



HELPING OUR MEMBERS WORK TOGETHER
TO KEEP THE LIGHTS ON... TODAY AND IN THE FUTURE.

SPP101

An Introduction to Southwest Power Pool



SouthwestPowerPool



SPPorg



southwest-power-pool

Our Mission

Helping our members work together to
keep the lights on ...
today and in the future.



OUR BEGINNING

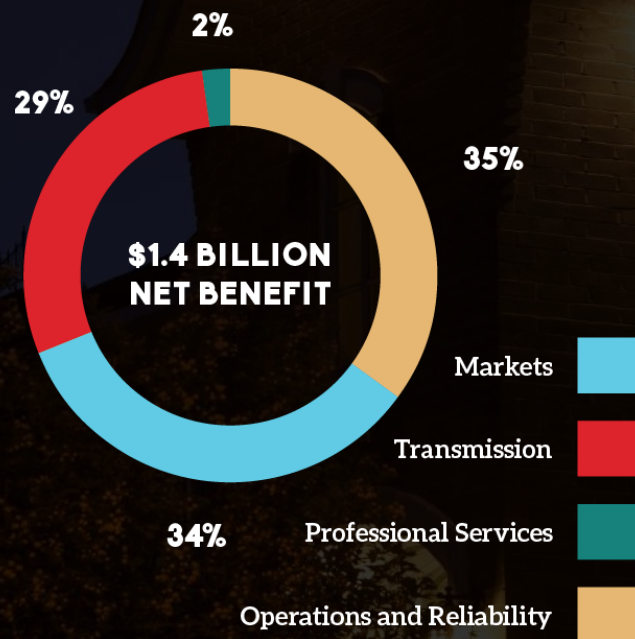
- In 1941, 11 member utilities pooled electricity to power aluminum plant at Jones Mill needed for critical defense
- Maintained after WWII to continue benefits of regional coordination

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 \$1.4 billion annually at a benefit-to-cost ratio of more than 10-to-1.
- For the typical end-use customer using 1,000 kWh per month, a monthly electric utility bill of \$100 would be \$105.65 without 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; became NERC Regional Entity

2009 Integrated Nebraska utilities

2010 FERC approved Highway/Byway cost allocation methodology and Integrated Transmission Planning Process



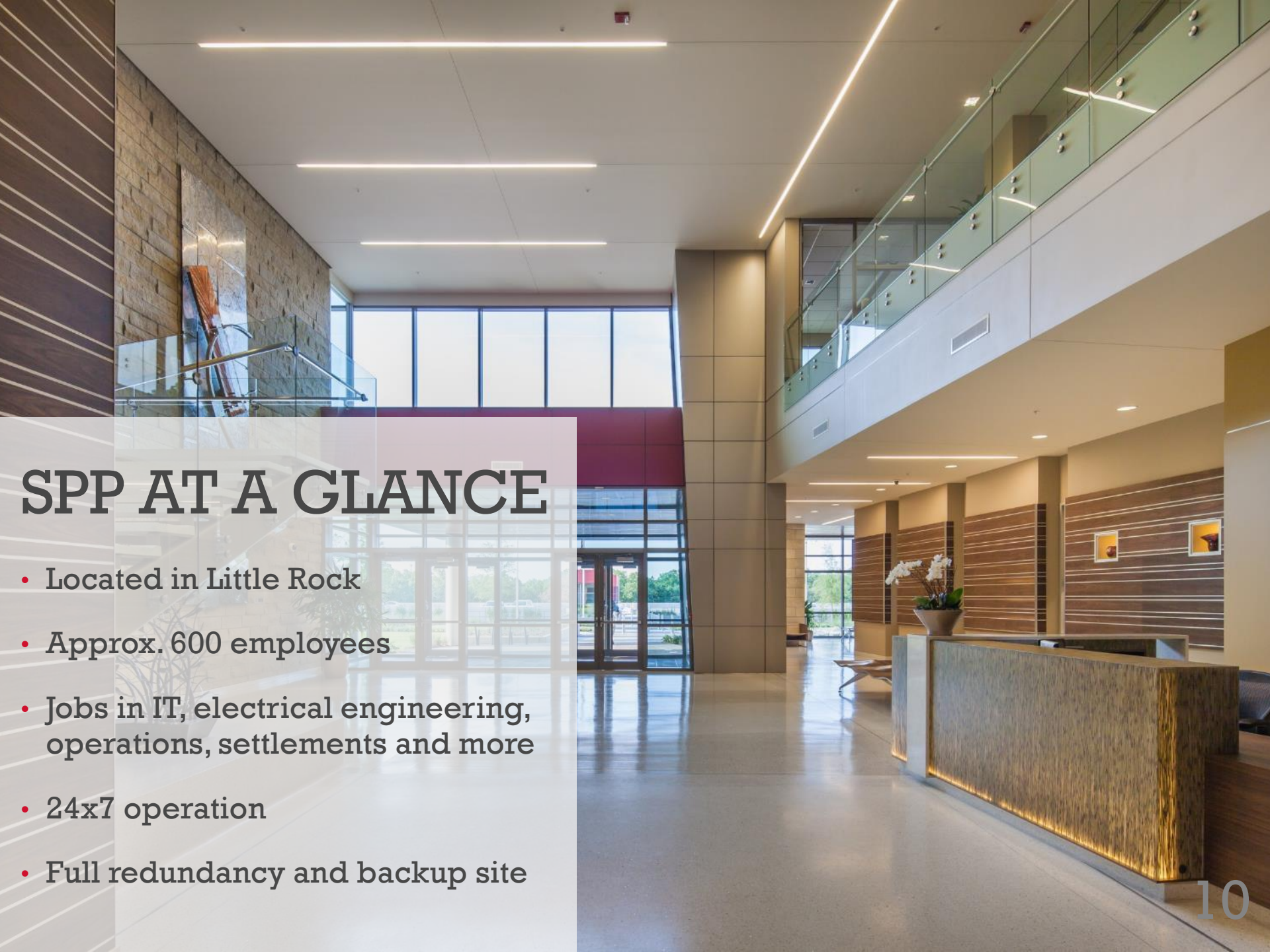
MILESTONES

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



SPP
Southeast
Power Pool



COMMUNITY INVOLVEMENT AND RECOGNITION

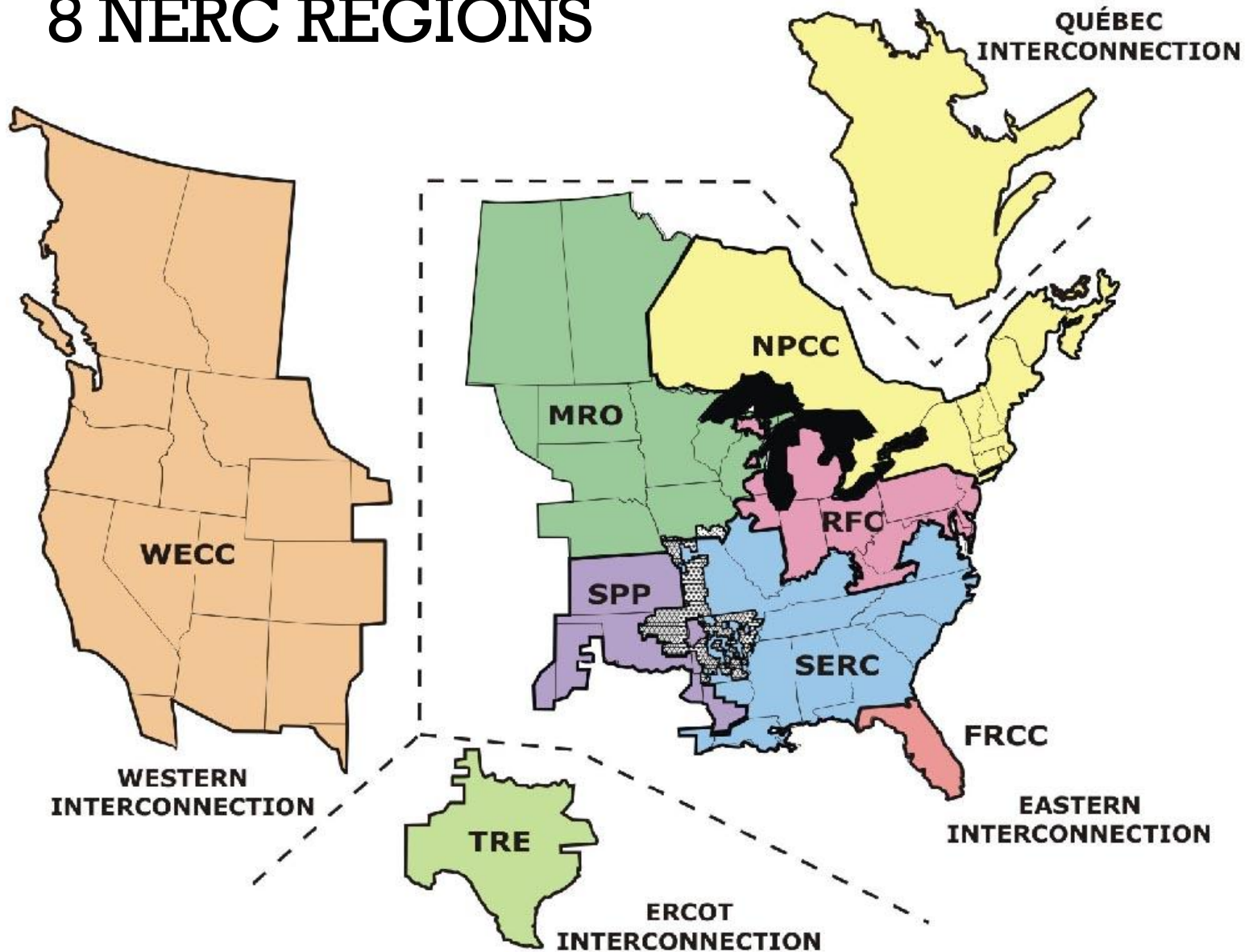
- Best Place to Work in Arkansas: 2014 Benchmark Award Winner 2013 Finalist
- Principal Financial Group “Top 10”
- SPP employees support more than 70 Central Arkansas charities including:
 - Arkansas Foodbank
 - Girls of Promise
 - Race for the Cure
 - Relay for Life
 - United Way
 - Youth Home

REGULATORY ENVIRONMENT

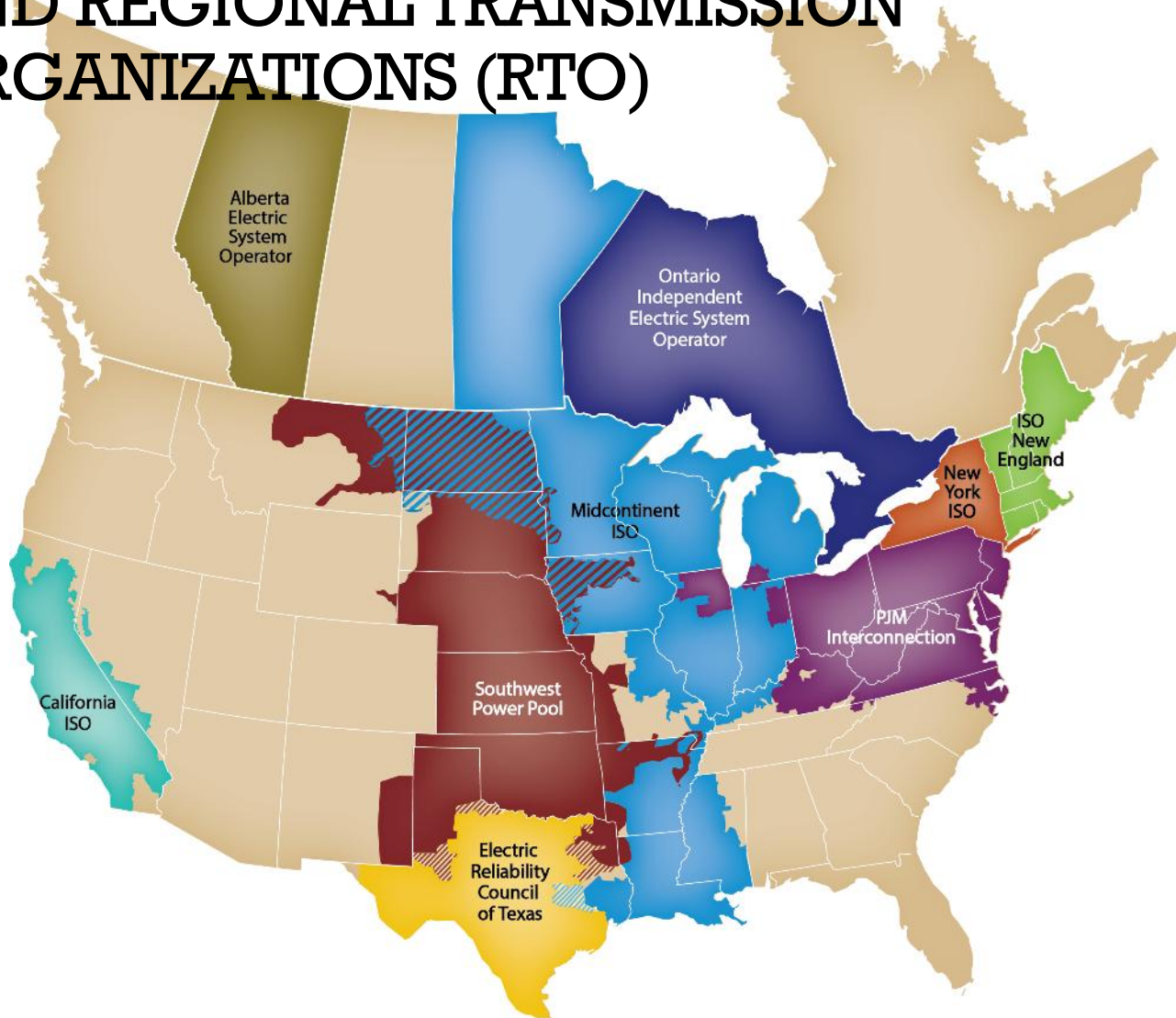
- Incorporated in Arkansas as 501(c)(6) nonprofit corporation
- Federal Energy Regulatory Commission (FERC)
 - Regulated public utility
 - Regional Transmission Organization
- North American Electric Reliability Corporation (NERC)
 - Founding member
 - Regional Entity

3 ELECTRIC INTERCONNECTIONS

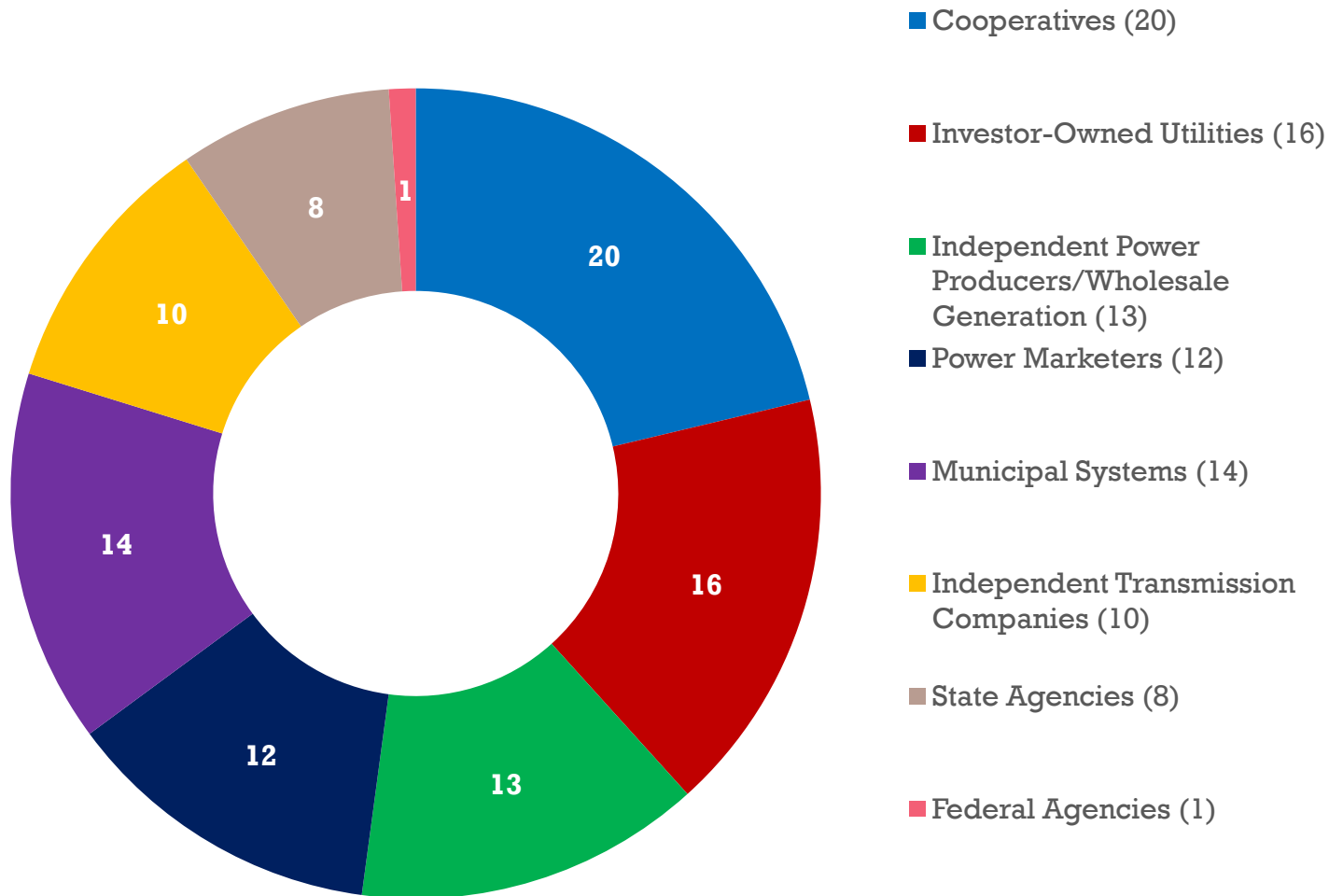
8 NERC REGIONS



NORTH AMERICAN INDEPENDENT SYSTEM OPERATORS (ISO) AND REGIONAL TRANSMISSION ORGANIZATIONS (RTO)

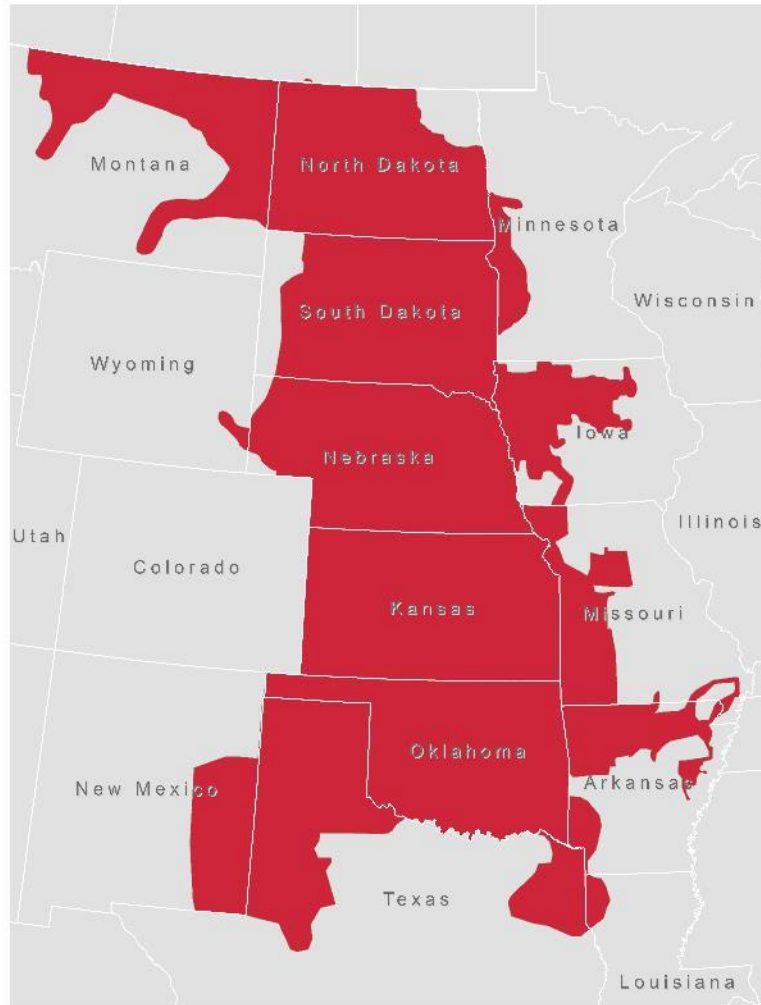


SPP'S 94 MEMBERS: INDEPENDENCE THROUGH DIVERSITY



As of August 11, 2016

THE SPP FOOTPRINT: MEMBERS IN 14 STATES



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

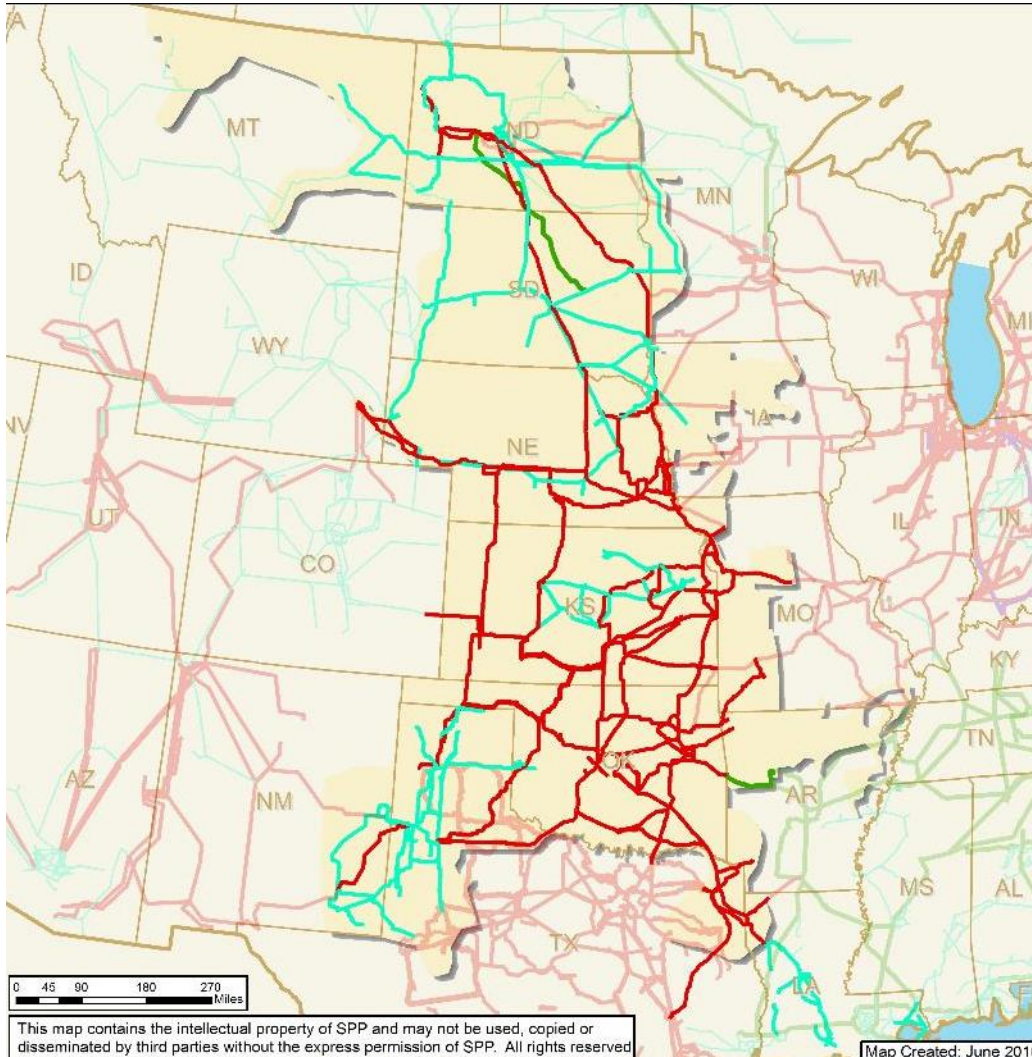


SPP MANAGES THE GRID IN 5 OF THE TOP 100 CITIES IN AMERICA:

Kansas City, Oklahoma City, Tulsa, Omaha, and Wichita

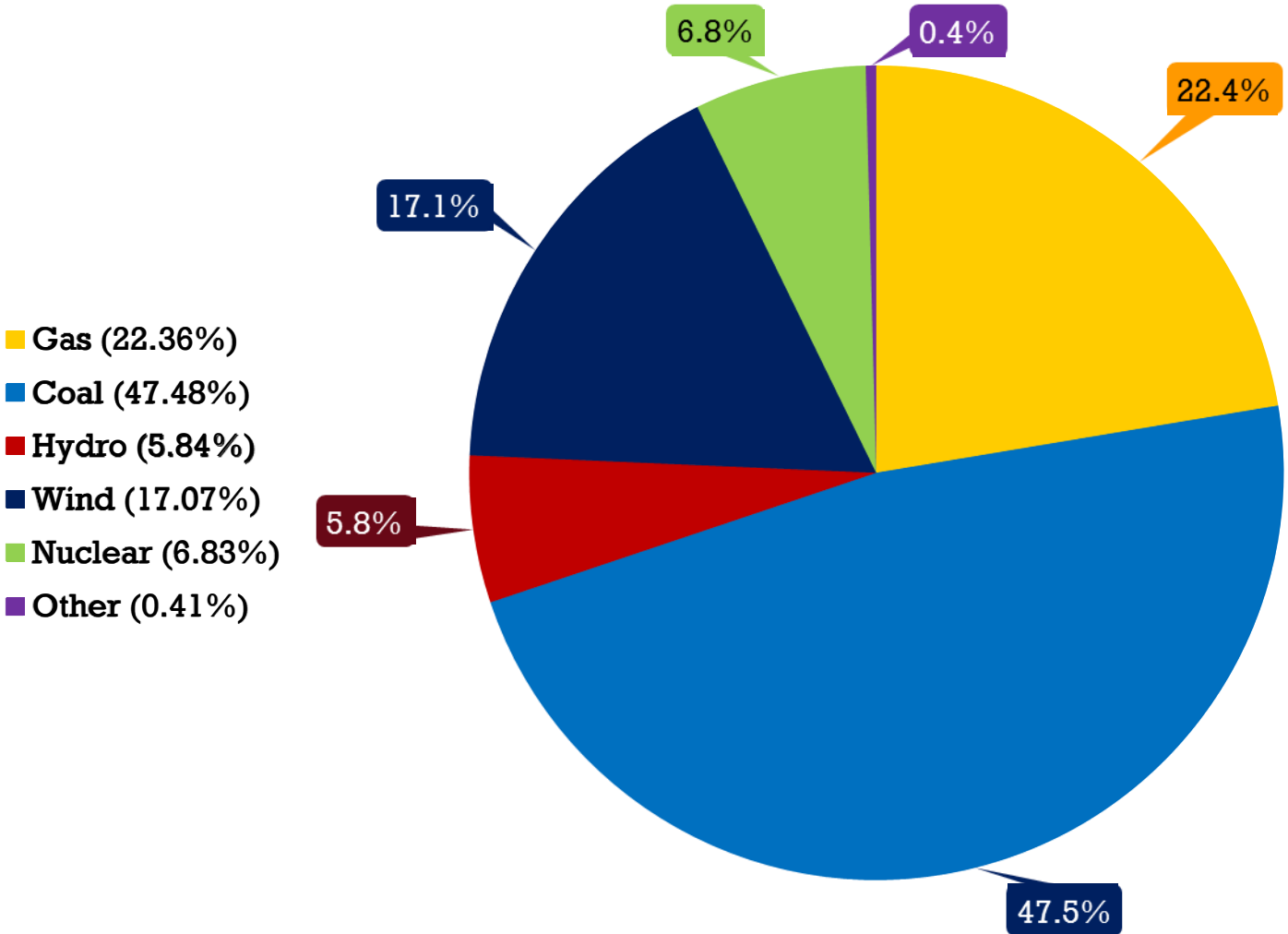


OPERATING REGION

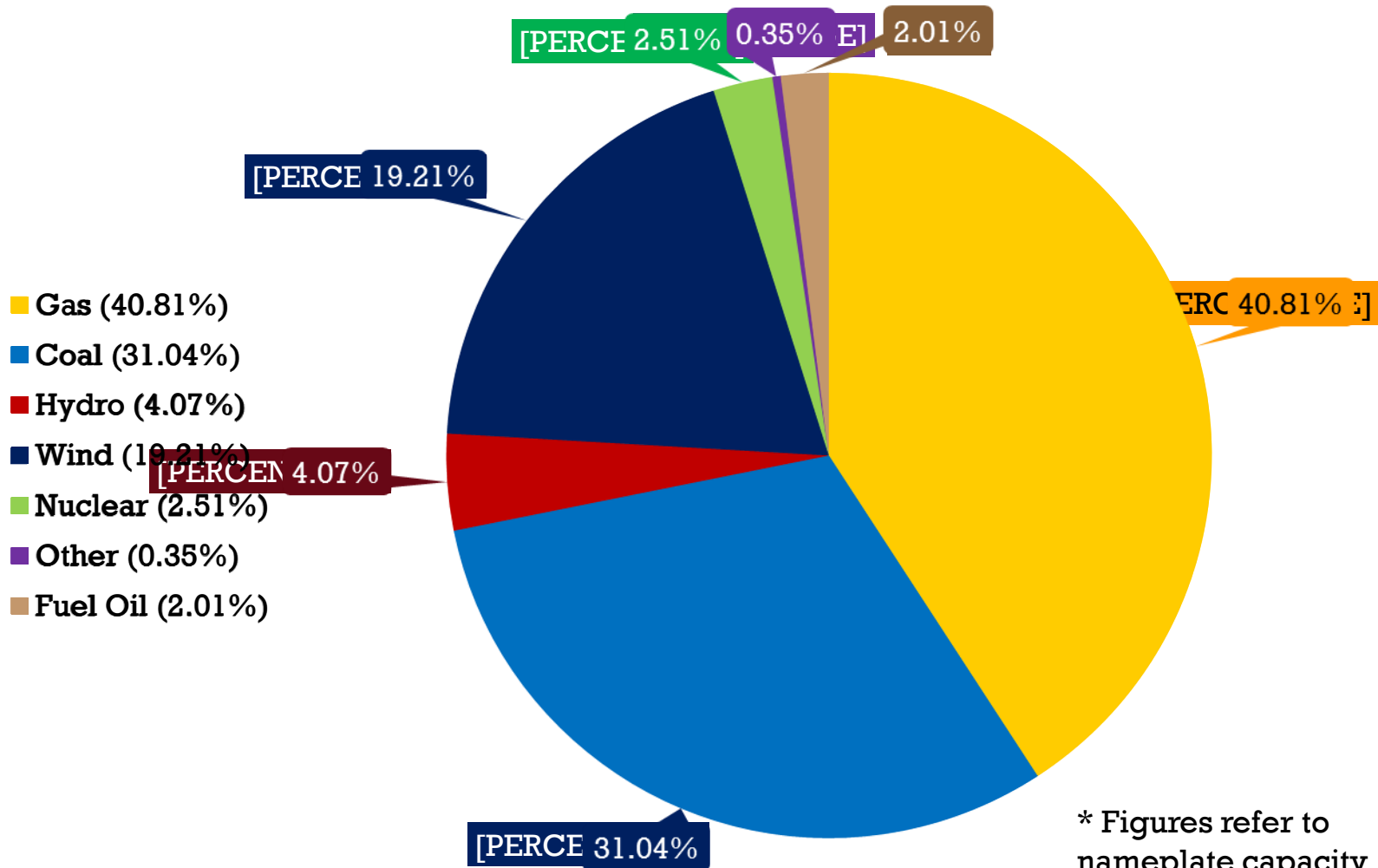


- Miles of service territory: 546,000
- Population served: 17.5M
- Generating Plants: 790
- Substations: 4,835
- Miles of transmission: 65,755
 - 69 kV 16,808
 - 115 kV 15,512
 - 138 kV 9,471
 - 161 kV 5,596
 - 230 kV 7,518
 - 345 kV 10,758
 - 500kV 92

2016 ENERGY CONSUMPTION BY FUEL TYPE (266,442 GWH TOTAL)



ENERGY CAPACITY* BY FUEL TYPE



* Figures refer to nameplate capacity as of 1/1/17

MARKET FACTS

- 185 participants
- 726 generating resources
- 2016 Marketplace Settlements = \$15.8 billion
- 50,622 MW coincident peak load (7/21/16)
- Wind penetration record: 52.65% (3/6/17 @ 02:25)

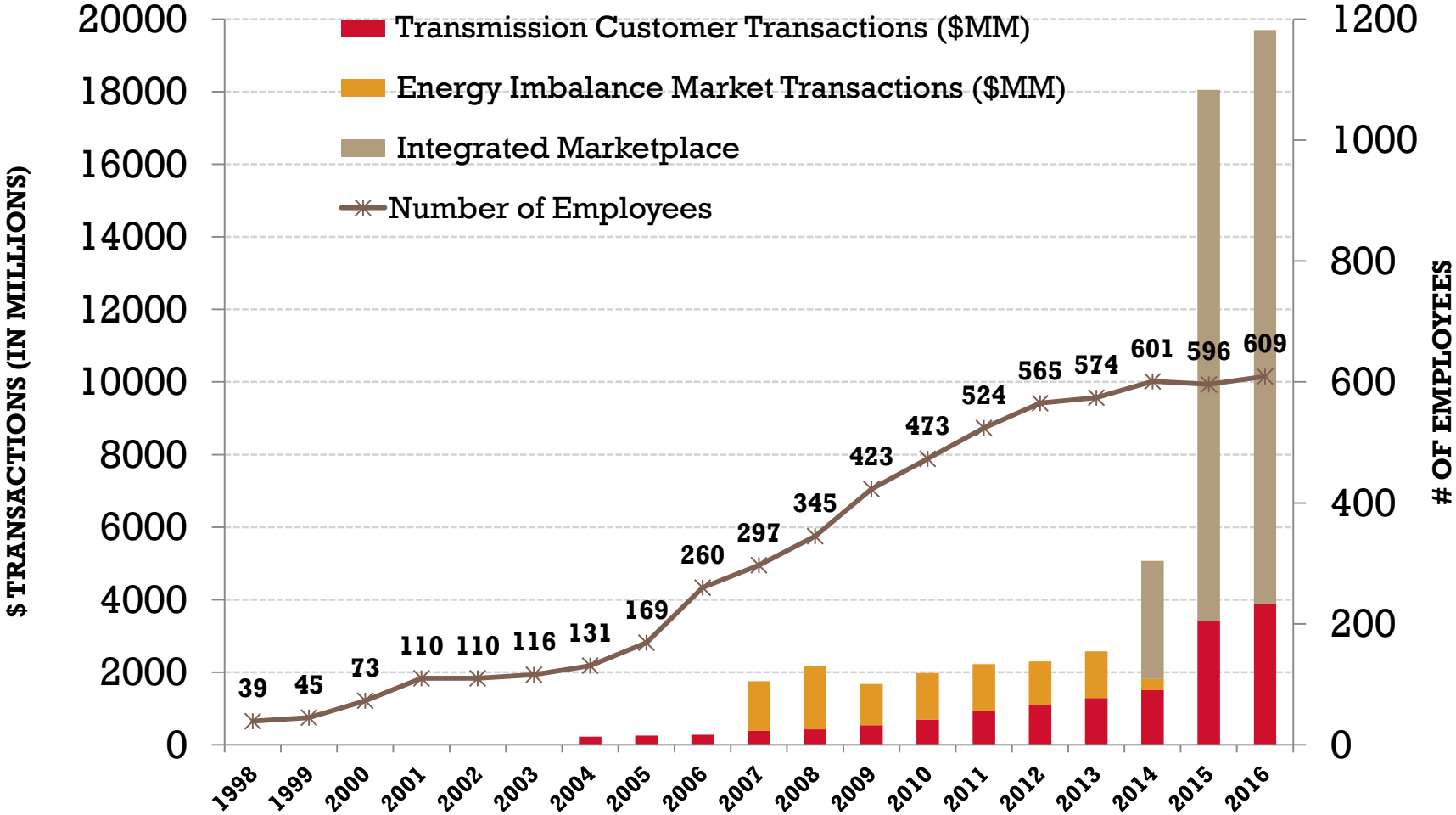
TRANSMISSION IN SPP

- In 2016, SPP members completed 78 transmission projects totaling more than \$939 million.
- More than \$9.7 billion in transmission upgrades were planned and approved from 2004-2016.
- 65,755 miles of transmission lines in SPP's footprint would circle the earth more than twice!

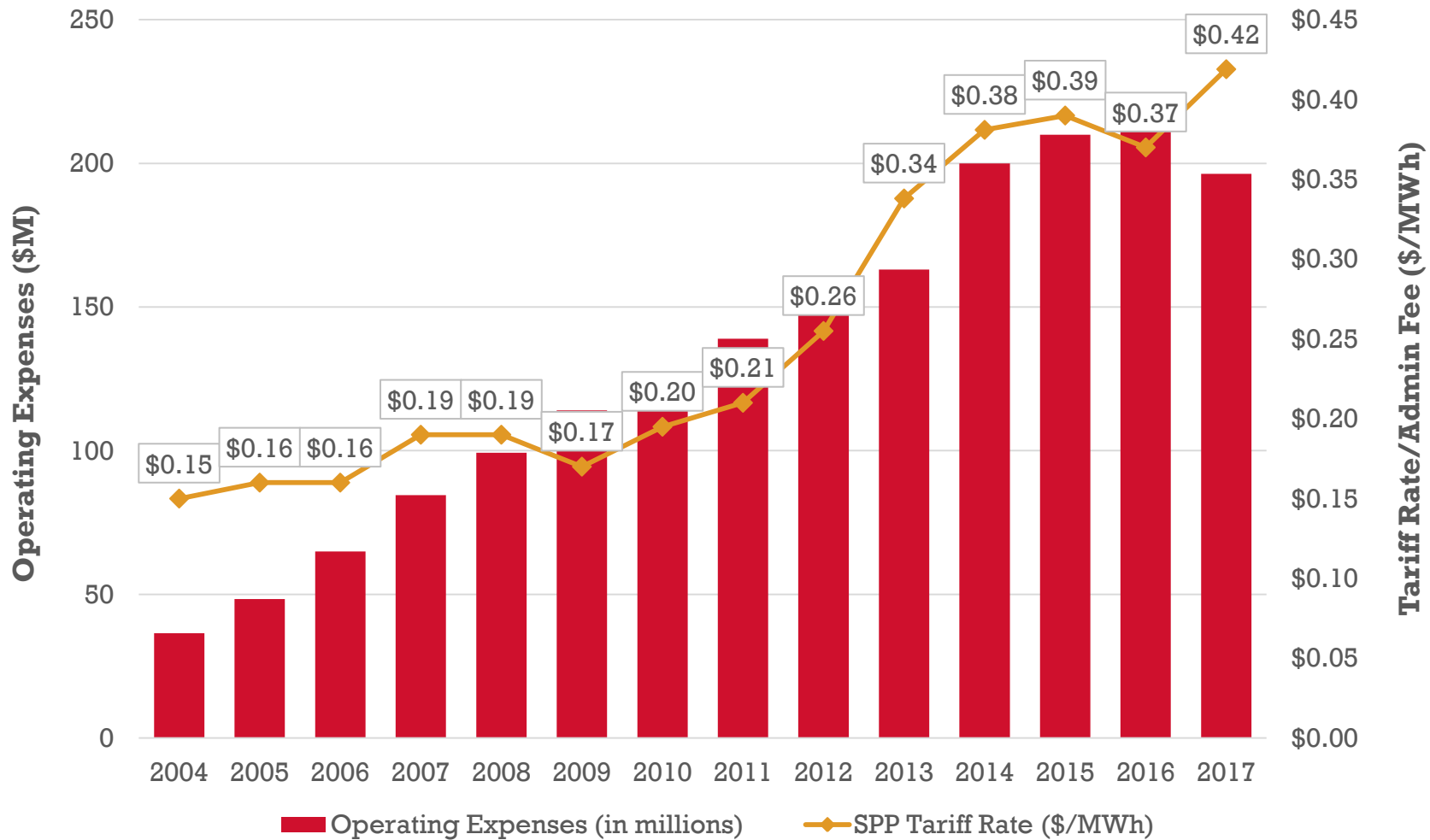
SPP'S IT INFRASTRUCTURE

- 166,000+ data points updated every 2-30 seconds
- Operations model solves 47,150 x 80,548 matrix every two minutes
- Approx. 2,000 servers
- More than 2.14 petabytes of storage

GROWTH IN RESPONSIBILITIES



SPP EXPENSES: 2004-2017



INTERREGIONAL COORDINATION

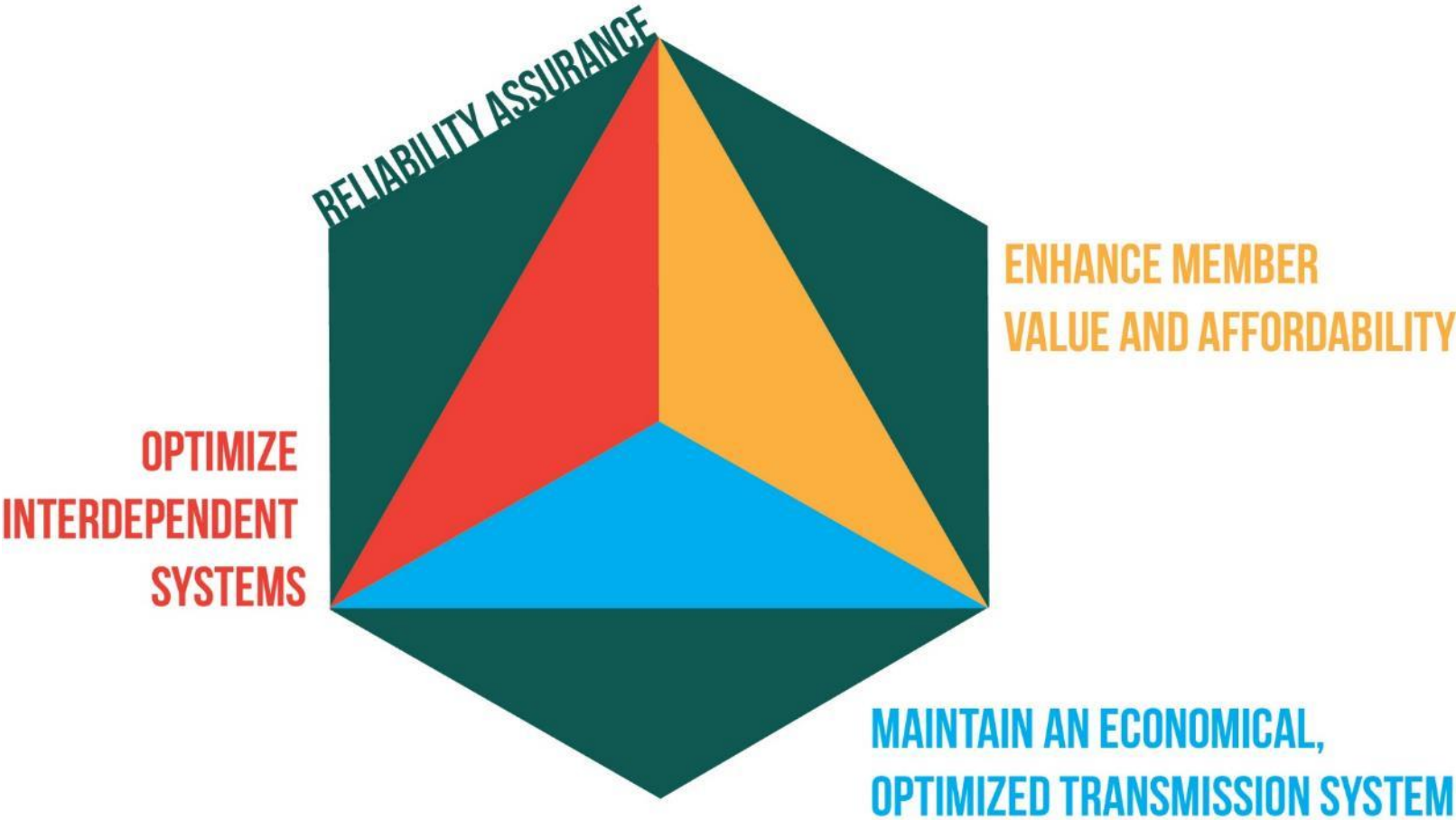
- ISO-RTO Council
- Interregional planning efforts
- North American Energy Standards Board (NAESB)
- National Association of Regulatory Utility Commissioners



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



SERVICES

OUR MAJOR SERVICES

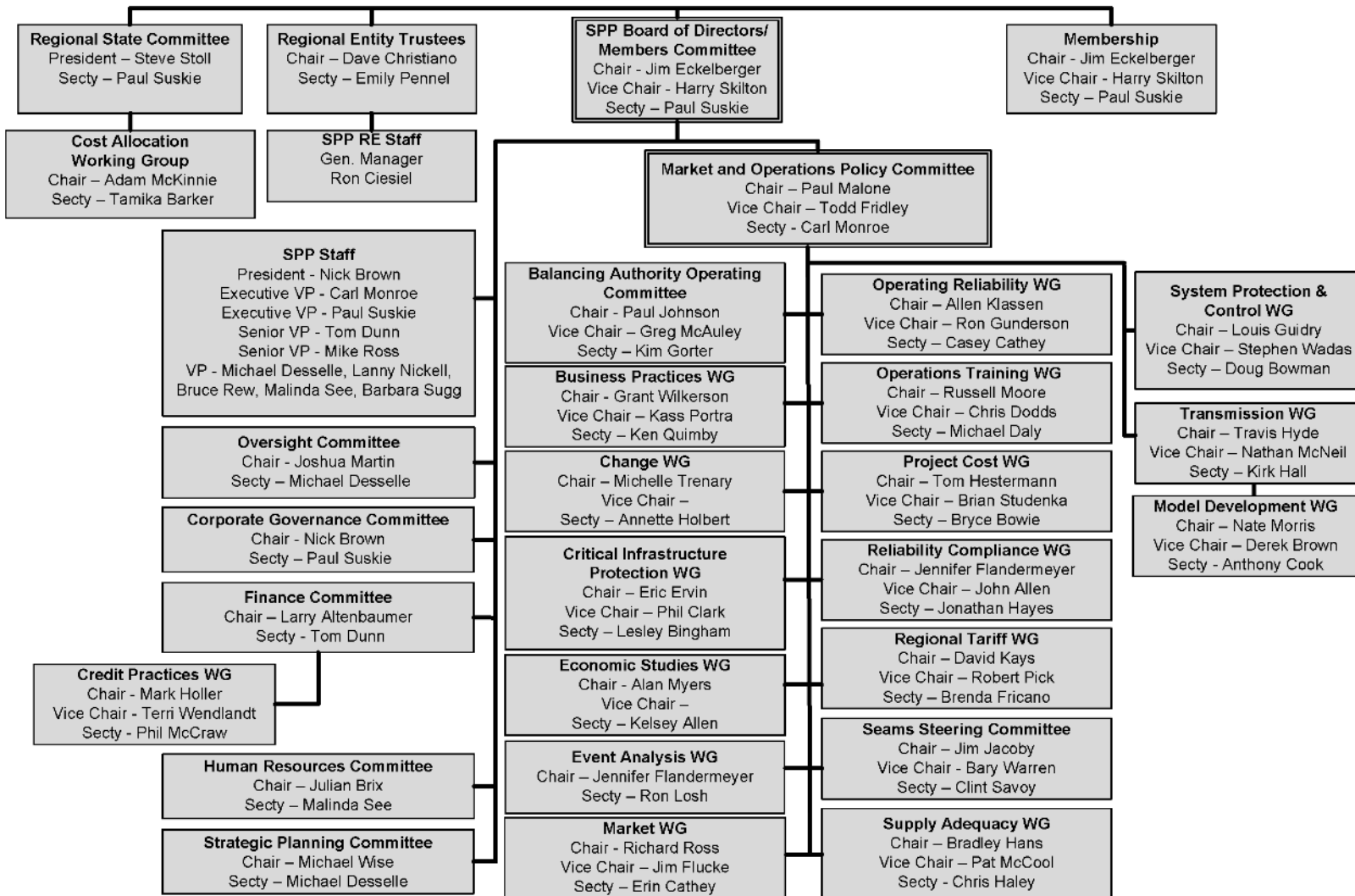
- Facilitation
- Reliability Coordination
- Balancing Authority
- Transmission Service/Tariff Administration

- Market Operation
- Transmission Planning
- Training
- Standards Setting
- Compliance Enforcement

OUR APPROACH:

Regional, Independent, Cost-Effective and Focused on Reliability

FACILITATION



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 2016 SPP's training programs delivered 28,046 training hours to 46 member companies, including instructor-led, virtual-led and self-study, computer-based training.
- SPP offers:
 - Regional System restoration drills
 - Integrated Marketplace training
 - Regional Emergency Operations sessions
 - Train-the-Trainer classes

THE SPP REGIONAL ENTITY

- Independent and functionally separate from SPP RTO
- Monitors and enforces Registered Entities' compliance with NERC reliability standards
- Assesses and evaluates grid reliability
- Provides regional outreach on compliance issues
- Analyzes system events and develops lessons learned

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.

WHAT IS A MARKET?

General Concepts:



Buyers/Sellers OR
Producers/Consumers



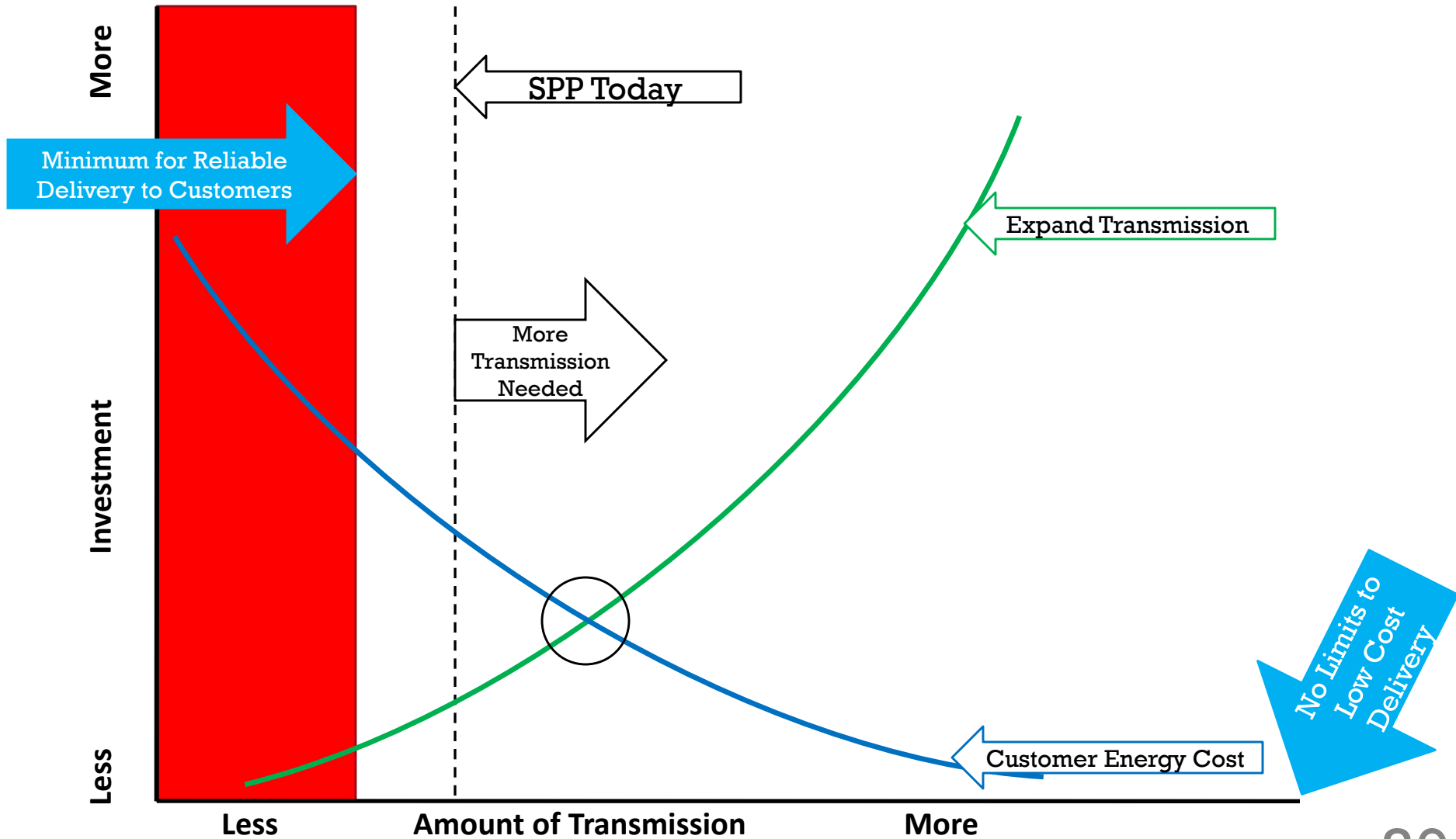
Prices driven by
Supply and Demand



Products

TRANSMISSION MARKET

FINDING BALANCE



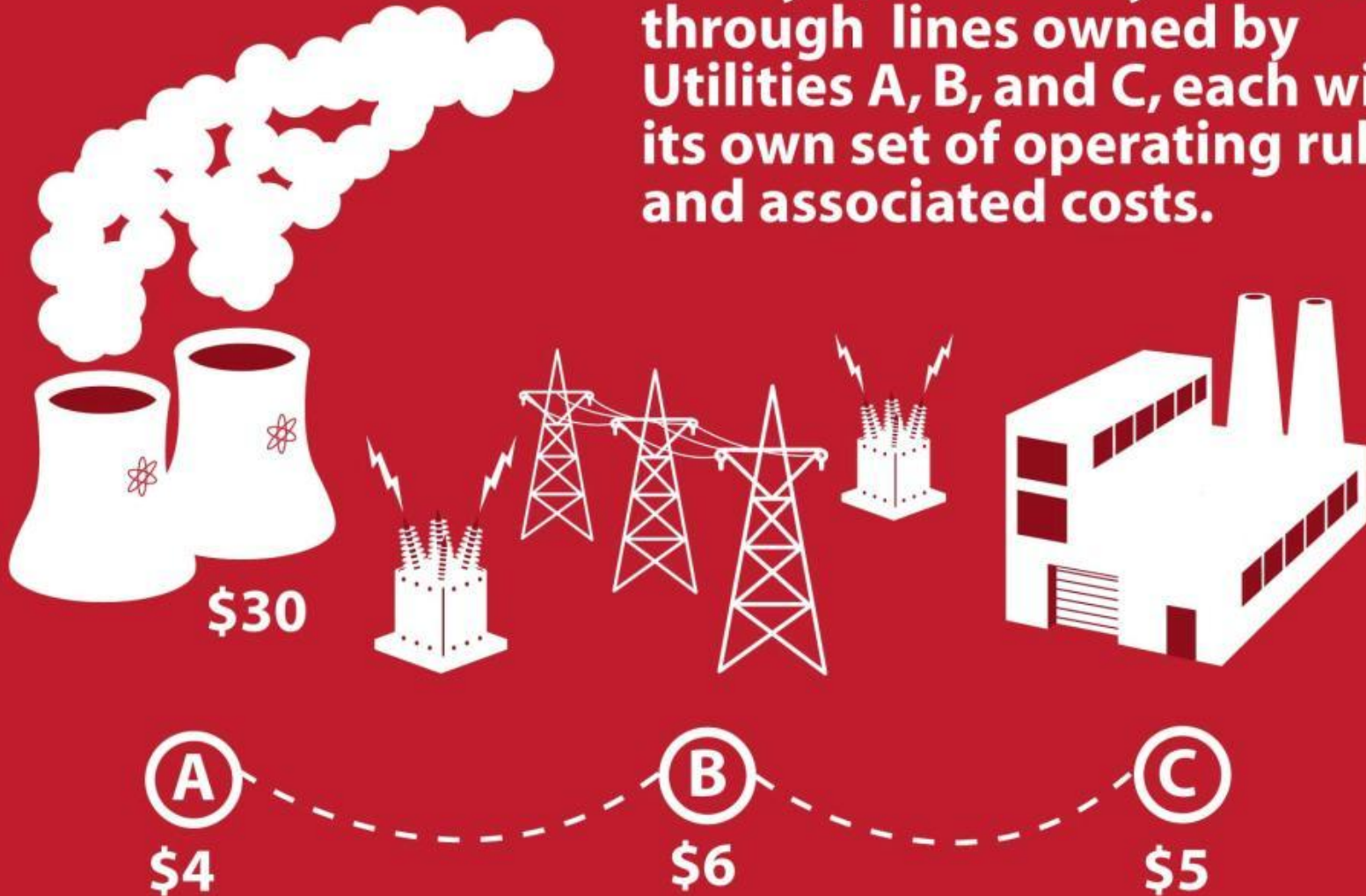
TRANSMISSION MARKET

- Provides “one-stop shopping” for use of regional transmission lines
- Consistent rates, terms, conditions for all users
- Independent
- More than 4,700 transactions per month on average
- 2016 transmission customer transactions = \$3.879 billion

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

Without SPP

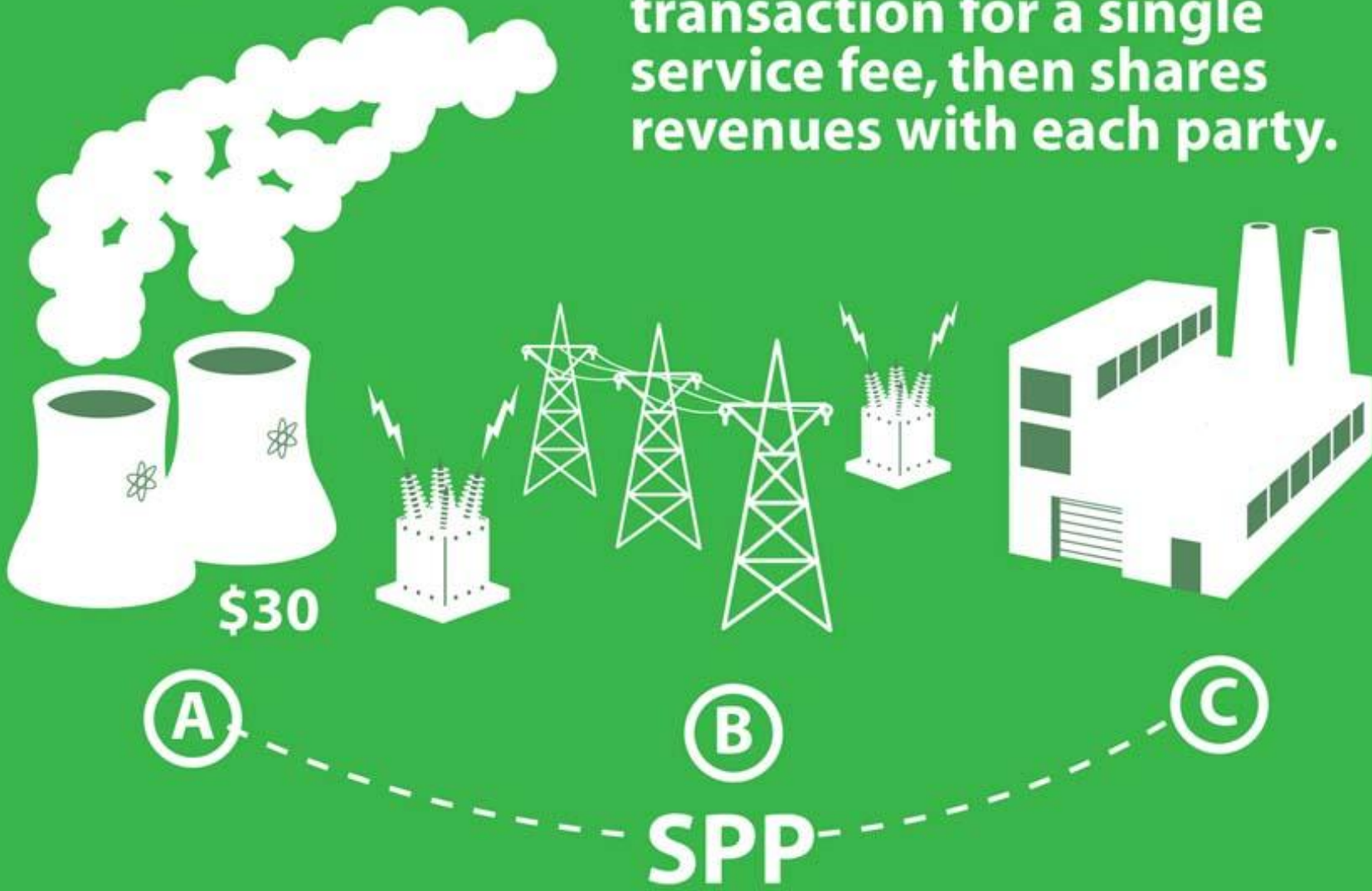
To get from a generator in Utility A to a customer in Utility C, electricity must flow through lines owned by Utilities A, B, and C, each with its own set of operating rules and associated costs.



\$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.



SPP

\$5 transmission service + \$30 energy = \$35

HOW TRANSMISSION SERVICE WORKS

- 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

1. SPP facilitates the Marketplace

- ✓ Provides the infrastructure and systems

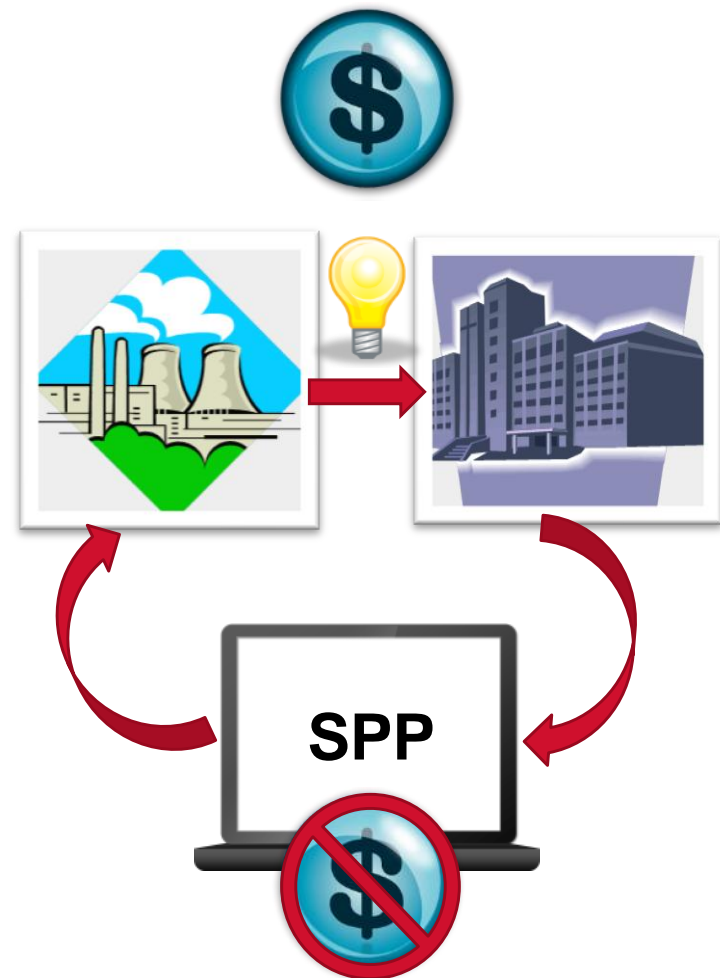
- ✓ Maintains and follows 900+ pages of Marketplace protocols

- ✓ 24/7 market operations



SPP'S ENERGY MARKET: INTEGRATED MARKETPLACE

2. SPP financially settles the Marketplace
 - Calculates prices
 - Captures wholesale energy production and consumption
 - Collects from market participants (MPs) who owe the market
 - Pays MPs who are owed by the market
 - Remains revenue neutral
3. SPP has an independent Market Monitor



MARKET MONITORING UNIT (MMU) ENSURES MARKET'S 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

INTEGRATED MARKETPLACE OVERVIEW

KEY COMPONENTS

- Day-Ahead Market
- Centralized Unit Commitment
- Real-Time Balancing Market
- Transmission Congestion Rights Market

PRODUCTS

- Energy
- Operating Reserve (Regulation Up, Regulation Down, Spinning, Supplemental)
- Congestion Rights

MARKETPLACE BENEFITS

- SPP's markets provide participants \$422M 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

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 DA Market, price separation of MP's resource to load may occur due to congestion leaving the MP exposed to high prices
- A TCR can be used as hedge against congestion that allows MPs to reduce their 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)

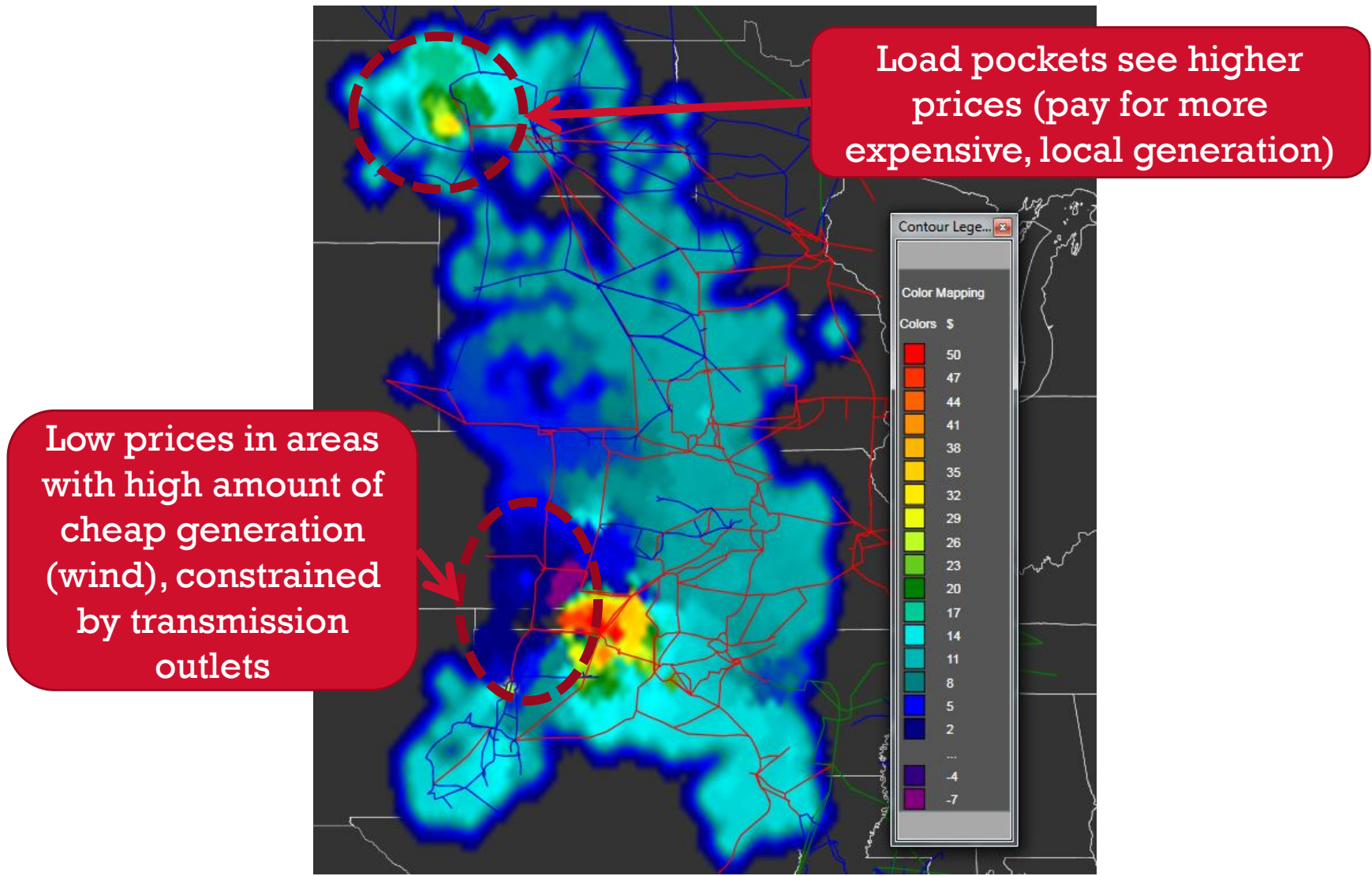
GRID CONGESTION

Impacts 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



CONGESTION'S IMPACT ON MARKET PRICES

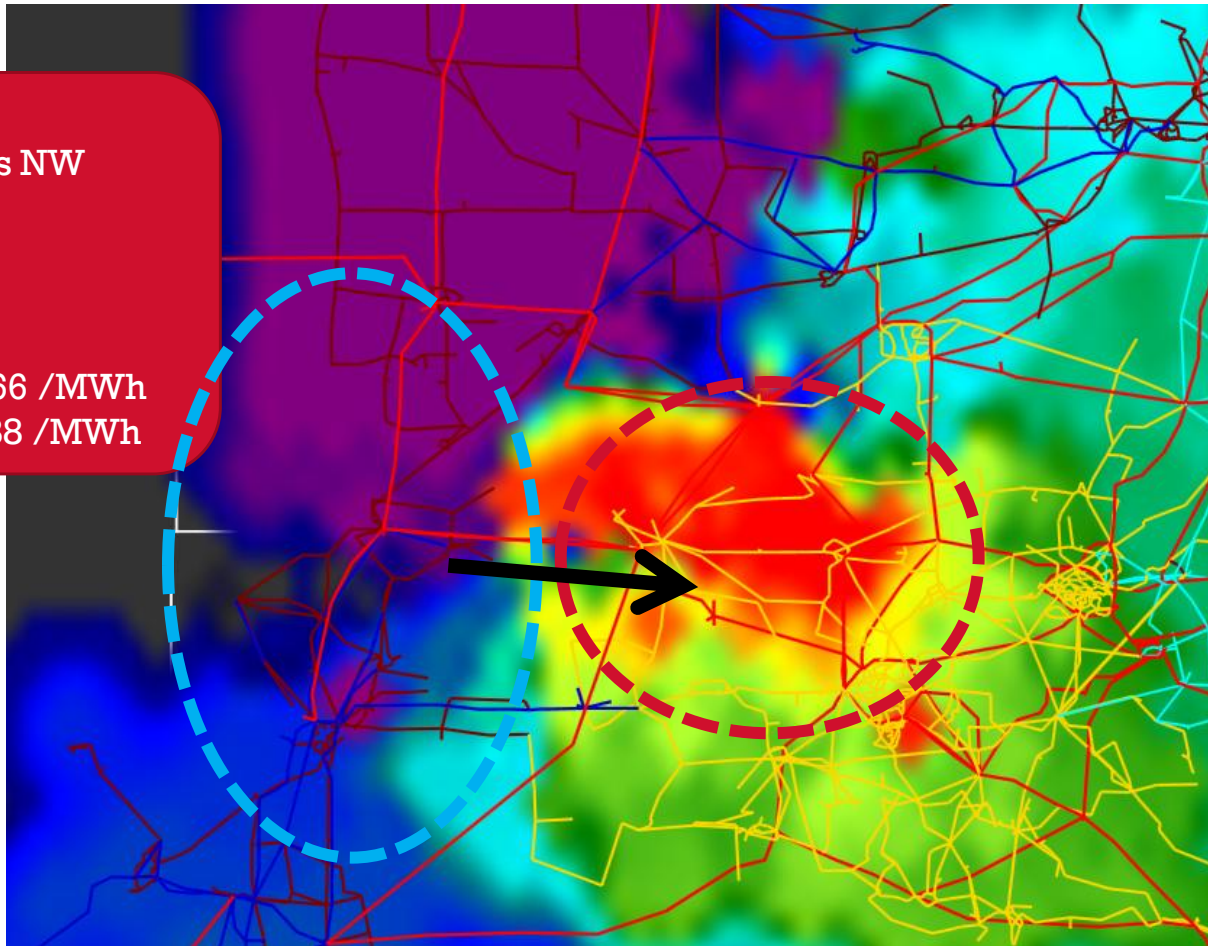
WDWFPLTATNOW

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

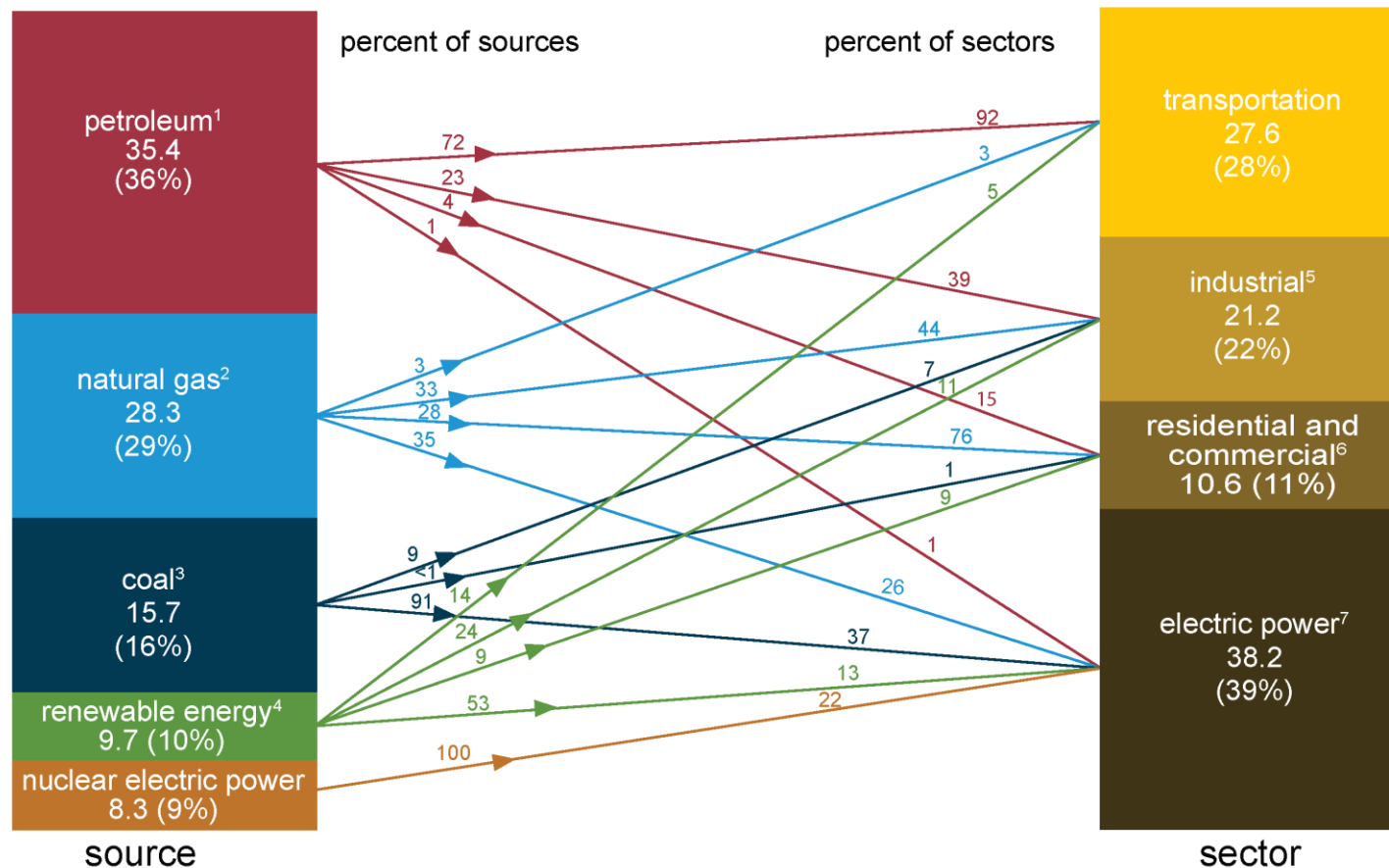
TRANSMISSION PLANNING: BASIC CONCEPTS

Services

U.S. ENERGY CONSUMPTION

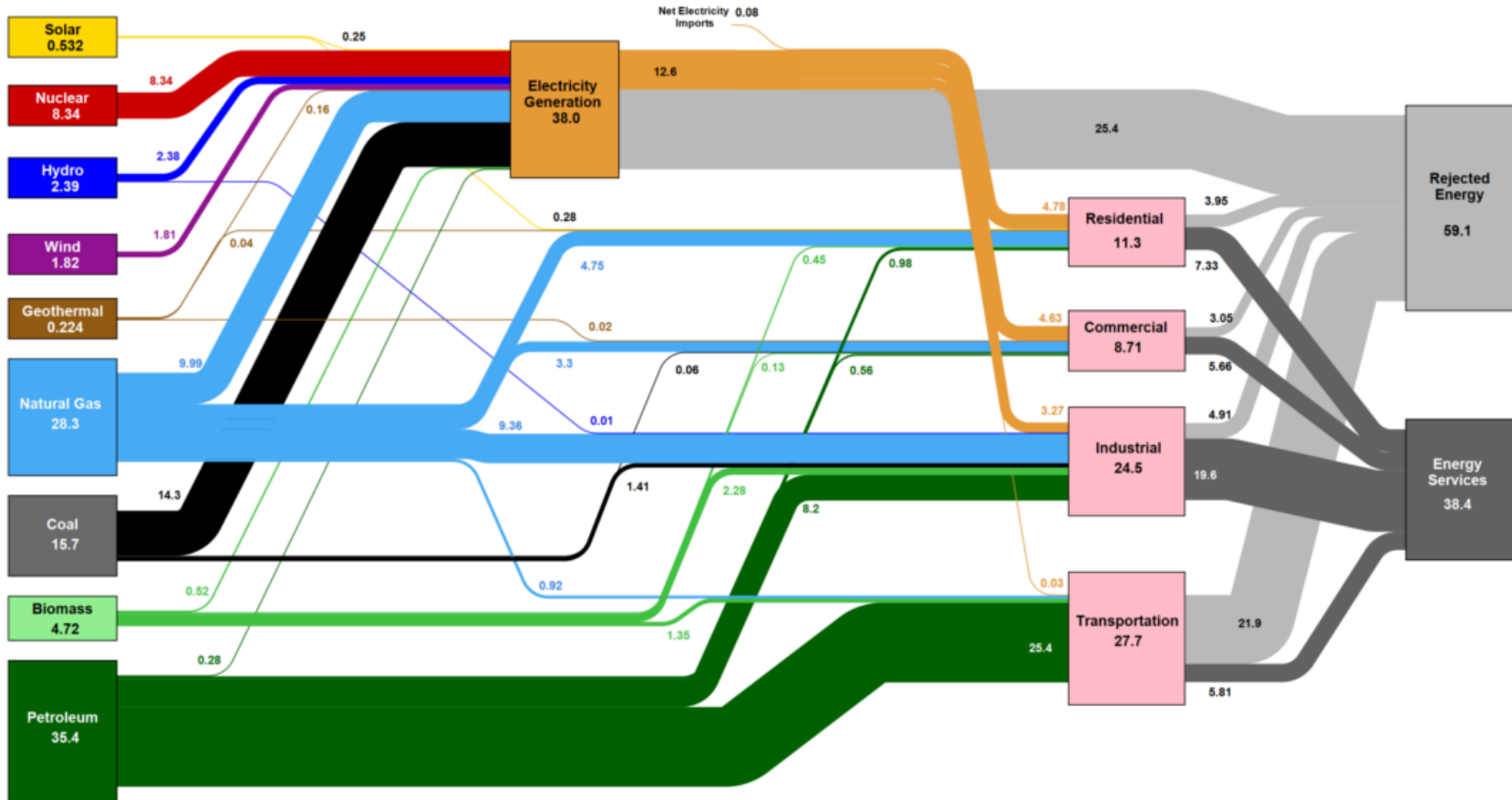
U.S. primary energy consumption by source and sector, 2015

Total = 97.7 quadrillion British thermal units (Btu)



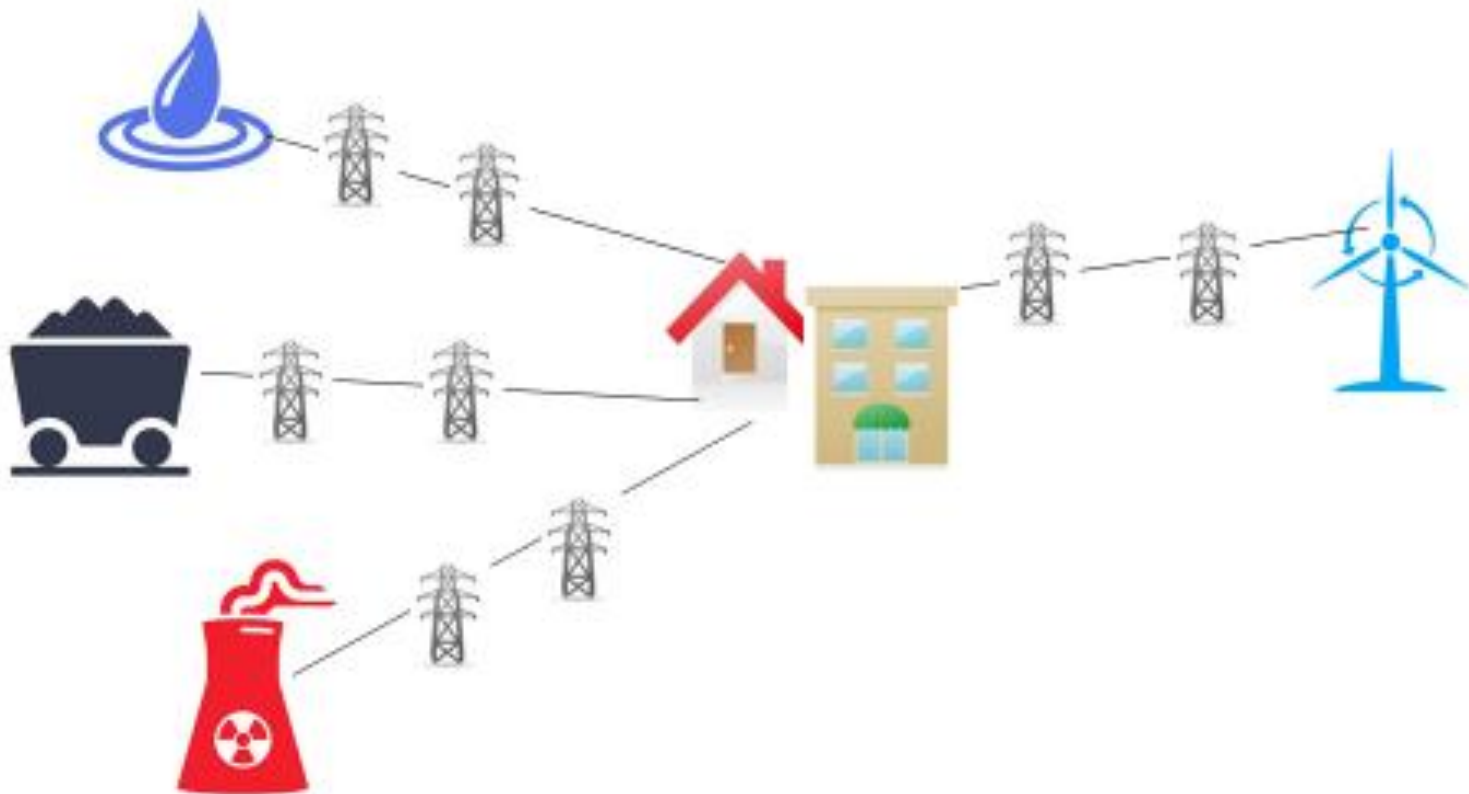
U.S. ENERGY CONSUMPTION

Estimated U.S. Energy Consumption in 2015: 97.5 Quads



Source: LLNL March, 2016. Data is based on DOE/EIA MER (2015). If this information or a reproduction of it is used, credit must be given to the Lawrence Livermore National Laboratory and the Department of Energy, under whose auspices the work was performed. Distributed electricity represents only retail electricity sales and does not include self-generation. EIA reports consumption of renewable resources (i.e., hydro, wind, geothermal and solar) for electricity in BTU-equivalent values by assuming a typical fossil fuel plant heat rate. The efficiency of electricity production is calculated as the total retail electricity delivered divided by the primary energy input into electricity generation. End use efficiency is estimated as 0.65% for the residential sector, 0.65% for the commercial sector, 0.8% for the industrial sector, and 0.21% for the transportation sector. Totals may not equal sum of components due to independent rounding. LLNL-MI-410527

ENERGY CONSUMED WHEN GENERATED



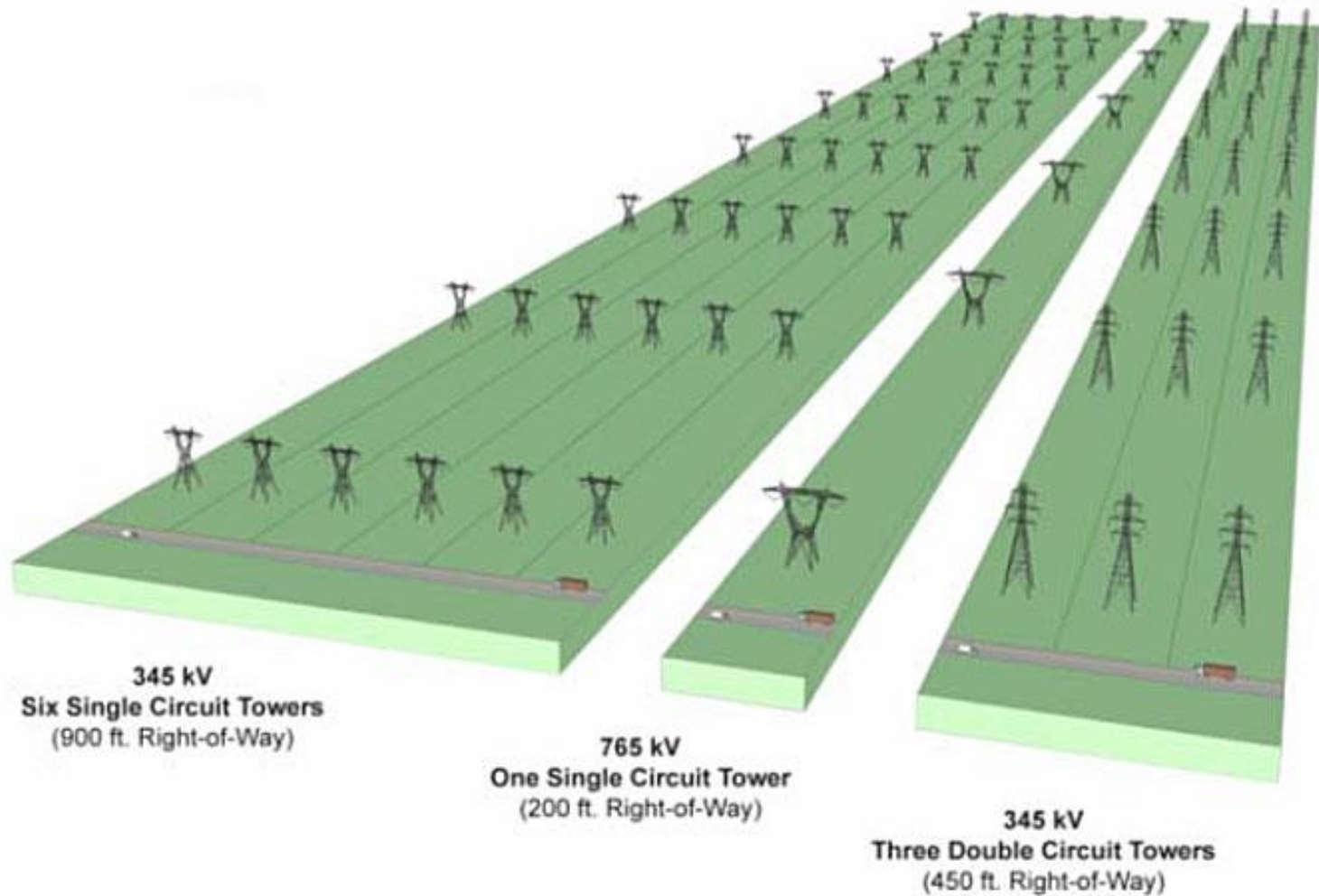
OTHER WAYS ELECTRIC INDUSTRY IS UNIQUE

- Location of “manufacturing” plants is limited
 - Wind farms must be in areas of high wind, solar farms in areas with strong sun, hydroelectric plants on a river
 - Coal and natural gas can only be extracted where fuel is
 - Coal mine may be far from coal-fired power plants – Expensive to transport coal long distances
 - Location of coal and gas plants have limitations
- Manufacturing plants may be far from people, and “roads” may not exist to deliver product to consumers
- Some products are only available at certain times

TRANSMISSION PLANNING CONSIDERATIONS

- What parts of grid need strengthening to “keep the lights on?”
 - Redundancies necessary to account for a line being out
- Where are current and future generations located?
- Where are electricity consumers located?
- Where on the grid do we frequently see congestion (more traffic than roads can accommodate)?
- 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

LARGER TRANSMISSION REDUCES RIGHT OF WAY

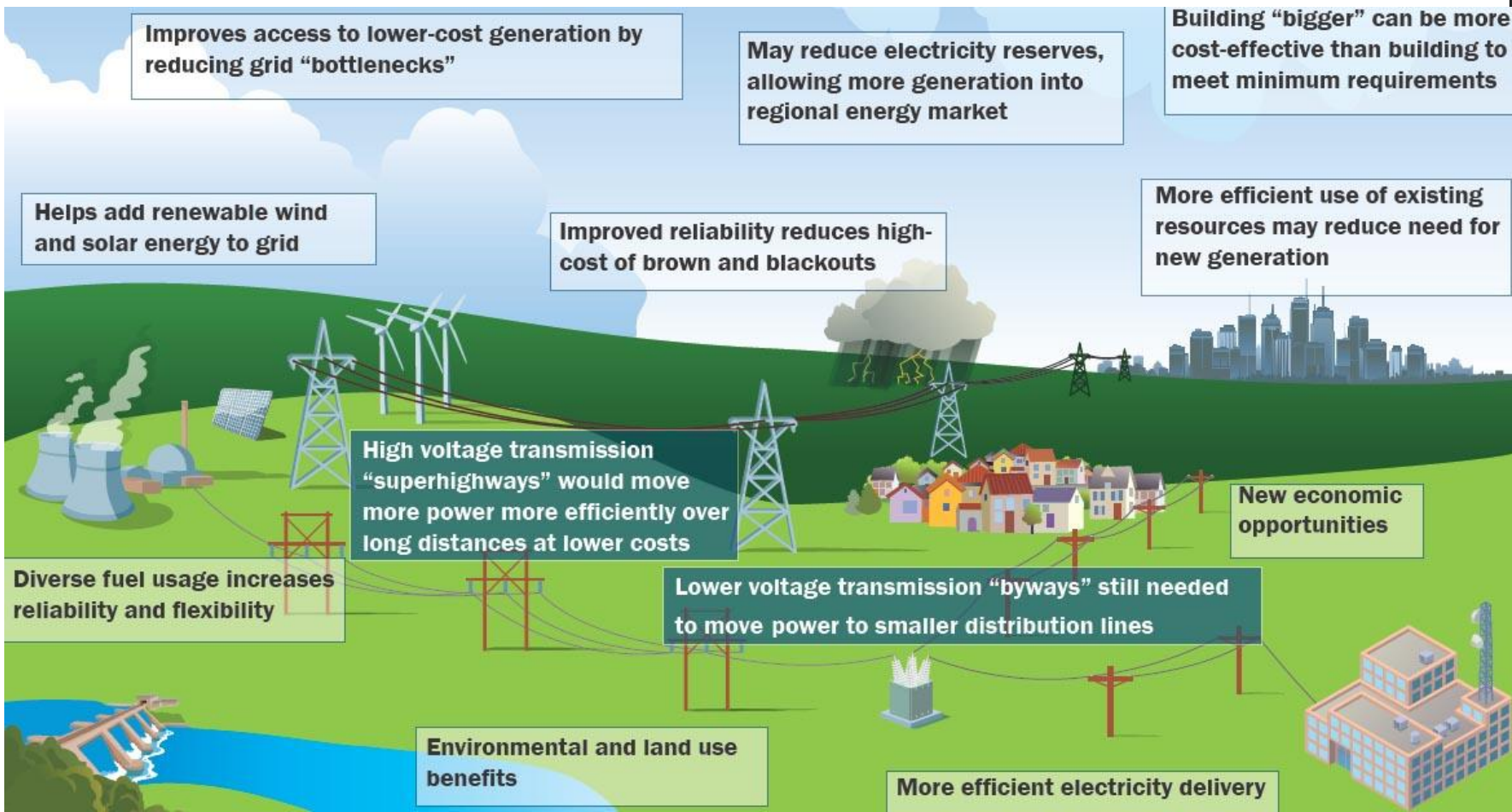


TRANSMISSION PLANNING AT SPP

Services

WHY WE NEED MORE TRANSMISSION?

- In the past, built least-cost transmission to meet local needs
- Today, proactively building “highways” to benefit region



HOW SPP MAKES TRANSMISSION 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

ITP: ECONOMICS AND RELIABILITY ANALYSIS

ITP20

- Develops 345 kV+ backbone for 20-year horizon
- Studies broad range of possible futures

ITP10

- Analyzes transmission system for 10-year horizon
- Establishes timing of ITP20 projects

ITPNT

- Annual Near-Term plan
- Reliability is primary focus
- Identifies potential problems and needed upgrades
- Coordinates with ITP10, ITP20, Aggregate and Generation Interconnection study processes

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

Voltage	Region Pays	Local Zone Pays
300 kV and above	100%	0%
above 100 kV and below 300 kV	33%	67%
100 kV and below	0%	100%

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 the 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 (QRP) utilizing the TOSP.

STATE REGULATORS' ROLE

- Regional State Committee — Retail regulatory commissioners from:

Arkansas	Nebraska	South Dakota
Iowa	New Mexico	Texas
Kansas	North Dakota	
Missouri	Oklahoma	

Louisiana maintains active observer status

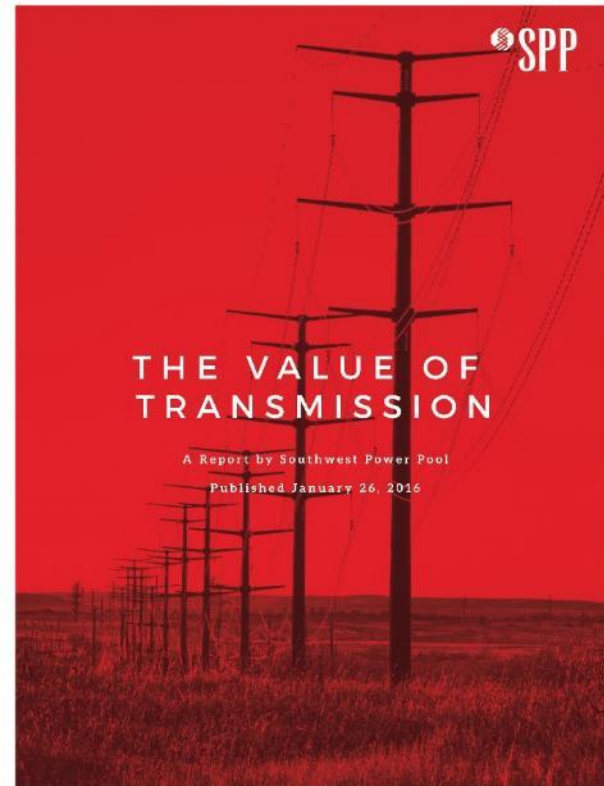
- Primary responsibility for:
- Cost allocation for transmission upgrades
- Approach for regional resource adequacy
- Allocation of transmission rights in SPP's markets

THE VALUE OF TRANSMISSION

SPP'S 2015 VALUE OF TRANSMISSION STUDY

Study Scope:

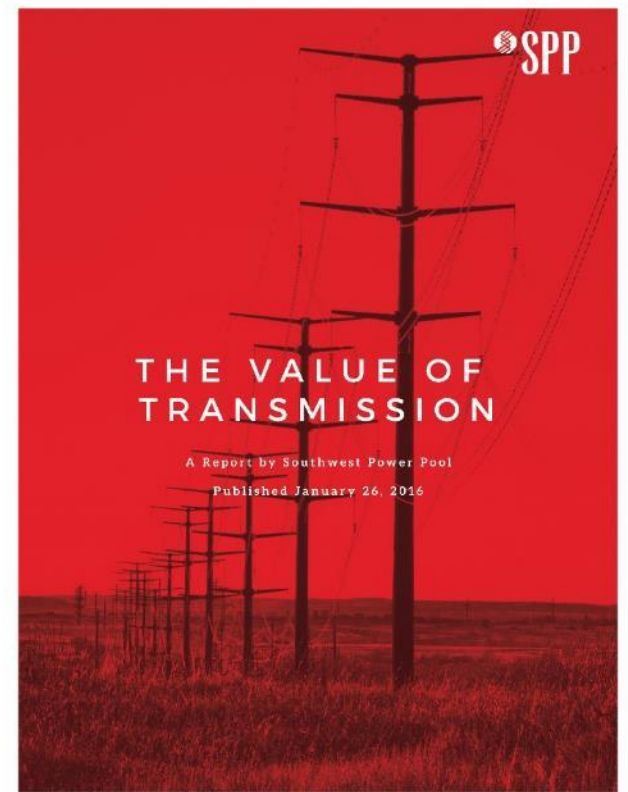
- Assessed 348 projects from 2012-14, representing \$3.4B of transmission investment
- Based on the first year of operation of Integrated Marketplace from March 2014 through February 2015



STUDY RESULTS

- APC Savings calculated at more than \$660k/day, or \$240M/year.
- Overall NPV of all benefits for considered projects are expected to exceed \$16.6B over 40 years.

BENEFIT-COST RATIO OF 3.5 TO 1



BRATTLE GROUP REVIEW

- “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...”

THE **Brattle** GROUP

December 30, 2015

Mr. Jay Caspary
Director, R&D and Special Studies
Southwest Power Pool
201 Worthen Drive
Little Rock AR 72223-4936

Re: SPP Value of Transmission Study

Dear Jay:

Thank you for giving us the opportunity to review the “Value of Transmission” report and the associated PowerPoint summary presentation prepared by SPP staff in December 2015. The SPP study attempts to quantify the overall value provided by SPP transmission projects placed in service during 2012-2014. Based on our review of the final drafts of your study and several prior rounds of discussions in response to earlier drafts, we are pleased to provide the following comments:

- The SPP Value of Transmission study is a path-breaking effort. It provides 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.
- Relying on a full “re-run” of SPP’s day-ahead and real-time markets without the evaluated transmission projects for 40 representative days during the first year of operation of SPP’s Integrated Marketplace and comparing the re-run results to actual market results (which include the evaluated transmission projects after they were placed in service) yields a more complete and more accurate estimate of the production cost savings provided by the evaluated projects than the savings estimated in traditional planning studies.
- The estimated present value of the production cost savings in the SPP study likely is understated because: (a) many of major transmission projects evaluated were not yet in service during most of the 40 days that were analyzed; (b) the selected representative days did not include a full spectrum challenging system conditions (such as extreme weather or generation/transmission outage events) that must be expected to occur over the long service life of the evaluated transmission projects; and (c) based on the experience from other SPP transmission benefit studies, the growth rate of the quantified production cost savings may exceed the assumed annual rate of 10% per year.
- The methodologies applied by SPP staff to quantify the range of other transmission-related benefits are consistent with the methodologies applied in the ITP and RCAR evaluation process. Where deviations from the ITP and RCAR processes exist (e.g., in the estimation of public policy benefits), the methodologies applied are reasonable and represent best available industry practice.

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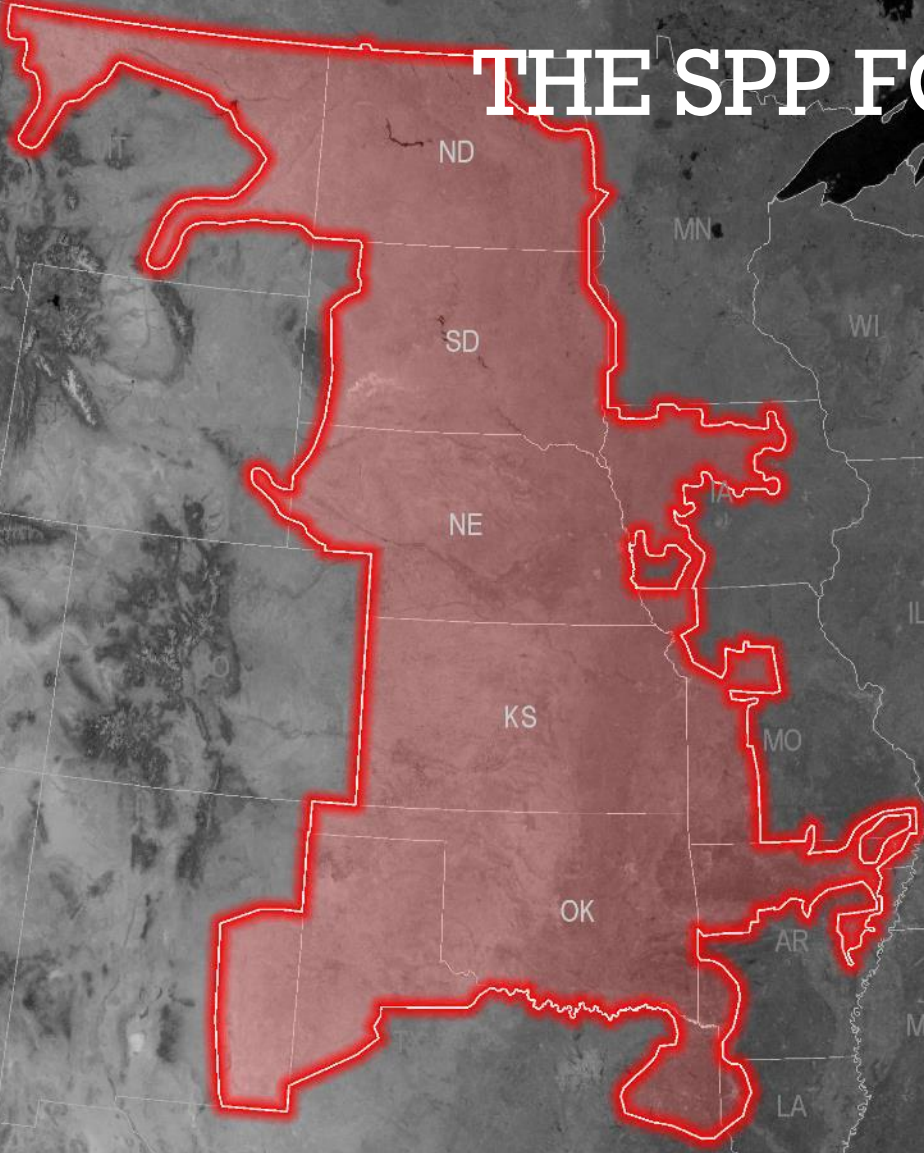
EMAIL office@brattle.com
WEB brattle.com

CAMBRIDGE NEW YORK SAN FRANCISCO WASHINGTON TORONTO LONDON MADRID ROME



TRANSMISSION PLANNING MAPS

THE SPP FOOTPRINT

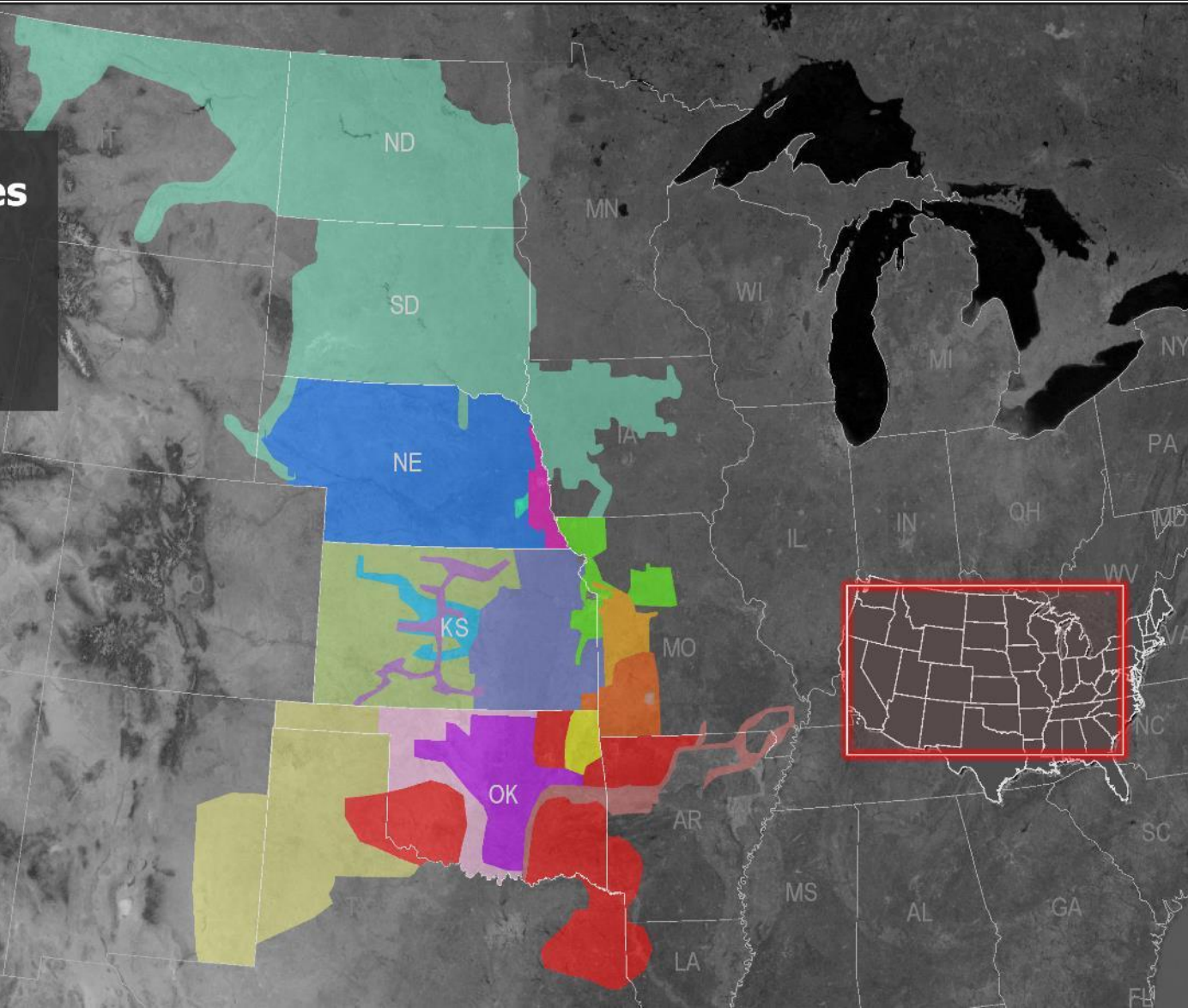


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Date Exported 3/20/2017 1 inch equals 182 miles

Transmission Zones



AEP	OPPD
EDE	SPA
GMO	SPRM
GRDA	SPS
INDN	SUNC
KCPL	UMZ
LES	WESTAR
MIDW	MKEC
NPPD	WFEC
OGE	



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 Date Exported 3/20/2017 1 inch equals 182 miles

Projects Constructed or with NTCs

(2005 - 2017)



- 115 kV
- 138 kV
- 161 kV
- 230 kV
- 345 kV



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Planned Expansion

(230 kV +)



NTC Projects

- 230 kV New Line
- 345 kV New Line
- 345 kV Line Upgrade

ITP 20 Projects

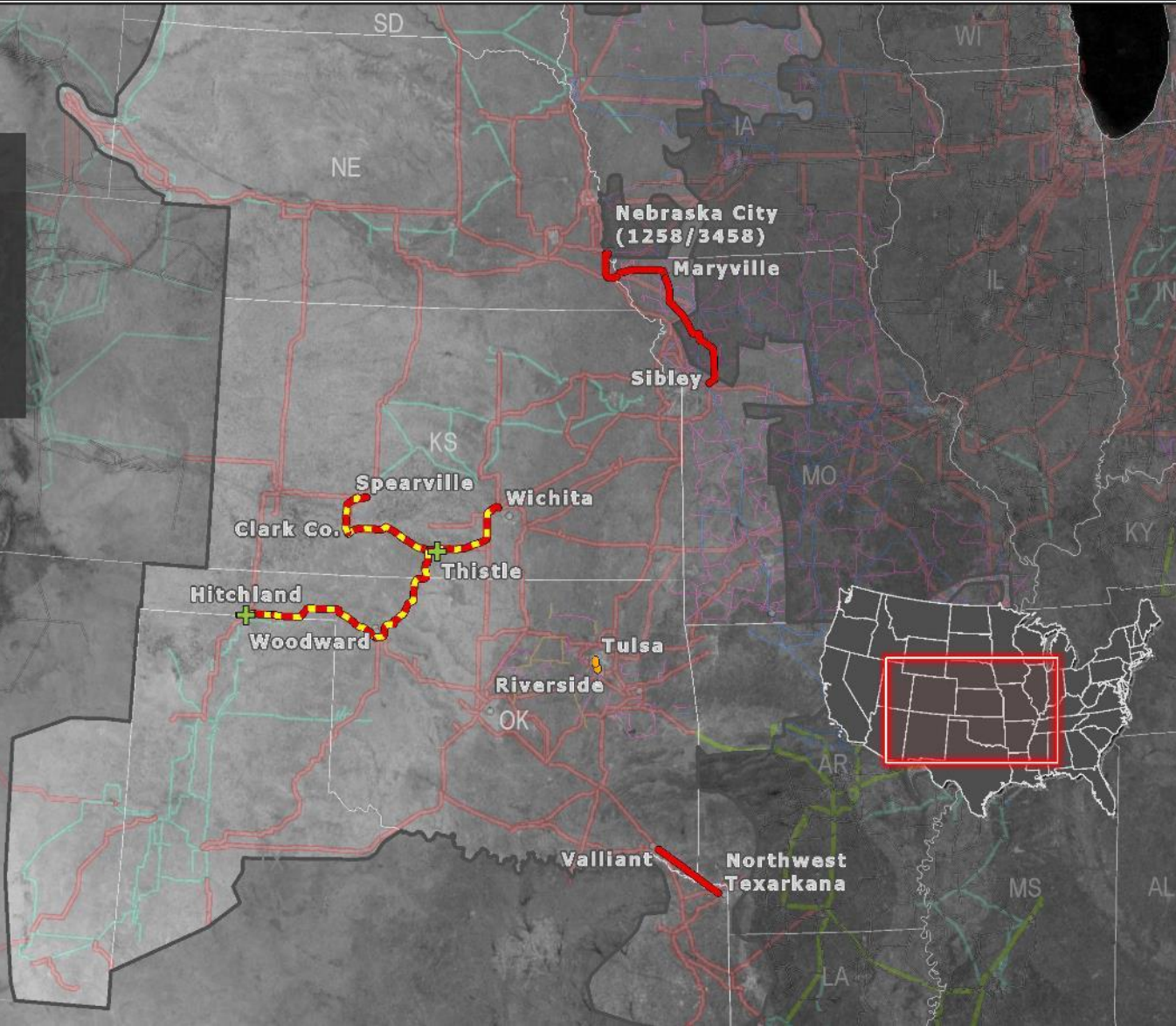
- New Line
- Line Upgrade

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Date Exported 3/15/2017 1 inch equals 173 miles

Priority Projects



- Transformer Upgrade
- 138 kV
- 345 kV
- 345 kV Double Circuit

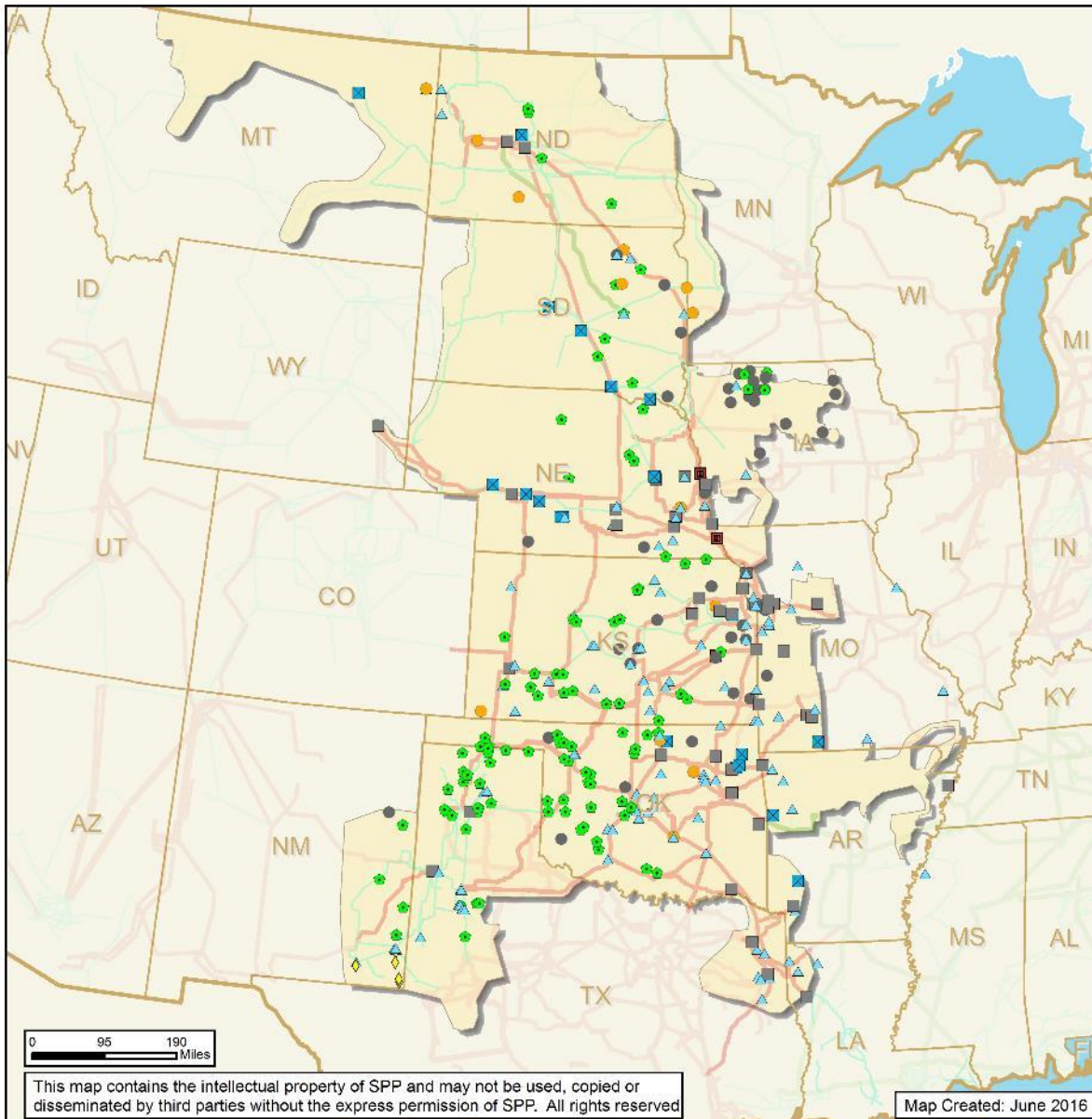


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Distribution of Generation (June 2016)

- | Fuel Type | Voltage |
|---------------|---------|
| ■ Coal | 230 kV |
| ● Fuel Oil | 345 kV |
| ▲ Natural Gas | 500 kV |
| ■ Nuclear | |
| ◆ Solar | |
| ⊠ Water | |
| ● Wind | |
| ● Other | |

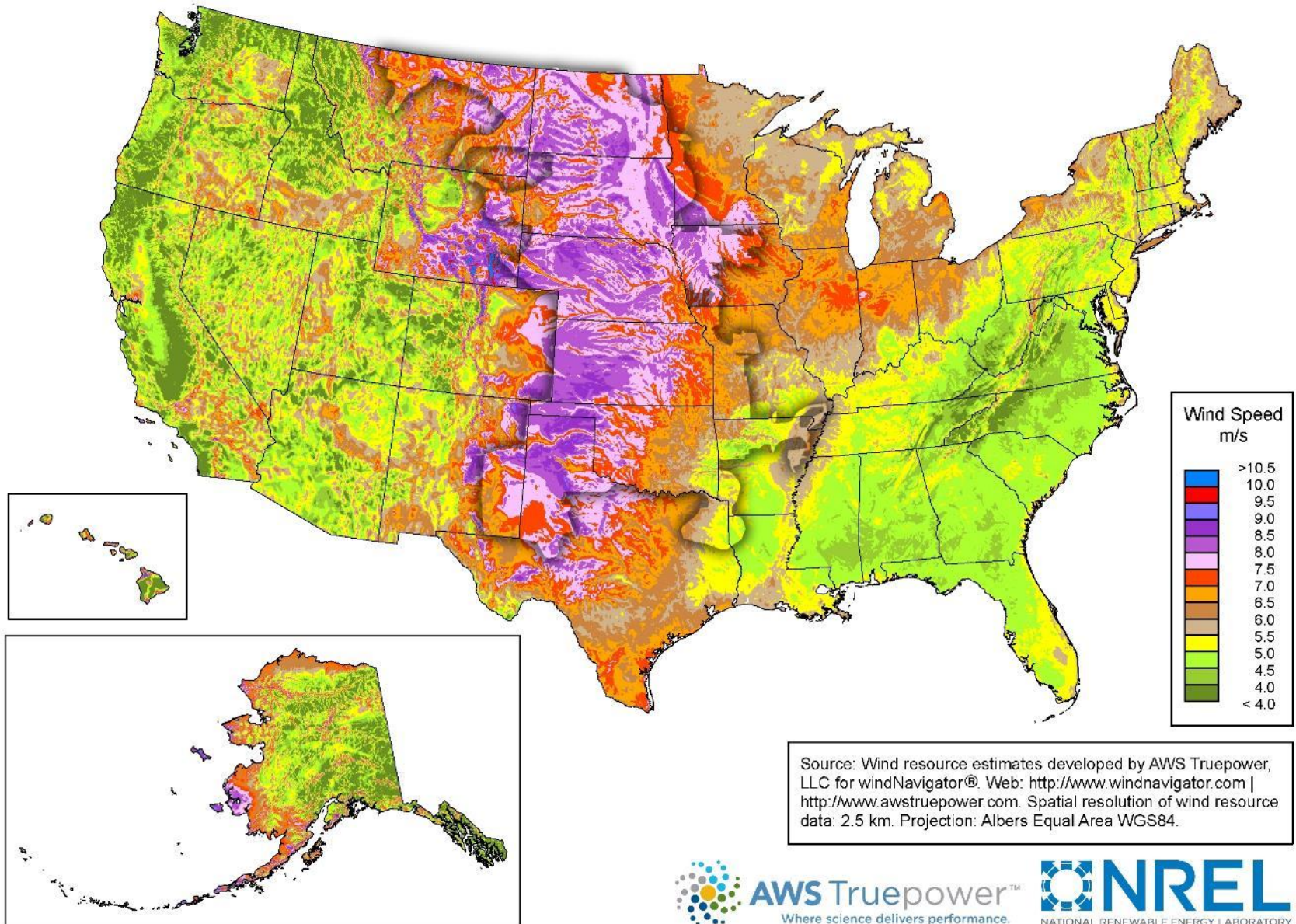


WIND ENERGY

WIND ENERGY DEVELOPMENT

- SPP's "Saudi Arabia" of wind: Kansas, Oklahoma, Nebraska, Texas Panhandle, and New Mexico
 - 60,000-90,000 MW potential
 - More wind energy than SPP uses during peak demand
- 16,114 MW capacity of in-service wind
- 55,573 MW wind in all stages of development
 - Includes Generation Interconnection queue and executed Interconnection Agreements

ANNUAL AVERAGE WIND SPEEDS

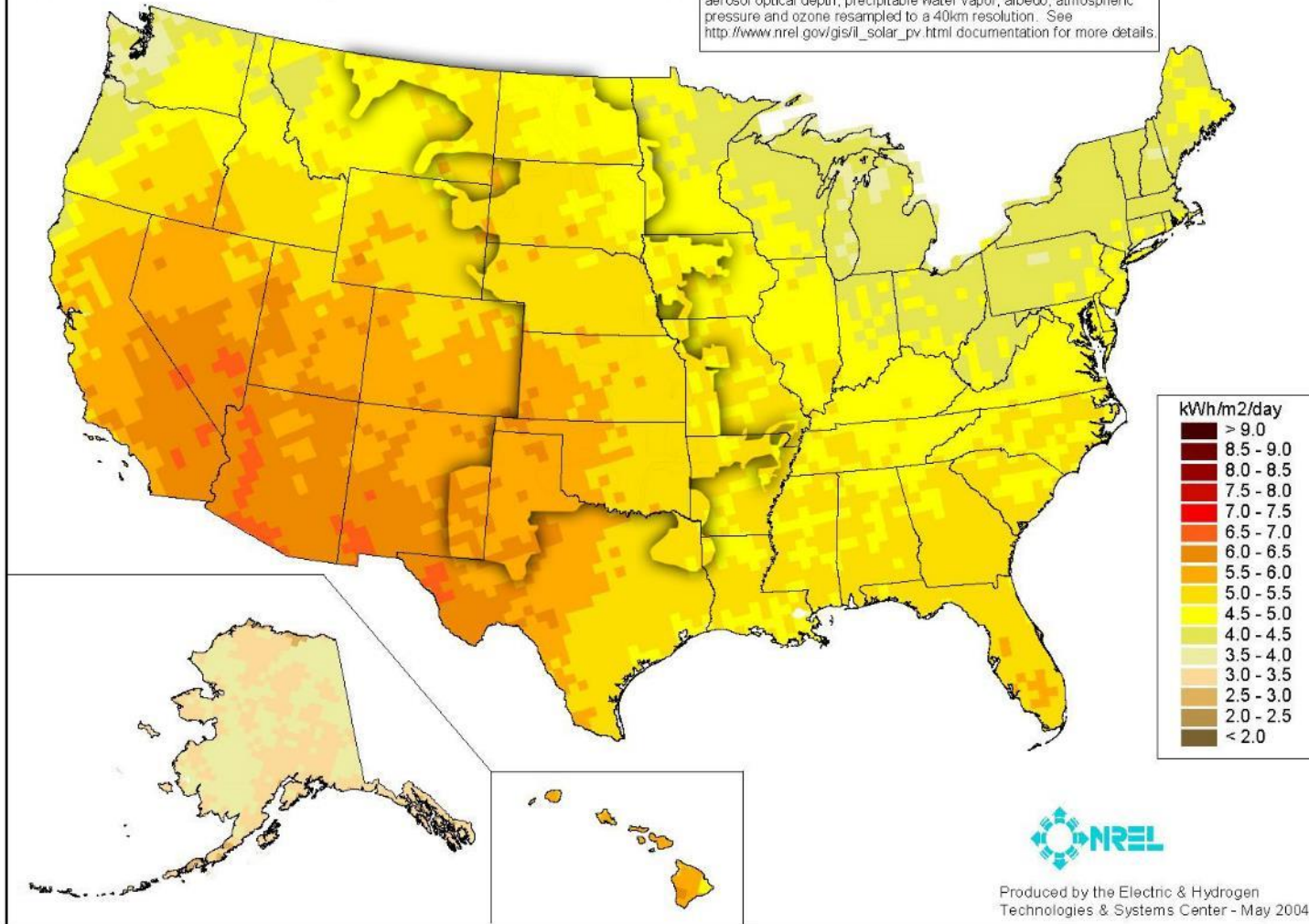


SOLAR IN THE U.S.

PV Solar Radiation
(Flat Plate, Facing South, Latitude Tilt)

Annual

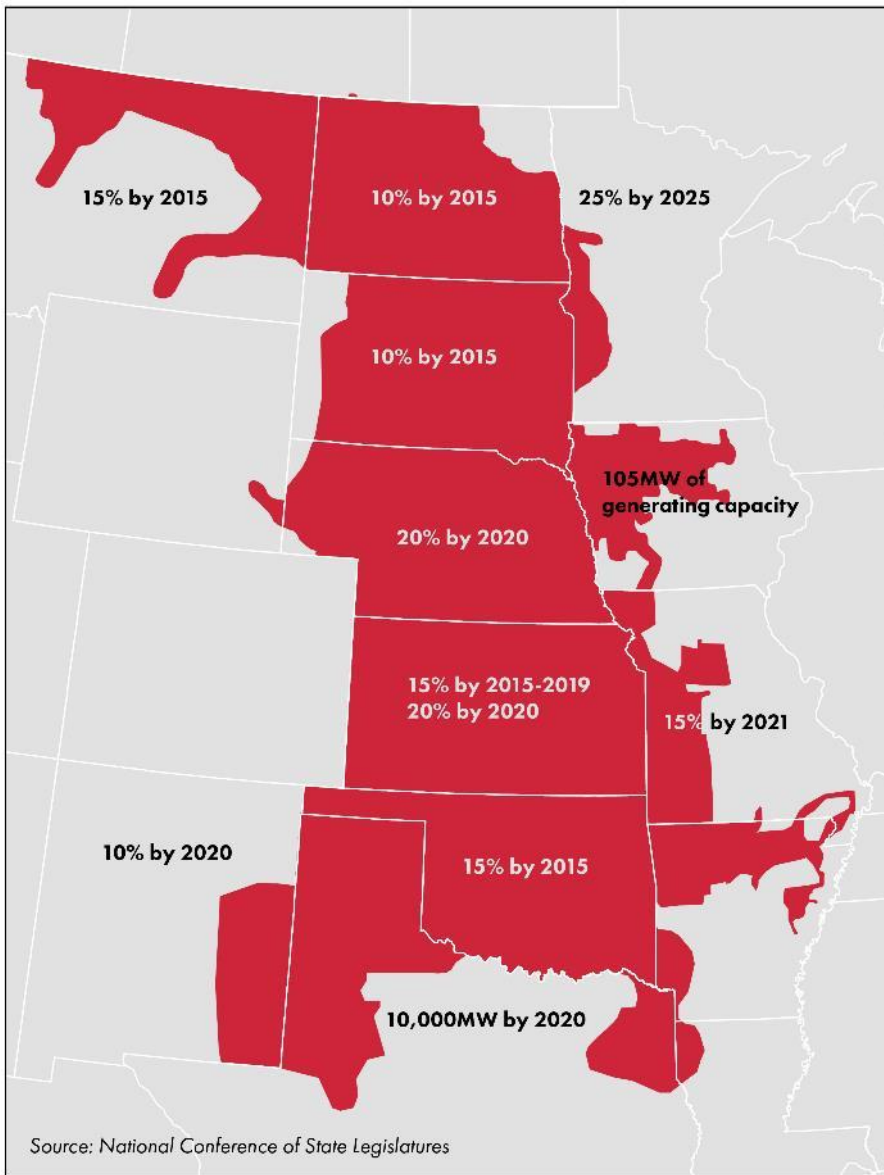
Model estimates of monthly average daily total radiation using inputs derived from satellite and/or surface observations of cloud cover, aerosol optical depth, precipitable water vapor, albedo, atmospheric pressure and ozone resampled to a 40km resolution. See http://www.nrel.gov/gis/il_solar_pv.html documentation for more details.



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

RENEWABLE PORTFOLIO STANDARDS



Wind Resources Registered In SPP Market



- ≤ 42
- ≤ 81
- ≤ 131
- ≤ 225
- ≤ 400



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Wind from GI Queue In Commercial Operation



Capacity (MW)

- ≤42
- ≤81
- ≤131
- ≤225
- ≤370



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Wind from GI Queue



- Signed IA/In Service
- Signed IA/On Schedule
- Signed IA/On Suspension
- Under Study



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