Potter-Tuco 345 kV	√	√	√	√	\$ 115,500,000
Tuco 345/230 kV Ckt 2	√	√	√	√	\$ 7,500,000
Axtell-Knoll-Spearville 345 kV	√	√	√	√	\$ 205,100,000
Hitchland 345/230 kV Ckt 2	√	√	√	√	\$ 7,500,000
Tuco 345/230 kV Ckt 3	√	√	√	√	\$ 7,500,000
Comanche-Wichita 345 kV	√	√	√	√	\$ 126,800,000
Potter-Tolk 345 kV	√	√	√	√	\$ 100,400,000
Tolk-Tuco 345 kV	√	√	√	√	\$ 56,000,000
Mooreland-Northwest 345 kV	√	√	√	√	\$ 120,700,000
Hitchland-Comanche 345 kV	√	√	√	√	\$ 148,800,000
Potter 345/230 kV Ckt 2	√	√	√	√	\$ 7,500,000
Knoll 345/230 kV Ckt 2	√	√	√	√	\$ 7,500,000
Hitchland 345/230 Ckt 3	√	√	√	√	\$ 7,500,000
Spearville 345/230 Ckt 3	√	√	√	√	\$ 7,500,000
JEC - Cooper 345kV	√	√	√	√	\$ 91,000,000
Fairport - Thomas Hill 345kV	√	√	√	√	\$ 112,100,000
Hoyt – JEC Ckt 2	√	√	√	√	\$ 30,500,000
Mooreland-Northwest 345 kV Ckt 2	√	√	√	√	\$ 120,700,000
Commanche - Wichita 345kV Ckt2	√	√	√	√	\$ 126,800,000
Spearville – Knoll 345kV Ckt 2	√	√	√	√	\$ 89,400,000
Total Cost for 2010	\$ 2,075,300,000				
Iatan-Nashua 345 kV		√	√	√	\$ 28,600,000
Hitchland-Comanche 345 Ckt 2		√	√	√	\$ 148,800,000
Hitchland-Mooreland 345 Ckt 2		√	√	√	\$ 145,500,000
Northwest – Arcadia 345kV Ckt 2		√	√	√	\$ 24,100,000
Commanche – Spearville Ckt 2		√	√	√	\$ 74,400,000
Total Cost for 2010 High Wind	\$ 2,496,700,000				
Comanche-Mooreland 345 kV Ckt 2			√	√	\$ 50,300,000
Swissvale – W. Gardner – Stilwell 345kV Rebuild/Rerate			√	√	\$ 60,800,000
Northwest – Cimarron Rebuild/Rerate			√	√	\$ 15,900,000
Mooreland-Northwest 345 kV ckt 3			√	√	\$ 120,700,000
Redwillow-Axtell 345kV			√	√	\$ 89,000,000
Ft Smith 500/345kV Ckt 2			√	√	\$ 7,500,000
Sooner-Cleveland 345 kV			√	√	\$ 40,000,000
LaCygne - WolfCreek 345kV Ckt 2			√	√	\$ 68,300,000
Wichita – Rose Hill 345kV			√	√	\$ 33,000,000

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Upgrades					
Scenario:	2010	2010-HW	2020	2020-HW	Estimated Costs
Total Wind (MW):	7550	8550	11050	15050	
Upgrade Project					
Hoyt – Stranger Ckt 2			√	√	\$ 43,400,000
Hoyt – JEC Ckt 3			√	√	\$ 30,500,000
Knoll - Summit 345kV			√	√	\$ 114,600,000
Total Cost for 2020					\$ 3,170,700,000
Lawton Eastside (LES) – Seminole 345kV				√	\$ 108,400,000
Chamber Springs – Flint Creek 345kV				√	\$ 15,800,000
Mooreland - Hitchland 345kV Ckt3				√	\$ 145,500,000
Comanche - Wichita 345kV Ckt3				√	\$ 126,800,000
Comanche - Hitchland 345kV Ckt3				√	\$ 148,800,000
LaCygne - WolfCreek 345kV Ckt 3				√	\$ 68,300,000
Lawton Eastside (LES) - Sunnyside 345kV Replace CTs and WT				√	\$ 200,000
Northwest - Mooreland 345kV Ckt4				√	\$ 120,700,000
Potter - Tuco 345kVCkt2				√	\$ 115,500,000
Muskogee - FtSmith 345kV Ckt2				√	\$ 81,600,000
Lawton Eastside (LES) - Oklaunion 345kV Ckt2				√	\$ 78,600,000
Oklaunion - Tuco 345kV Ckt2				√	\$ 180,600,000
Pittsburg-Valliant 345kV Replace Switch at Pittsburg				√	\$ 75,000
Cimarron - Draper 345kV Replace WT and CTs				√	\$ 200,000
Pittsburg-Seminole 345kV Replace Switch at Pittsburg				√	\$ 75,000
Lawton Eastside (LES) - Oklaunion 345kV Ckt 3				√	\$ 78,600,000
Pittsburg-Seminole 345kVCkt 2				√	\$ 61,500,000
Lydia - NW Texarkana 345kV Ckt 2				√	\$ 39,400,000
Total Cost for 2020 High Wind					\$ 4,541,350,000

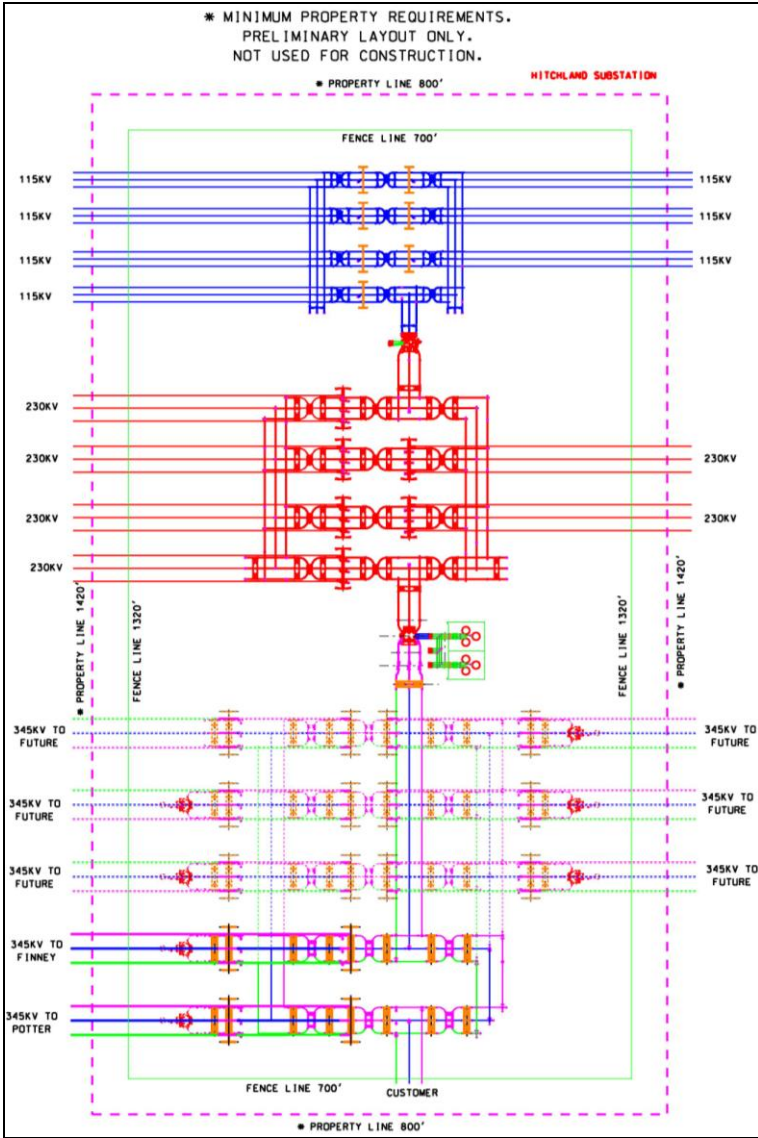
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765kV Alternative Upgrade Costs	
Upgrade Project	Estimated Costs
Spearville-Commanche 765 kV	\$ 174,650,000
Comanche-Mooreland 765 kV	\$ 130,650,000
Hitchland-Mooreland 765 kV	\$ 326,650,000
Mooreland-Stateline 765 kV	\$ 214,050,000
Tuco-Stateline 765 kV	\$ 360,550,000
Stateline-LES 765 kV	\$ 269,650,000
Seminole-LES 765 kV	\$ 239,650,000
LES-Cimarron 345 kV	\$ 110,450,000
Hitchland-Finney(holcomb) 765 kV	\$ 254,000,000
Finney (holcomb)-Spearville 765 kV	\$ 174,650,000
Axtell-Knoll 345 kV	\$ 108,200,000
Knoll-Spearville 765 kV	\$ 195,650,000
Comanche-Wichita 765 kV	\$ 326,650,000
Mooreland-Northwest 345 kV	\$ 120,700,000
Wolf Creek-Lacygne 765 kV	\$ 175,300,000
Muskogee-Ft. Smith 765 KV	\$ 197,300,000
Total Cost	\$ 3,378,750,000

Generic Cost Assumptions	
Upgrade	Cost
115 - 161 kV Breakers 2	\$ 750,000
115-138 kV Line/mile	\$ 375,000
161 kV Line/mile	\$ 450,000
230 kV Line/mile	\$ 562,500
345 kV Breakers 2	\$ 1,500,000
345 kV Line/mile	\$ 1,000,000
500 kV Line/mile	\$ 1,200,000
69 kV Line/mile	\$ 300,000
765 kV Line/mile	\$ 2,000,000
765 kV Substation	\$ 22,650,000
Bulk XF	\$ 7,500,000
cap/MVAR	\$ 27,000
Replace CTs	\$ 50,000
switch or terminal jumper	\$ 75,000
Wavetrap	\$ 150,000
XF per MVA	\$ 15,000

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E. SPS Proposed Hitchland Substation Layout



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