SPP 101
AN INTRODUCTION TO SOUTHWEST POWER POOL
WHO WE ARE
OUR MISSION: HELPING OUR MEMBERS WORK TOGETHER TO KEEP THE LIGHTS ON ... TODAY AND IN THE FUTURE.
### AIR TRAFFIC CONTROL: AN ANALOGY

<table>
<thead>
<tr>
<th>Air Traffic Control</th>
<th>Southwest Power Pool</th>
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</thead>
<tbody>
<tr>
<td>Does not own airplanes, airlines or airports</td>
<td>Does not own utilities, power generators or transmission lines</td>
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<tr>
<td>Does not own the sky it monitors</td>
<td>Does not own the land electricity flows across</td>
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<tr>
<td>Directs air routes to ensure airplanes and passengers are safely transported</td>
<td>Monitors and directs regional bulk power grid to ensure electricity gets from where it’s made to where it’s needed</td>
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</table>
OUR BEGINNING

- In 1941, 11 member utilities pooled electricity to power aluminum plant at Jones Mill for critical defense.
- Maintained after WWII to continue benefits of regional coordination.
THE SPP DIFFERENCE

• Relationship-based
• Member-driven
• Independence Through Diversity
• Evolutionary vs. Revolutionary
• Reliability and Economics Inseparable
THE VALUE OF SPP

- Transmission planning, market administration, reliability coordination, and other services provide net benefits to SPP’s members in excess of more than $2.2 billion annually at a benefit-to-cost ratio of 14-to-1.

- A typical residential customer using 1,000 kWh saves $7.63/month because of the services SPP provides.
MILESTONES

1968  Became NERC Regional Council
1980  Implemented telecommunications network
1991  Implemented operating reserve sharing
1994  Incorporated as nonprofit
1997  Implemented reliability coordination
MILESTONES

1998  Implemented tariff administration
2004  Became FERC-approved Regional Transmission Organization
2007  Launched EIS market
2009  Integrated Nebraska utilities
2010  FERC approved Highway/Byway cost allocation methodology and Integrated Transmission Planning Process
MILESTONES

2012  Moved to new Corporate Center
2014  Launched Integrated Marketplace
       Became regional Balancing Authority
2015  Integrated System joins SPP
**SPP AT A GLANCE**

- Located in Little Rock
- Approx. 600 employees
- Jobs in IT, electrical engineering, operations, settlements and more
- 24x7 operation
- Full redundancy and backup site
SPP CORPORATE CENTER
COMMUNITY INVOLVEMENT AND RECOGNITION

• Best Place to Work in Arkansas: 2014 Benchmark Award Winner 2013 Finalist

• Principal Financial Group “Top 10”

• SPP employees support more than 70 Central Arkansas charities including:
  • Arkansas Children’s Hospital
  • Arkansas Foodbank
  • Carelink
  • Girls of Promise
  • Museum of Discovery
  • Our House
  • Race for the Cure
  • Relay for Life
  • St. Jude
  • United Way
  • Youth Home
Our Goal:
To promote and support the STEM career pipeline for Arkansas youth from elementary school through college.

Learn about our efforts at SPP.org/STEM
SPP’s STEM OUTREACH PROGRAM

• Partnership with Little Rock School District:
  • Elementary school reading program
  • Middle school science fairs
  • High school problem-based learning activities
  • Teacher training
  • Supply Drive
• Additional support for:
  • Women’s Foundation of Arkansas’ Girls of Promise Coding Summit
  • Arkansas School for Math, Sciences and the Arts’ Coding AR Future program
  • Arkansas STEM Coalition
• School visits, field trips, outreach events, reading days, and more.
• Incorporated in Arkansas as 501(c)(6) nonprofit corporation
• Federal Energy Regulatory Commission (FERC)
  • Regulated public utility
  • Regional Transmission Organization
• Founding member of the North American Electric Reliability Corporation (NERC)
NORTH AMERICAN INDEPENDENT SYSTEM OPERATORS (ISO) AND REGIONAL TRANSMISSION ORGANIZATIONS (RTO)
ISO/RTO GROWTH BEFORE 1996
ISO/RTO GROWTH BY 1996

1996: ERCOT
ISO/RTO GROWTH BY 2002
ISO/RTO GROWTH BY 2008
SPP’S 99 MEMBERS: INDEPENDENCE THROUGH DIVERSITY

- 16 Investor-Owned Utilities
- 14 Municipal Systems
- 20 Generation and Transmission Cooperatives
- 8 State Agencies
- 15 Independent Power Producers
- 12 Power Marketers
- 11 Independent Transmission Companies
- 1 Federal Agency
- 2 Large Retail Customers

July 12, 2019
SPP MANAGES THE GRID IN 5 OF THE TOP 100 CITIES IN AMERICA: KANSAS CITY, OKLAHOMA CITY, TULSA, OMAHA, AND WICHITA
MEMBERS IN 14 STATES

- Arkansas
- Kansas
- Iowa
- Louisiana
- Minnesota
- Missouri
- Montana
- Nebraska
- New Mexico
- North Dakota
- Oklahoma
- South Dakota
- Texas
- Wyoming
OPERATING REGION

- Service territory: 546,000 square miles
- Population served: 17.5 million
- Generating plants: 818*
- Substations: 5,054*

* In SPP’s reliability coordination footprint
MILES OF TRANSMISSION: 66,892

- 69 kV 17,340
- 115 kV 15,846
- 138 kV 9,367
- 161 kV 5,567
- 230 kV 7,534
- 345 kV 11,146
- 500 kV 92
2018 ENERGY PRODUCTION BY FUEL TYPE: 275,887 GWH TOTAL

- Natural Gas (23.4%)
- Coal (42.4%)
- Wind (23.5%)
- Nuclear (5.4%)
- Fuel Oil (0.2%)
- Hydro (4.8%)
- Solar (0.2%)
- Other (0.1%)
ENERGY PRODUCTION BY GENERATION TYPE OVER TIME

![Energy production chart showing different generation types over time. The chart displays data from 2008 to 2018, with energy production in MWh for each year.

The chart includes the following generation types:
- Coal
- Gas
- Wind
- Nuclear
- Hydro
- Other

The energy production trends are as follows:
- Coal shows a steady increase.
- Gas remains relatively stable.
- Wind production grows significantly over the years.
- Nuclear production stays consistent.
- Hydro production increases gradually.
- Other production shows a slight variation.

The y-axis represents energy production in MWh, ranging from 0 to 300,000,000.

The x-axis represents the years from 2008 to 2018.}
GENERATING CAPACITY* BY FUEL TYPE:
89,999 MW TOTAL

* NAMEPLATE CAPACITY AS OF 1/1/19

- Natural Gas (40.3%)
- Coal (28.6%)
- Wind (22.9%)
- Nuclear (2.3%)
- Fuel Oil (1.8%)
- Hydro (3.8%)
- Solar (0.2%)
- Other (0.1%)
ENERGY CAPACITY BY FUEL MIX OVER TIME
GENERATOR INTERCONNECTION REQUESTS UNDER STUDY (BY FUEL TYPE): 85,074 MW TOTAL

- Wind (48,683 MW)
- Solar (29,224 MW)
- Storage (6,836 MW)
- Gas (331 MW)
- Other (0 MW)

August 19, 2019
MIN AND MAX PERCENT OF GENERATION MIX BY FUEL TYPE

June 2018 – June 2019
MARKET FACTS

- 225 market participants
- 757 generating resources
- 2018 marketplace settlements = $20.5 billion
- 50,662 MW coincident peak load (8/19/19)
  - Winter peak: 43,584 MW (1/17/18)
SPP’S IT INFRASTRUCTURE

- 136,000+ data points updated every 2-30 seconds
- Operations model solves 91,400 x 228,948 matrix every two minutes
- Approx. 2,650 servers
- More than 3.6 petabytes of storage
INTERREGIONAL COORDINATION

• ISO-RTO Council
• Interregional planning efforts
• North American Energy Standards Board (NAESB)
• National Association of Regulatory Utility Commissioners
CONTRACT SERVICES

• Alternative to RTO membership for Transmission Owners
• Oversight of Transmission Owners’ system operations:
  – Reliability Coordination
  – Transmission Planning
  – Tariff Administration
  – Interregional Coordination
• Provides process for assigning cost responsibility for transmission upgrades
OUR STRATEGY

RELIABILITY ASSURANCE

ENHANCE MEMBER VALUE AND AFFORDABILITY

OPTIMIZE INTERDEPENDENT SYSTEMS

MAINTAIN AN ECONOMICAL, OPTIMIZED TRANSMISSION SYSTEM
OUR SERVICES
OUR MAJOR SERVICES

• Facilitation
• Reliability Coordination
• Balancing Authority
• Transmission Service/Tariff Administration

• Market Operation
• Transmission Planning
• Training

OUR APPROACH:
Regional, Independent, Cost-Effective and Focused on Reliability
ACTIVITIES OUTSIDE SPP’S SCOPE

• Transmission siting
• Generation planning/siting
• Transmission/generation construction
• Transmission/generation permitting
FACILITATION
# BOARD OF DIRECTORS

<table>
<thead>
<tr>
<th>Larry Altenbaumer, Chairman</th>
<th>T. Graham Edwards, Vice Chairman</th>
<th>Nicholas A. (Nick) Brown, President and CEO</th>
<th>Phyllis E. Bernard</th>
</tr>
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<tbody>
<tr>
<td>Julian Brix</td>
<td>Susan Certoma</td>
<td>Mark Crisson</td>
<td>James E. (Jim) Eckelberger, Emeritus</td>
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<tr>
<td>Joshua W. Martin, III</td>
<td>Darcy Ortiz</td>
<td>Bruce A. Scherr</td>
<td>Harry Skilton, Emeritus</td>
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</table>
REGIONAL STATE COMMITTEE
RELIABILITY COORDINATION: AIR TRAFFIC CONTROLLERS OF THE BULK POWER GRID

• Monitor grid 24 x 365
• Anticipate problems
• Take preemptive action
• Coordinate regional response
• Independent
• Comply with more than 5,500 pages of reliability standards and criteria
TRAINING

• In 2018, SPP provided 30,240 training hours to 157 organizations, representing reliability, train-the-trainer, Integrated Marketplace and transmission settlement courses.

• SPP awarded 26,255 NERC Continuing Education Hours to 37 member organizations and staff.

• SPP offers:
  • Regional system-restoration drills
  • Integrated Marketplace training
  • Regional Emergency Operations sessions
  • Train-the-trainer classes
MARKETS
Like any market, SPP’s electricity markets feature:

- Sellers/producers with a product and buyers/consumers who want to buy it
- Prices driven by supply and demand
FINDING BALANCE

MINIMUM FOR RELIABLE DELIVERY TO CUSTOMERS

SPP TODAY

NO LIMITS TO LOW COST DELIVERY

EXPAND TRANSMISSION

MORE TRANSMISSION NEEDED

CUSTOMER ENERGY COST

LESS INVESTMENT
WHAT KIND OF MARKETS DOES SPP OPERATE?

• Transmission Service: Participants buy and sell use of regional transmission lines that are owned by different parties.

• Integrated Marketplace: Participants buy and sell wholesale electricity in day-ahead and real-time.
  • Day-Ahead Market commits the most cost-effective and reliable mix of generation for the region.
  • Real-Time Balancing Market economically dispatches generation to balance real-time generation and load, while ensuring system reliability.
TRANSMISSION SERVICE MARKET
TRANSMISSION MARKET

- Provides “one-stop shopping” for use of regional transmission lines
- Consistent rates, terms, conditions for all users
- Independent
- Approx. 7,900 transactions per month on average in 2018
- 2018 transmission customer transactions = $4.47 billion

As a “sales agent,” SPP administers a transmission tariff greater than 5,500 pages in length on behalf of its members and customers.
THE VALUE OF TRANSMISSION SERVICE

Without SPP

To get from a generator in Utility A to a customer in Utility C, electricity must flow through lines owned by Utilities A, B, and C, each with its own set of operating rules and associated costs.

$30

$4
$6
$5

$15 transmission service + $30 energy = $45

With SPP

SPP moves electricity across Utilities A, B, and C in one transaction for a single service fee, then shares revenues with each party.

$30

$5 transmission service + $30 energy = $35
Reserving transmission service = reserving a seat on a plane
- Customer specifies priority, time, source/sink, capacity
- Tariff administrator approves if capacity exists

Issuance of NERC Tag = receiving boarding pass
- Won’t be approved if improper use of reservation

Creation of schedule from tag = sitting on the plane
- Generators ramp to provide energy for transaction
- May be curtailed if transmission system overloaded
WHOLESALE ENERGY MARKET
WHAT IS A WHOLESALE ENERGY MARKET?

**Sellers/Producers**
- Utilities
- Municipals
- Independent Power Producers
- Generators
- Power Marketers

**Buyers/Consumers**
- Utilities
- Municipals
- Load Serving Entities (LSEs)
- Power Marketers

**Locational Prices**
- Driven by supply and demand at defined locations

**Products**
- Energy
- Operating Reserves
- Congestion Rights
SPP'S ENERGY MARKET: INTEGRATED MARKETPLACE

SPP facilitates the marketplace, providing the infrastructure, systems and 24/7 market operations.
SPP’S INTEGRATED MARKETPLACE

SPP financially settles the marketplace

• Calculates prices
• Captures wholesale energy production and consumption
• Collects from market participants (MP) who owe the market
• Pays MPs who are owed by the market
• Remains revenue neutral

SPP has an independent market monitor
INTEGRATED MARKETPLACE OVERVIEW

Key Components

- Day-Ahead (DA) Market
- Real-Time Balancing Market (RTBM)
- Transmission Congestion Rights (TCR) Market

Products

- Energy
- Operating Reserve (Regulation Up, Regulation Down, Spinning, Supplemental)
- Congestion Rights
THE INTEGRATED MARKETPLACE DAY-AHEAD AND REAL-TIME COMMITMENT SCHEDULE

<table>
<thead>
<tr>
<th>Sun</th>
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</table>

- **OCTOBER 7** Day-Before Operating Day (OD-1)
- **OCTOBER 8** Operating Day (OD)
  - REAL-TIME BALANCING MARKET (RTBM)
- **OCTOBER 9** Post Operating Day (OD+1, 2, etc.)
  - FINANCIAL SETTLEMENT of all MARKET ACTIVITES
MARKETPLACE BENEFITS

• SPP’s markets provide participants $570M in net savings annually

• Reduce total energy costs through centralized unit commitment while maintaining reliable operations

• Day-ahead market allows additional price assurance capability prior to real-time

• Operating reserve products support implementation of the SPP balancing authority and facilitate reserve sharing
AVERAGE REAL-TIME MARKET PRICES: 2007-2018

SPP’s markets have helped lower region-wide wholesale electricity prices.
SPP’s markets have helped lower region-wide wholesale electricity prices
MARKETPLACE BENEFITS

- SPP’s Integrated Marketplace paid for itself in less than one year.
DAY-AHEAD MARKET

• Determines least-cost solution to meet energy bids and reserve requirements

• Participants submit offers and bids to purchase and/or sell energy and operating reserve:
  • Energy
  • Regulation-Up
  • Regulation-Down
  • Spinning Reserve
  • Supplemental Reserve
REAL-TIME BALANCING MARKET (RTBM)

- Balances real-time load and generation committed by the day-ahead market and reliability commitment processes
- Operates on continuous 5-minute basis
  - Calculates dispatch instructions for energy and clears operating reserve by resource
- Energy and operating reserve are co-optimized
- Settlements based on difference between results of RTBM process and day-ahead market clearing
- Charges imposed on market participants for failure to deploy energy and operating reserve as instructed
TRANSMISSION CONGESTION RIGHTS (TCR) MARKET

• In the day-ahead market, price separation of market participant’s resource to load may occur due to congestion leaving the market participant exposed to high prices

• A TCR can be used as hedge against congestion that allows market participants to reduce exposure to high market prices and potentially receive lower-priced deliverable energy

• TCR market has annual and monthly auction processes related to two products:
  • Auction Revenue Rights (ARRs)
  • Transmission Congestion Rights (TCRs)
MARKET MONITORING UNIT (MMU) ENSURES RELIABILITY, EFFECTIVENESS

- SPP’s internal MMU reports directly to the Board and Oversight Committee
- Independent from SPP RTO
- FERC Order 719 allows ISO/RTO markets to be overseen by internal, external or hybrid monitor
  - Three ISOs/RTOs have an external monitor, two have an internal monitor, and one has a hybrid
  - Order 719 authorizes RTO Board of Directors to decide on the monitor structure and the SPP Board has decided an internal form to be most appropriate for SPP
- MMU reviews real-time/historic data and reports any issues to FERC for investigation
## NOTABLE MARKET INITIATIVES

### NDVER to DVER Conversion
- ~7900 MW of Non-Dispatchable Variable Energy Resources
- SPP’s only mechanism to control NDVER output is through out-of-market actions
- Conversion results in increased reliability and market efficiencies

### Enhanced VER Data for Forecasting
- Individual wind turbine location data
- Mid-point and corner location data for solar farms
- Inverter technology and controls information
- Improved forecasting of VERs results in better unit commitment and dispatch, lower production costs, and increased reliability

### Economic Decommitment
- Resources committed in the Day-Ahead Market are not typically decommitted unless a reliability need arises that requires it
- Establishment of an economic decommitment process could alleviate prolonged periods of excess generation which creates severe depression on LMPs

### Regulation Up Market for VERS
- VERs precluded from participating in ‘Up’ products, except for Energy, because of fuel source uncertainty
- Would allow for additional competition in the regulation up product
- Addresses potential scenarios where grid is primarily renewable

### DVER Regulation Enhancement
- SPP has some inefficiencies in the clearing of Regulation and the requirements for DVERs
- Introduces use of real-time capability in real-time market for VERs

### Fast Start Resources
- FERC 206 proceeding
- Delays commitment of Quick Start Resources until Real-Time Balancing Market
FUTURE MARKET INITIATIVES

Longer Term Ramping/Uncertainty Product
- Builds on current short term ramping product
- With more renewables, SPP’s forecasting and uncertainty issues continue to grow past short-term into longer than 10-15 minute issues

Distributed Energy Resources
- Awaiting FERC Order
- Should allow for a broader spectrum of participation in SPP
- More flexibility is essential for coming changes

Coordinated Transaction Scheduling
- Most real time transactions in SPP are fixed transactions. Allowing transactions to be cleared by Market creates value for all participants.
- Should increase price convergence between seams with other RTOs
THIS ISN’T OUR PARENTS’ ELECTRIC GRID

Evolving grid

Energy efficiency

Smart meters

Generator retirements

Advanced technologies

Prosumers

Fuel prices

Demand response

Battery storage

Solar

Distributed generation

Consumer demand

Wind

Environmental constraints

Microgrids

Electric vehicles

Evolving grid

PlANNING FOR AN UNCERNAT FUTURE
GRID CONGESTION
AND ITS IMPACTS ON MARKETS AND TRANSMISSION PLANNING
WHAT IS CONGESTION?

• Congestion or “bottlenecks” happen when you can’t get energy to customers along a certain path
  • Desired electricity flows exceed physical capability

• Congestion caused by:
  • Lack of transmission, often due to load growth
  • Line and generator maintenance outages
  • Unplanned outages such as storms or trees on lines
  • Too much generation pushed to grid in a particular location
  • Preferred energy source located far from customers

• Results in inability to use least-cost electricity to meet demand
CONGESTION PREVENTS ACCESS TO GENERATION

Load pockets see higher prices (pay for more expensive, local generation)

Low prices in areas with high amount of cheap generation (wind), constrained by transmission outlets
CONGESTION’S IMPACT ON MARKET PRICES

WDWFPLTATNOW*
West → East flow across NW Oklahoma
MEC: $29.36/MWh
West of constraint: $-9.66 /MWh
East of constraint: $86.88 /MWh

*WDWFPLTATNOW: Woodward – FPL Switching Station 138kV for the loss of Tatonga – Northwest 345kV
Congestion can expose market participants to high energy costs.

Transmission Congestion Rights market allows participants to protect their load from price spikes.
TRANSMISSION CONGESTION RIGHTS MARKET

• Market participants select transmission paths they want to hedge (protect)
• Transmission Congestion Rights (TCRs) distribute hourly day-ahead congestion rents
• Auction revenue rights (ARR) are based on firm transmission service and distribute revenue generated in auctioning TCRs
• Annual auction has 14 products
• Monthly auction has 2 products
• Participants must do their due diligence when selecting which paths to hedge
TRANSMISSION PLANNING: BASIC CONCEPTS
SERVICES
U.S. primary energy consumption by source and sector, 2017

Total = 97.7 quadrillion British thermal units (Btu)

Source: https://www.eia.gov/energyexplained/?page=us_energy_home
TRANSMISSION PLANNING CHALLENGES

In most industries, you can put a manufacturing plant anywhere close to an interstate or railroad to transport your product. Locating electric generation is more challenging.

Wind, solar, and hydro energy can only be manufactured where those resources are located. A coal-fired plant must be located in a place with water for cooling, and the ability to deliver large quantities of coal to it. A natural gas-fired plant has to be on a pipeline.

In many cases, “roads” don’t exist to move wind and solar energy to electricity customers, and building them is a long and costly process.
TRANSMISSION PLANNING CONSIDERATIONS

Must take into account a number of considerations, including:

- Reliability
- Economics
- Public Policy
TRANSMISSION PLANNING CONSIDERATIONS

- What parts of grid need strengthening to “keep the lights on?”
  - Some redundancies are necessary to mitigate outage-related risks
- Where are current and future generation located?
- Where are electricity consumers located?
- Where on the grid do we frequently see congestion?
- Will laws mandating more renewable energy or a carbon tax impact traffic?
- How do coal/gas prices impact traffic?
  - People will use more coal if gas prices rise, and vice versa
- How do regional temperatures impact traffic?
  - If temperature differs across region, one area may need more energy
TRANSMISSION INVESTMENT DIRECTED BY SPP

$7.7B in completed projects
$1.9B in scheduled projects
TRANSMISSION IN SPP

- In 2018, SPP members completed 36 transmission projects totaling more than $779 million.
- More than $10 billion in transmission upgrades were planned and approved from 2004-2018.
- 66,892 miles of transmission lines in SPP’s footprint would circle the earth more than twice!
- SPP’s transmission owning members have approximately $15.6B in net transmission investment.
TRANSMISSION PLANNING
HOW SPP MAKES PLANNING DECISIONS

• Integrated Transmission Planning process

• Generation Interconnection Studies
  • Determines transmission upgrades needed to connect new generation to electric grid

• Aggregate Transmission Service Studies
  • Determines transmission upgrades needed to transmit energy from new generation to load
  • Shares costs of studies and new transmission

• Specific transmission studies
TRANSMISSION BUILD CYCLE IN SPP

- Planning Study (12-18 mo.)
- TO Selection (3-12 mo.)
- Design, ROW Acquisition, & Construction (2-6 yr.)

Responsible Party:
- SPP
- Transmission Owner
INTEGRATED TRANSMISSION PLANNING (ITP) PROCESS

• Annual planning cycle assesses near- and long-term economic and reliability needs

• Produces a 10-year transmission expansion plan each year, combining near-term, 10-year, and TPL-001-4 assessments into one study

• 20-year assessment performed no more than once every five years except when directed by the SPP board of directors

• 30 study models assess a variety of potential scenarios
SPP’S TRANSMISSION PLANNING STUDIES

Stakeholder-driven, member-funded

- Integrated Transmission Planning
- High Priority
- Balanced Portfolio
- Interregional Projects

Customer-initiated, customer-funded

- Transmission Service
- Congestion Hedging*
- Generation Interconnection Service
- Sponsored Upgrades

*Currently funded by members, but new admin fee structure will charge to market participants
LONG-TERM TRANSMISSION SERVICE STUDIES

- **Aggregate**
  - Attachment Z1

- **Delivery point transfer**
  - Attachment AR

- **Delivery point addition**
  - Attachment AQ
AGGREGATE STUDIES

• Analyzes clusters of requests for transmission service needed to assure delivery of generation to load
• Cluster studies performed semi-annually
• Costs of transmission upgrades shared among study participants
• Highway/byway cost allocation for upgrade costs up to safe harbor limit
DELIVERY POINT TRANSFER STUDIES

• Analyzes impacts of transferring load from one customer to another
• Performed as requested
• If impacts found, customer required to submit aggregate study request
DELIVERY POINT ADDITION STUDIES

• Analyzes transmission needed to add new load to network or modify load service points
• Performed on a monthly basis, as requested
• SPP determines network upgrades, local TO determine load connection facilities
• Highway/byway cost allocation

Recent load-addition requests have included:
• Data centers
• Oil & gas infrastructure
• Irrigation
WHO PAYS FOR TRANSMISSION PROJECTS?

- **Sponsored**: Project owner builds and receives credit for use of transmission lines.
- **Directly-assigned**: Project owner builds and is responsible for cost recovery and receives credit for use of transmission lines.
- **Highway/Byway**: Most SPP projects paid for under this methodology.

<table>
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<th>Voltage</th>
<th>Region Pays</th>
<th>Local Zone Pays</th>
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<tbody>
<tr>
<td>300 kV and above</td>
<td>100%</td>
<td>0%</td>
</tr>
<tr>
<td>above 100 kV and below 300 kV</td>
<td>33%</td>
<td>67%</td>
</tr>
<tr>
<td>100 kV and below</td>
<td>0%</td>
<td>100%</td>
</tr>
</tbody>
</table>
TRANSMISSION OWNER SELECTION: ORDER 1000

• SPP developed the Transmission Owner Selection Process (TOSP) to allow competitive bidding on certain transmission projects.

• Transmission Facilities that meet criteria in the SPP Tariff and are approved for construction (or are endorsed by the SPP board of directors) are known as competitive upgrades.

• SPP will solicit proposals for competitive upgrades from qualified RFP participants utilizing the TOSP.
STATE REGULATORS’ ROLE

• Regional State Committee — Retail regulatory commissioners from:
  - Arkansas
  - Missouri
  - Oklahoma
  - Iowa
  - Nebraska
  - South Dakota
  - Kansas
  - New Mexico
  - Texas
  - Louisiana
  - North Dakota

• Primary responsibility for:
  • Cost allocation for transmission upgrades
  • Approach for regional resource adequacy
  • Allocation of transmission rights in SPP’s markets
THE VALUE OF TRANSMISSION
**2015 VALUE OF TRANSMISSION STUDY**

- Assessed 348 projects from 2012-14, representing $3.4B of transmission investment
- Based on Integrated Marketplace’s first year of operation (March 2014 – Feb. 2015)
- APC savings > $660k/day ($240M/year)
- Overall NPV of all benefits expected to exceed $16.6B over 40 years.

**BENEFIT-COST RATIO OF 3.5 TO 1**
"The SPP Value of Transmission study is a path-breaking effort..."

"... A more accurate estimate of the total benefits that a more robust and flexible transmission infrastructure provides to power markets, market participants and, ultimately, retail electric customers."

"Estimated present value of the production cost savings in the SPP study likely is understated..."
TRANSMISSION PLANNING MAPS
Projects Constructed or with NTCs
(2005 - 2018)

Southwest Power Pool

This map contains the intellectual property of SPP and may not be used, copied or disseminated by third parties without the express permission of SPP. All rights reserved.
Date Exported: 10/19/2018
1 inch equals 189 miles.
Distribution of Generation

SPP Southwest Power Pool

Capacity (MW)
- 1 - 138
- 139 - 370
- 371 - 730
- 730 - 1334
- > 1334

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Date Exported: 8/3/2018

1 inch equals 182 miles
RENEWABLES IN SPP
OUR EVOLVING ENERGY MIX

Trend By Year

<table>
<thead>
<tr>
<th>Year</th>
<th>Coal</th>
<th>Gas</th>
<th>Wind</th>
</tr>
</thead>
<tbody>
<tr>
<td>2011</td>
<td>63%</td>
<td>24%</td>
<td>6%</td>
</tr>
<tr>
<td>2012</td>
<td>59%</td>
<td>27%</td>
<td>8%</td>
</tr>
<tr>
<td>2013</td>
<td>61%</td>
<td>21%</td>
<td>11%</td>
</tr>
<tr>
<td>2014</td>
<td>60%</td>
<td>19%</td>
<td>12%</td>
</tr>
<tr>
<td>2015</td>
<td>55%</td>
<td>22%</td>
<td>14%</td>
</tr>
<tr>
<td>2016</td>
<td>48%</td>
<td>23%</td>
<td>17%</td>
</tr>
<tr>
<td>2017</td>
<td>46%</td>
<td>23%</td>
<td>20%</td>
</tr>
<tr>
<td>2018</td>
<td>42%</td>
<td>23%</td>
<td>23%</td>
</tr>
</tbody>
</table>
RENEWABLE PENETRATION

- Renewable penetration record: 71.4%
  - 1:25 a.m. on 4/27/19
  - 16072 MW of 22517 MW of load served by renewables
WIND AND SOLAR IN THE SPP REGION
THE COUNTRY’S HIGHEST WIND SPEEDS ARE IN THE SPP BALANCING AUTHORITY

WIND ENERGY’S SHARE OF STATE-BY-STATE ELECTRICITY GENERATION

Source: EIA
WIND IN SPP’S SYSTEM

• 21,578 MW: Wind installed today
  • 11,029 turbines at 207 wind resources (most are 80m hub height)
  • Largest wind resource: 478 MW (Hale Wind Farm in Hale County, TX)
• 9,065 MW: Unbuilt wind w/signed interconnection agreements
• 50,210 MW: Wind in all stages of study and development
• ~23 GW: Forecast wind installation by 2020 (more than SPP’s current minimum load)
WIND PENETRATION IN THE SPP SYSTEM

- Maximum wind output: 16,972 MW (9/11/2019)
- Minimum wind output (last 12 mos.): 146 MW (8/9/18 @ 10:47)
- Maximum wind penetration: 67.3% (4/27/19)
- Average wind penetration (2018): 23.5%
- Max wind swing in one day: >13 GW on March 14-15, 2019 (14.8 GW to 1.8 GW in 18 hours)
- Max 1-hour ramp: 3,700 MW
INSTALLED WIND CAPACITY BY YEAR

Megawatts

On Dec. 20, 2018 at 07:40, a record output of 16,283 MW of wind power served 48 percent of our load. A day later, wind shrunk to 17 percent of our generation mix, and other sources like coal and gas ramped up to serve load. This illustrates the value of a diverse fuel mix able to accommodate a wide variety of operational circumstances!
WHY FUEL DIVERSITY MATTERS: SPP'S RECORD WIND SWING (13.3 GW IN 22 HOURS)

Max @ 21:45 on 3/14: 15,147 MW

Min @ 19:46 on 3/15: 1,843 MW
Wind Resources Registered In SPP Market

SPP Southwest Power Pool

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Wind from GI Queue In Commercial Operation

SPP Southwest Power Pool

Capacity
- ≤42
- ≤90
- ≤160
- ≤250
- ≤600

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WIND DEVELOPMENT CHALLENGES

• Intermittent
• Must be supplemented with constant generating sources
• Wind in remote areas
• Expensive new transmission needed
• “Not in my backyard” siting issues
• Seams agreements
• Renewable Energy Standards
SOLAR IN SPP’S SYSTEM

- Solar in service: 215 MW
- Solar in all stages of study and development: 29,330 MW
Solar Resources Registered In SPP Market

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DISTRIBUTION OF RENEWABLE GENERATOR INTERCONNECTION REQUESTS
DISTRIBUTION OF NEW RENEWABLE RESOURCES
NEW ELECTRICITY GENERATION IN U.S. RTOS

Source: NRDC analysis of S&P Global Market Intelligence data
TOP 10 CORPORATE BUYERS OF CLEAN ENERGY IN SPP’S MARKET

MW in Power Purchase Agreements

- Google: 1135 MW
- T-Mobile USA: 320 MW
- Facebook: 320 MW
- AT&T: 220 MW
- Royal Caribbean Cruises: 200 MW
- Microsoft: 178 MW
- Anheuser-Busch InBev NV: 153 MW
- Iron Mountain: 145 MW
- Equinix: 125 MW
- Kimberly-Clark: 120 MW

MW in Purchased-Power Agreements