

# Kansas Wind Energy

Living Up to Our Potential

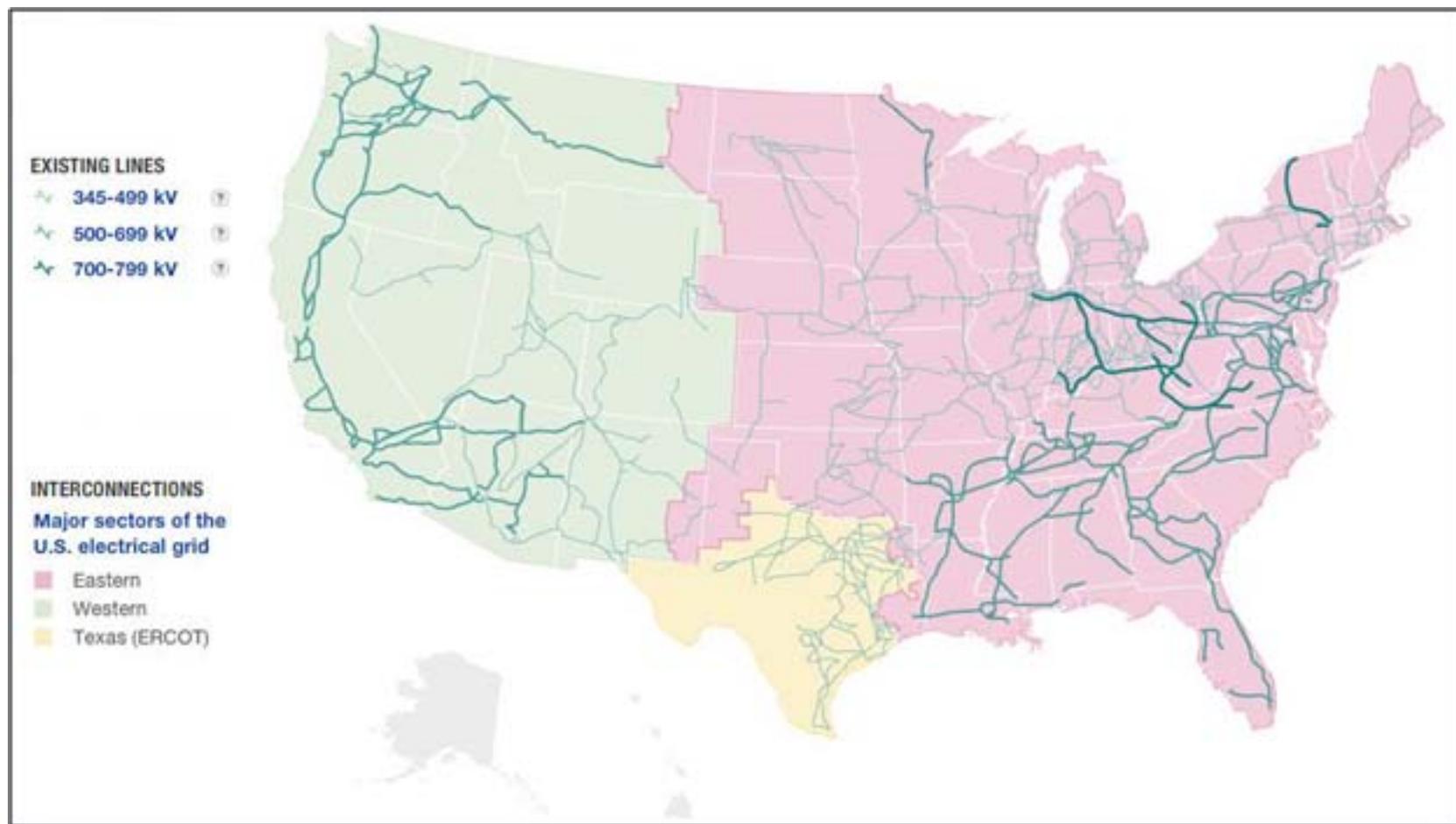


# Kansas' wind energy potential far exceeds demand

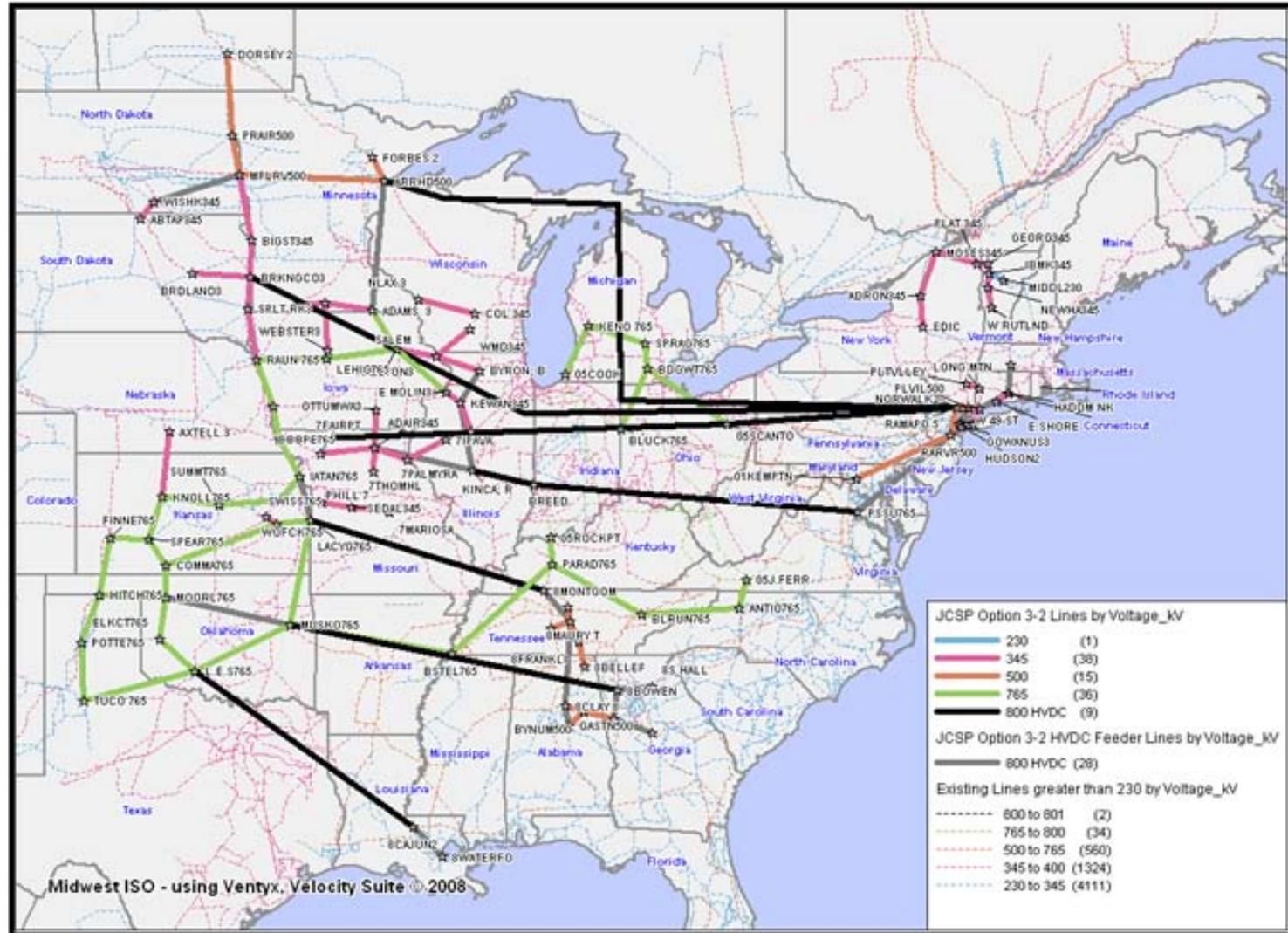
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- Installed capacity: 1,011.9 MW
- Kansas RES goal: ~2,000 MW
- SPP Demand:
  - 10% = 6,840 MW (KS: ~2,500 MW)
  - 20% = 13,674 MW (KS: ~4,000 MW)
- Kansas wind projects in SPP queue: 9,000 MW
- Export capability is required for Kansas to realize its wind energy potential

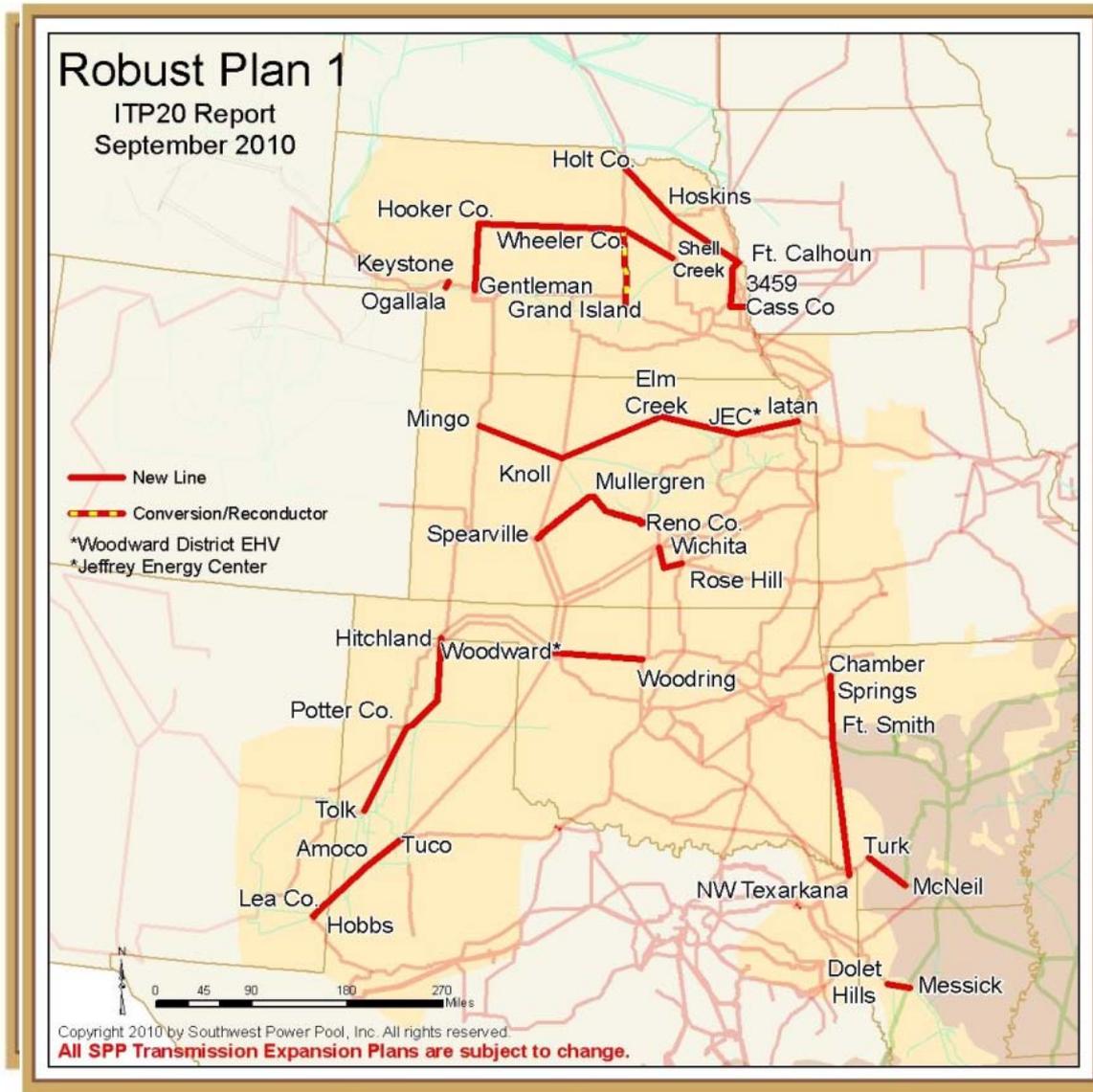
# The existing grid lacks EHV lines connecting the Central Plains to areas with greater electrical demand



# Joint Coordinated System Plan 2008 showed HVDC is needed to bring renewable energy farther east



# SPP Transmission Expansion Plans are focused on serving SPP load

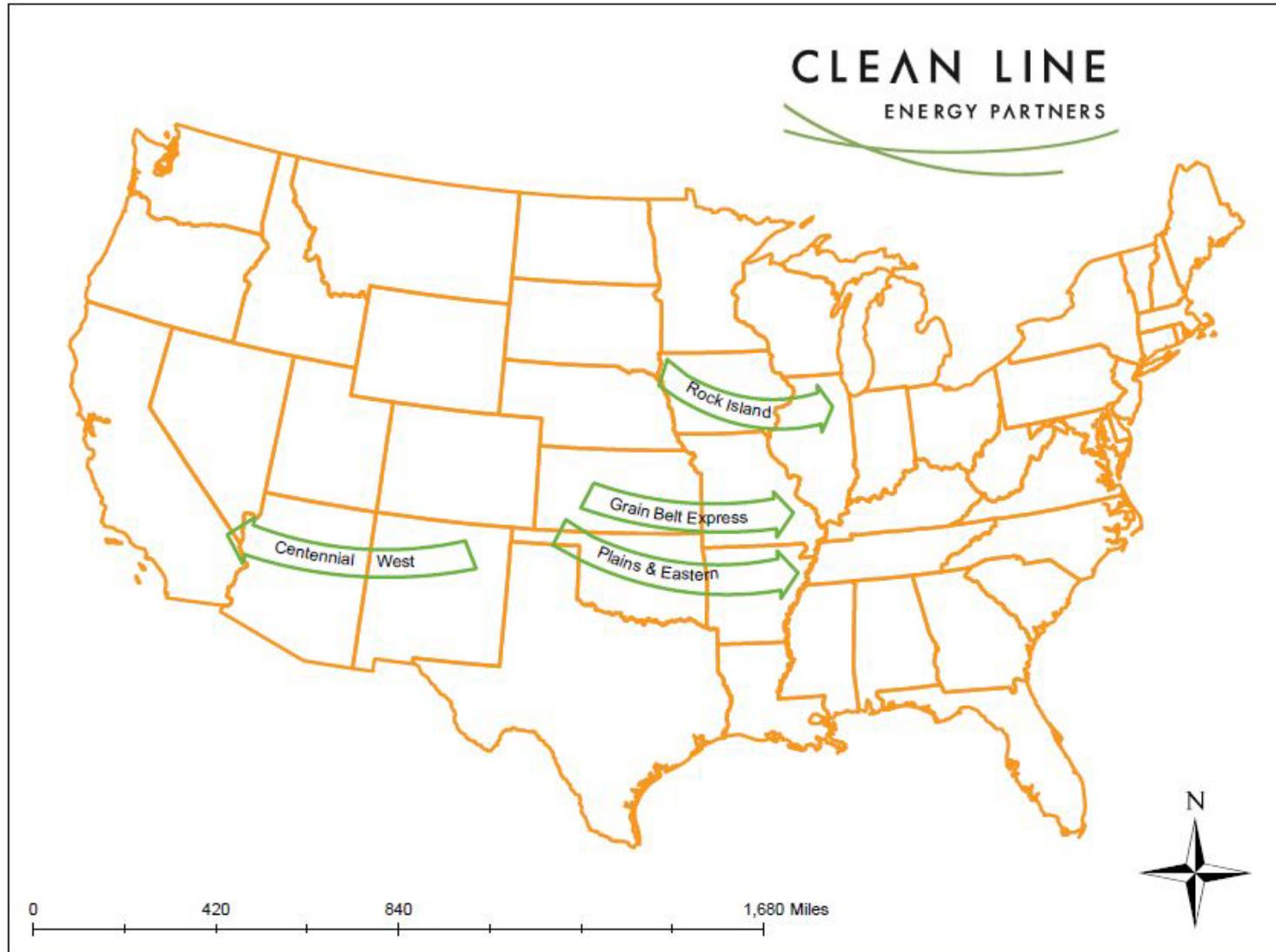


# Who is Clean Line Energy Partners?

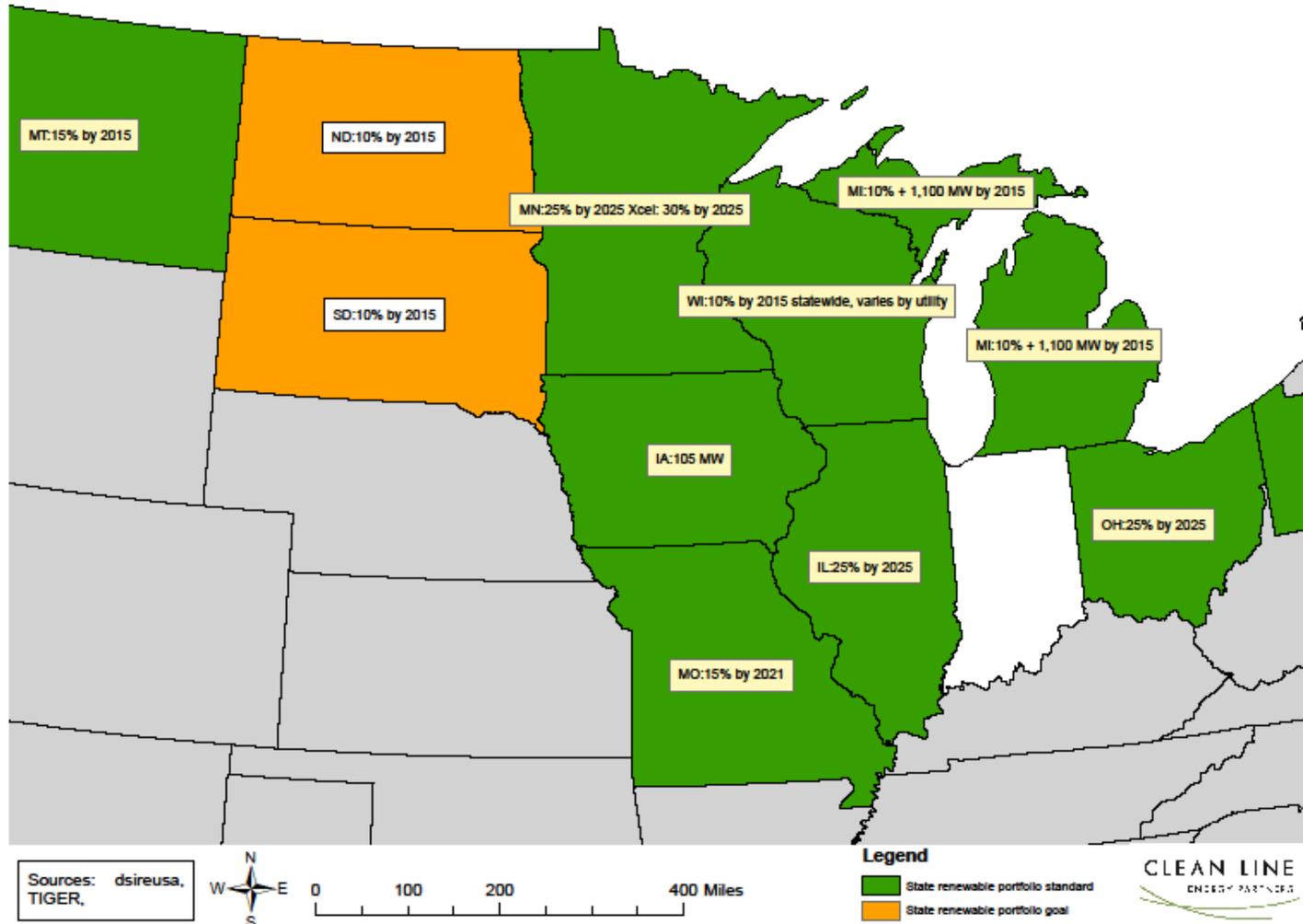
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- Clean Line Energy Partners (“Clean Line”) focuses on connecting renewable resources to demand centers
- Clean Line is developing and seeks to own and operate long haul, high voltage direct current (“HVDC”) transmission lines across the US
- Clean Line’s principals, partners and investors bring unique perspective, experience and focus to transmission development along with a track record of success

# Clean Line is developing four HVDC projects to connect the best wind resources to load



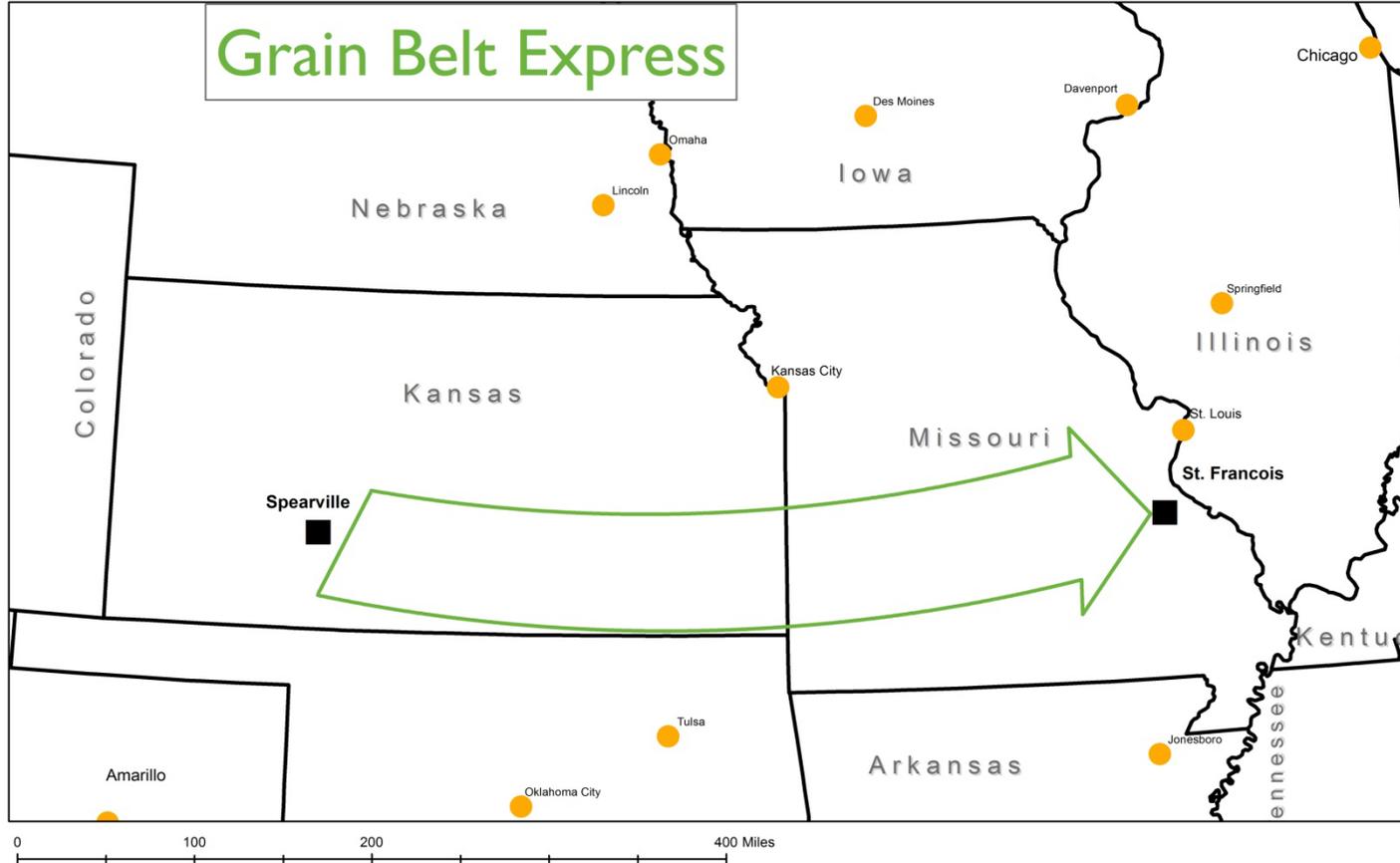
# Renewable energy demand is high in the Midwest ISO



# Current Demand in MISO/PJM

State	RTO	RPS Mandate or Goal	Year
Iowa	MISO	105 MW	
Minnesota	MISO	25%	2025
Missouri	MISO	15%	2021
Montana	MISO	15%	2015
North Dakota*	MISO	10%	2015
South Dakota*	MISO	10%	2015
Wisconsin	MISO	10%	2015
Illinois	MISO and PJM	25%	2025
Michigan	MISO and PJM	10%	2015
Ohio**	MISO and PJM	25%	2025
Pennsylvania**	MISO and PJM	18%	2021
Delaware	PJM	25%	2026
Maryland	PJM	20%	2022
New Jersey	PJM	22.5%	2021
North Carolina	PJM	12.5%	2021
Virginia	PJM	15%	2025
Washington DC	PJM	20%	2020
West Virginia	PJM	25%	2025

# Grain Belt Express Clean Line connects the winds of western Kansas to Missouri and the Midwest ISO

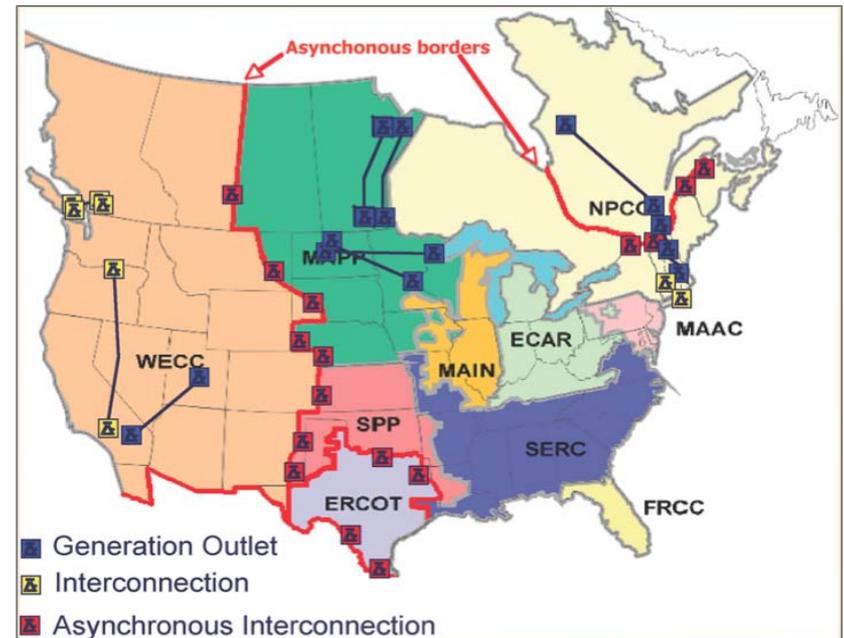
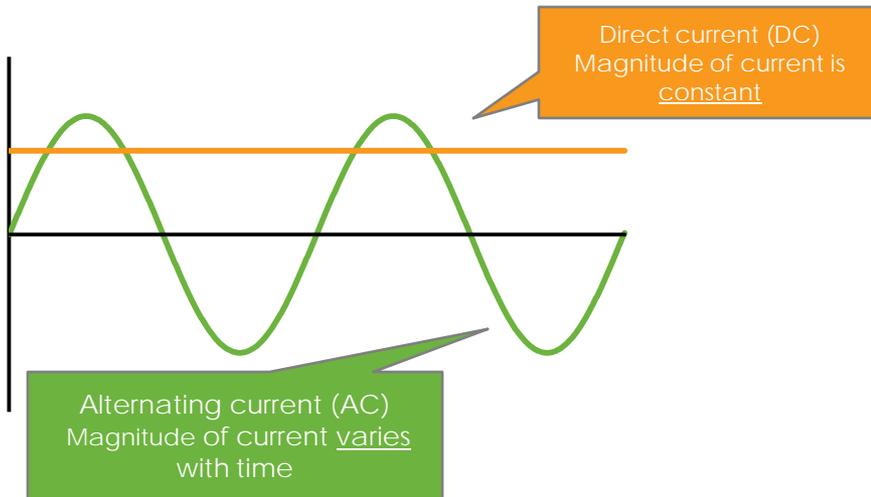


Sources: Map Royalty, TIGER,  
Clean Line Energy, Platts

## Legend

- Major Cities
- Endpoints

# What is Direct Current (DC)?



- Has been around since Thomas Edison and George Westinghouse
  - Power line to your house - AC
  - Car batteries - DC
  - AC easier to change voltage
- High voltage conversion is expensive so DC makes sense only for specific applications
  - Take a large amount of generation a long way (typically more than 400 miles)
  - Asynchronous interconnections

- Proven technology
  - More than 25 HVDC facilities in US
  - Hundreds more around the world
- Can be an effective complement to the AC system

# HVDC brings economic, policy and electric reliability benefits

- Efficient—Due to lower losses, DC is most efficient solution to move bulk power over long distances
- Smaller footprint—DC utilizes narrower right of way and shorter towers than comparable AC systems, simplifying siting processes

AC	<u>3000-4000 MW Capacity</u>	DC
Three 500 kV lines		One $\pm$ 500kV bipole

Source: ABB

- Improved reliability—DC converters allow for controllable power flows, enhancing system stability and facilitating increased wind integration
- Technological advances—Improved HVDC technology will help reduce costs over the long term
- Simpler commercial structure—Generator or load pays

# Grain Belt Express offers environmental benefits

Cleaner air, better use of precious resources

**Lower pollution**  
(annual reductions)



12 million tons  
carbon dioxide



29 thousand tons  
sulfur dioxide



7 thousand tons  
nitrogen oxide



160 pounds

**MERCURY**

**Save water**  
(avoided use per year)



1.1 million acre-feet of  
water (equivalent to over  
300 billion gallons)

Source: ICF International

# Grain Belt Express Clean Line

## Summary

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- Major transmission projects are needed to meet state and national renewable energy goals
- The Grain Belt Express project will bring broad economic and environmental benefits
- Clean Line is carrying out a methodical, long range development process designed to incorporate the concerns of many stakeholders
- Grain Belt Express can and will happen with the right level of support, but will require the collaboration of many stakeholders