Western Dakota Energy Association

Report from North Dakota Transmission Authority

John Weeda

Director

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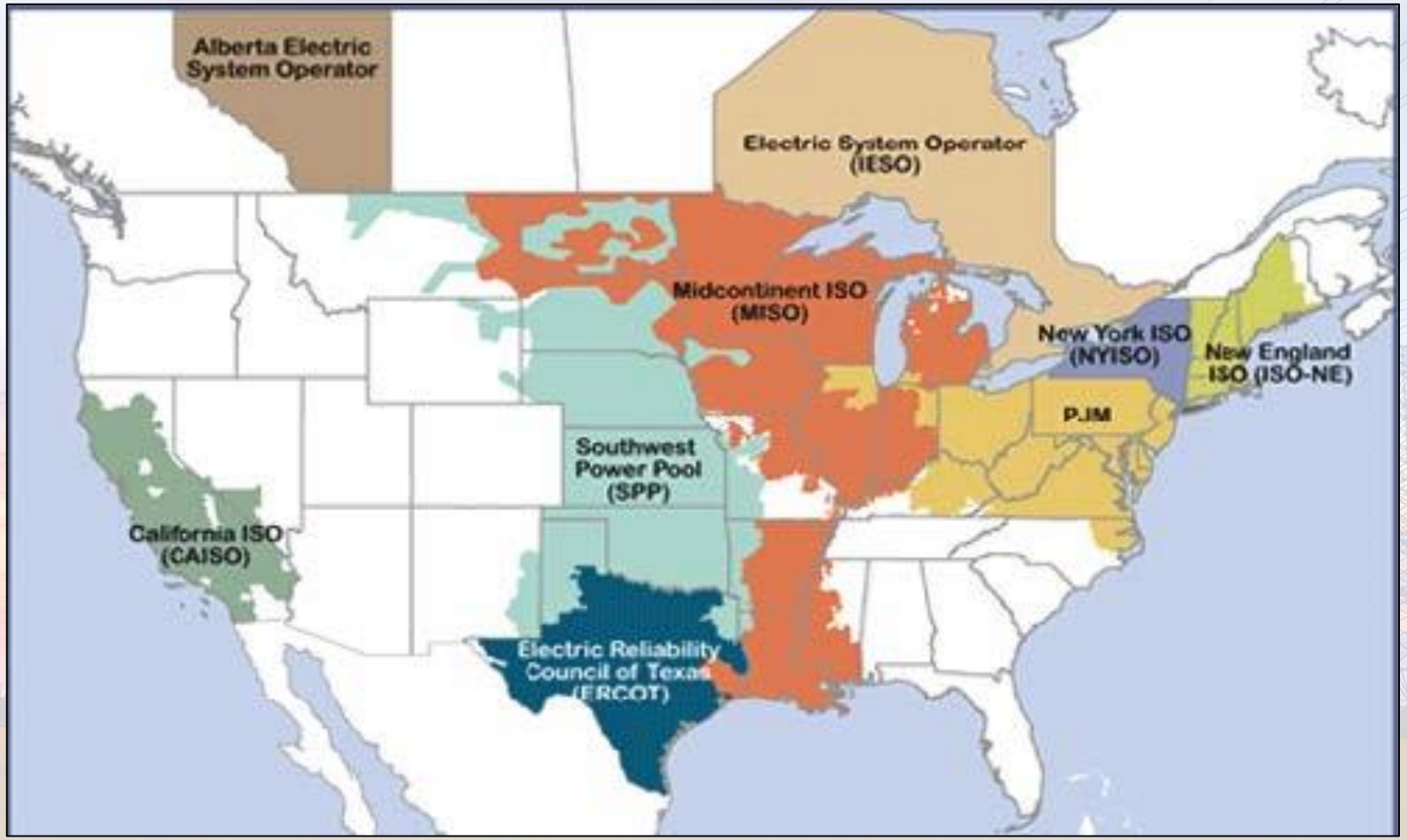
Role of the Transmission Authority

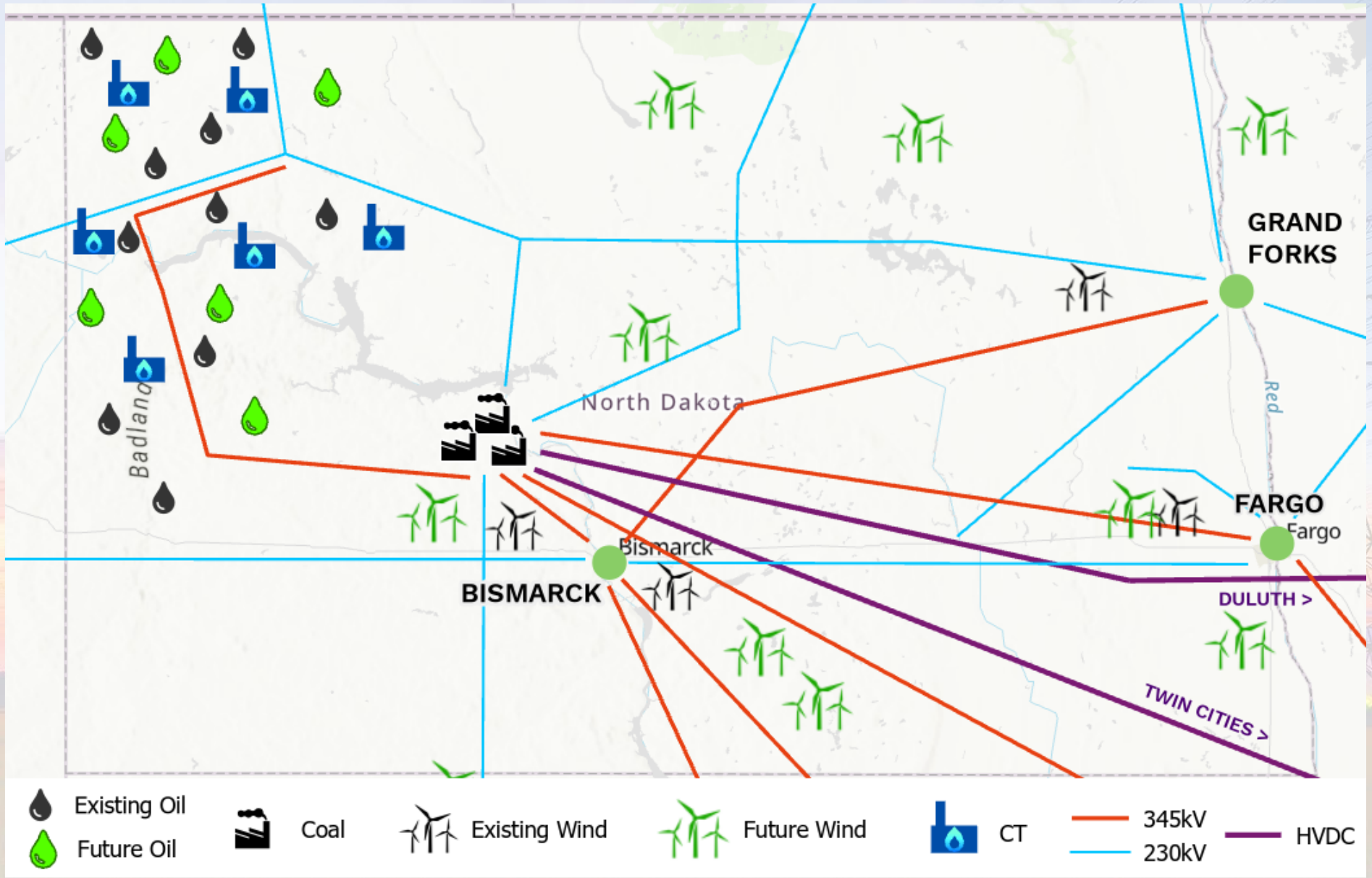
- Monitor the adequacy of the ND electrical transmission grid and advocate for additions as needed to effectively utilize North Dakota resources

- ND Transmission Authority does have bonding authority to build transmission in North Dakota if other interests do not accept the responsibility

MISO and SPP Share North Dakota

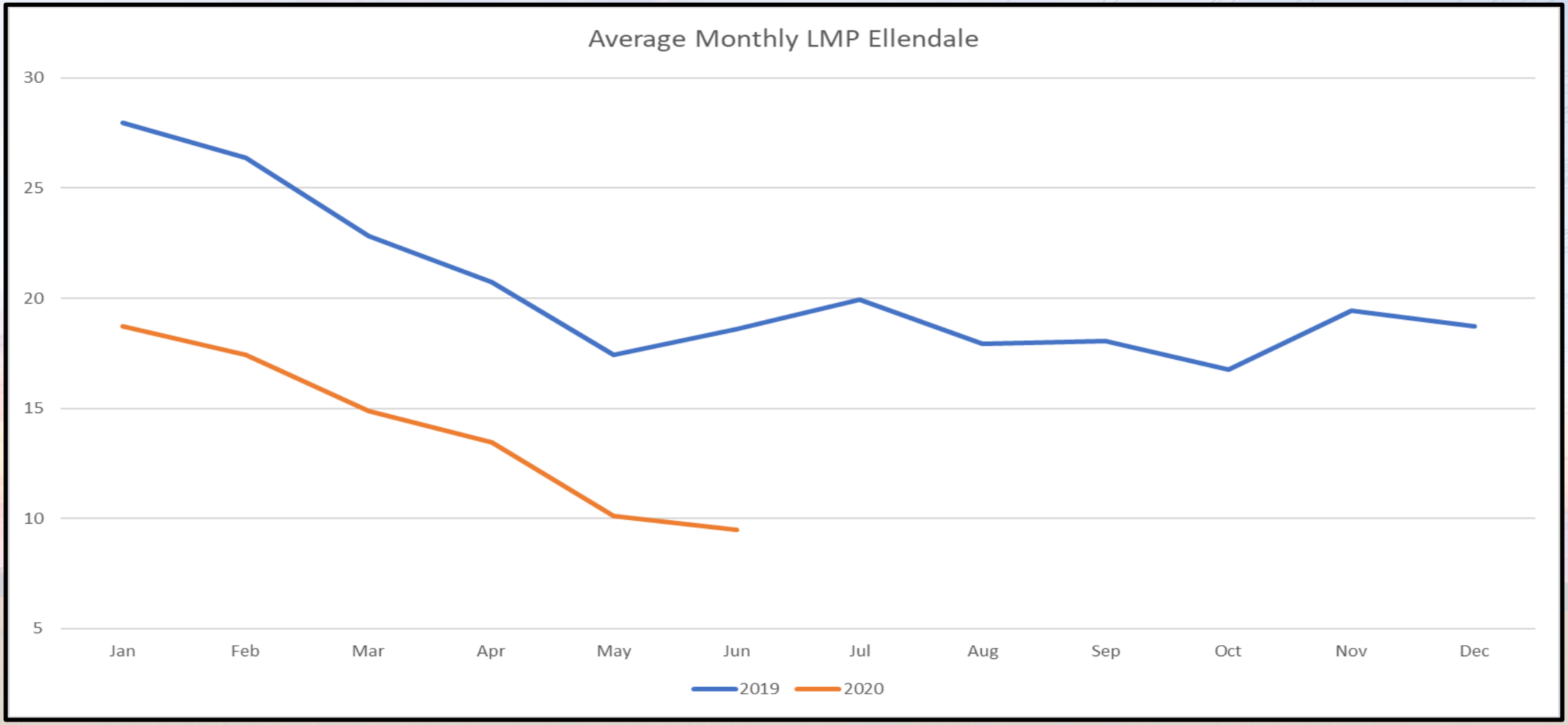


North Dakota Generation and Transmission Map

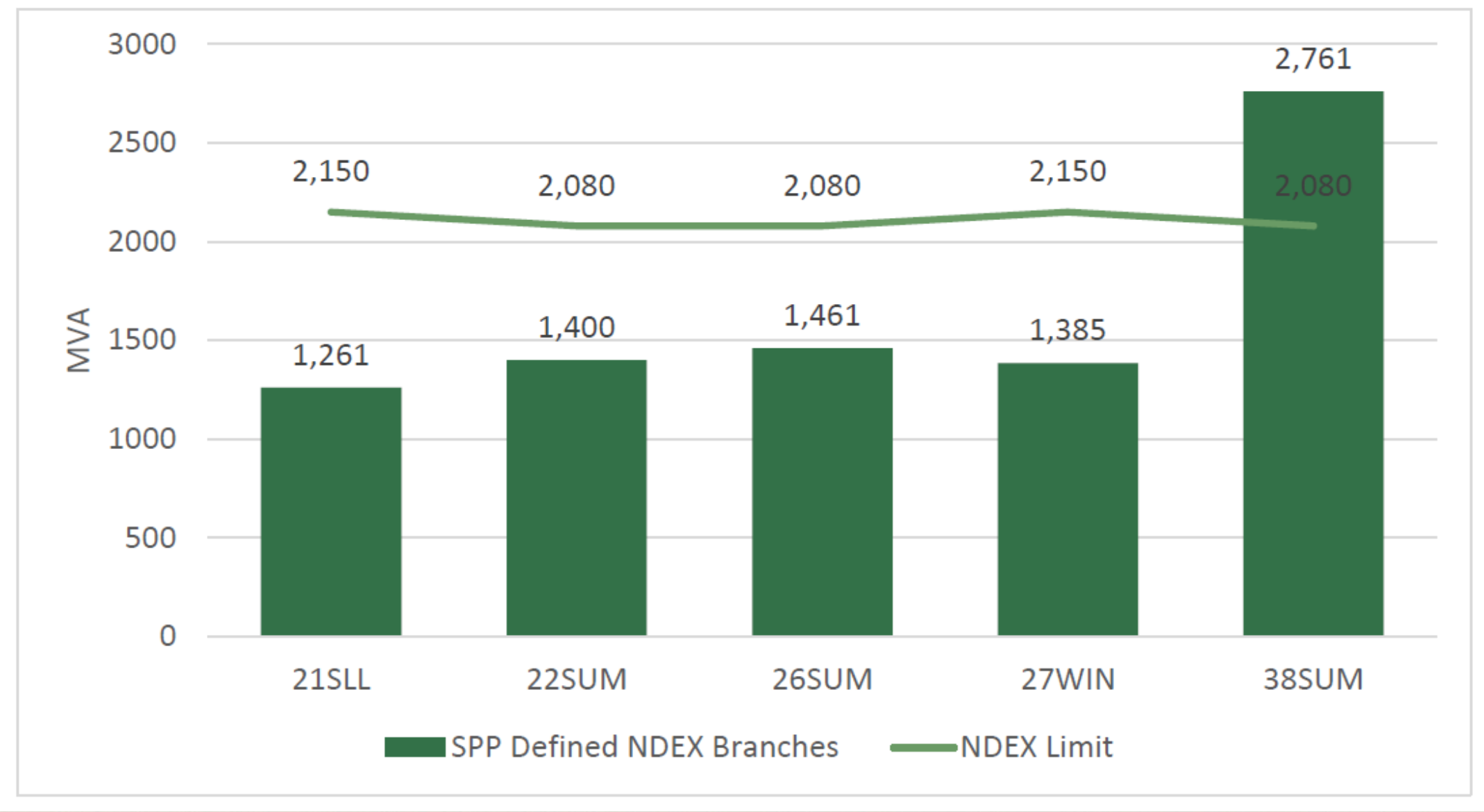


The key message

Full Grid indicated by Market pricing at Ellendale



NDEX Tie Line MVA Flow Totals point to full grid



Pricing on the full grid is also showing more volatility especially negative basis

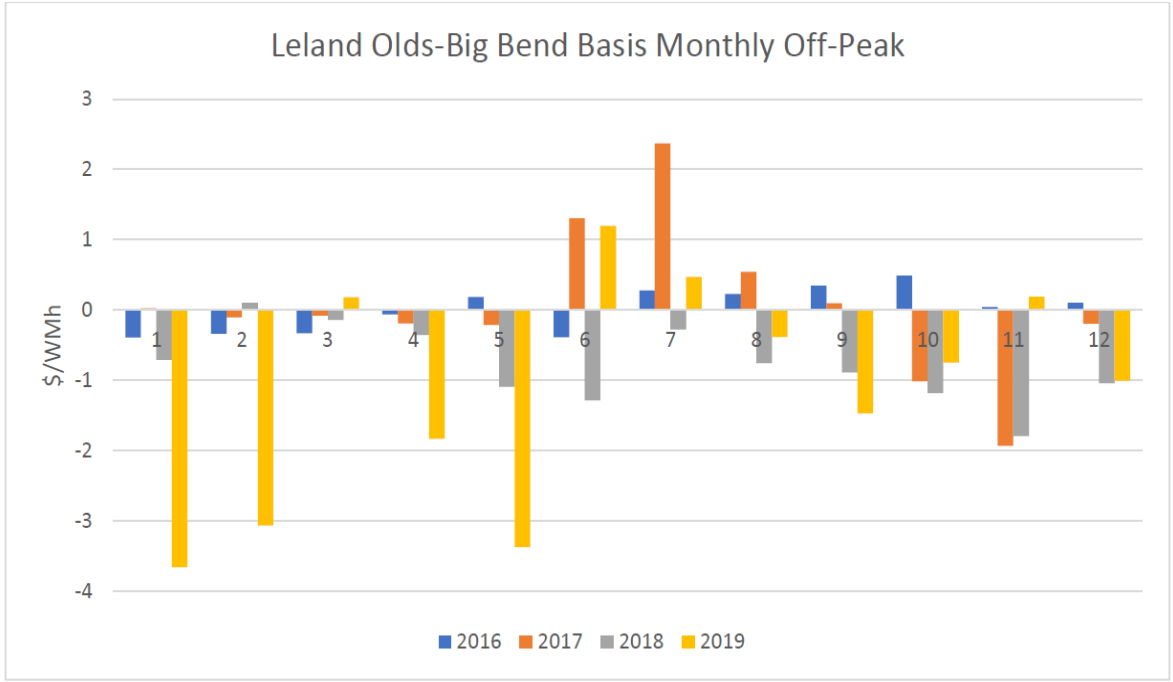


Figure 3-11: Leland Olds-Big Bend Basis Monthly Off-Peak

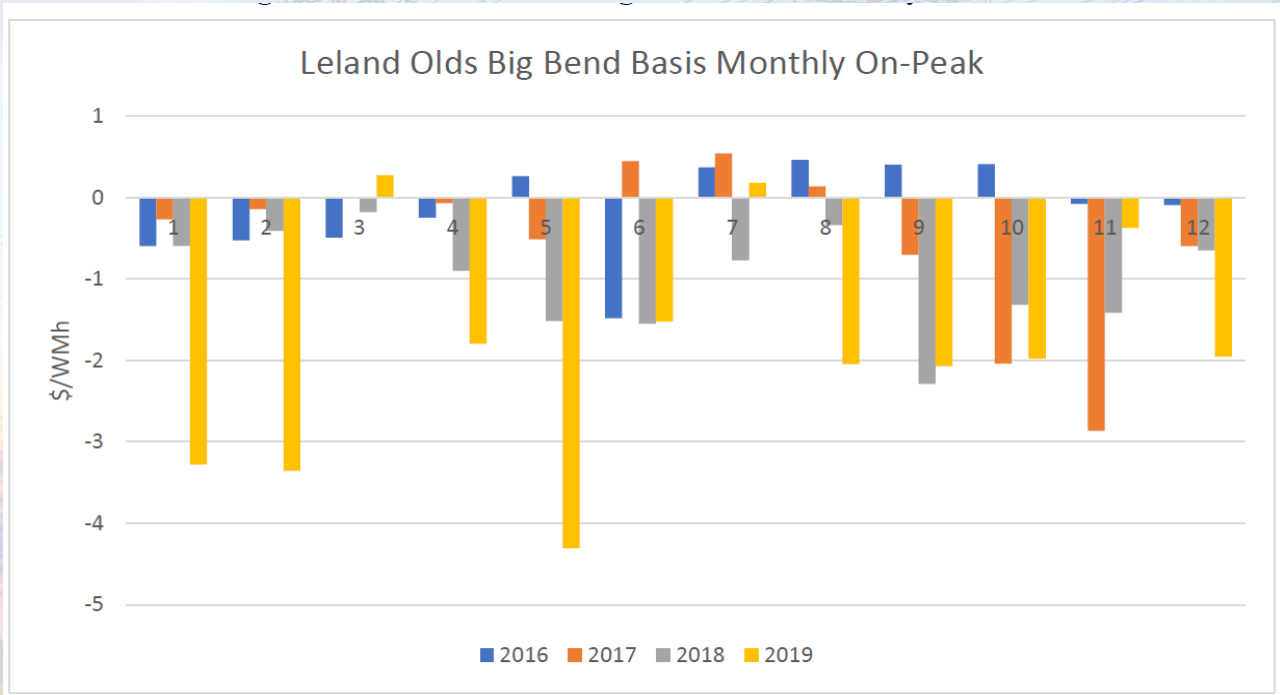
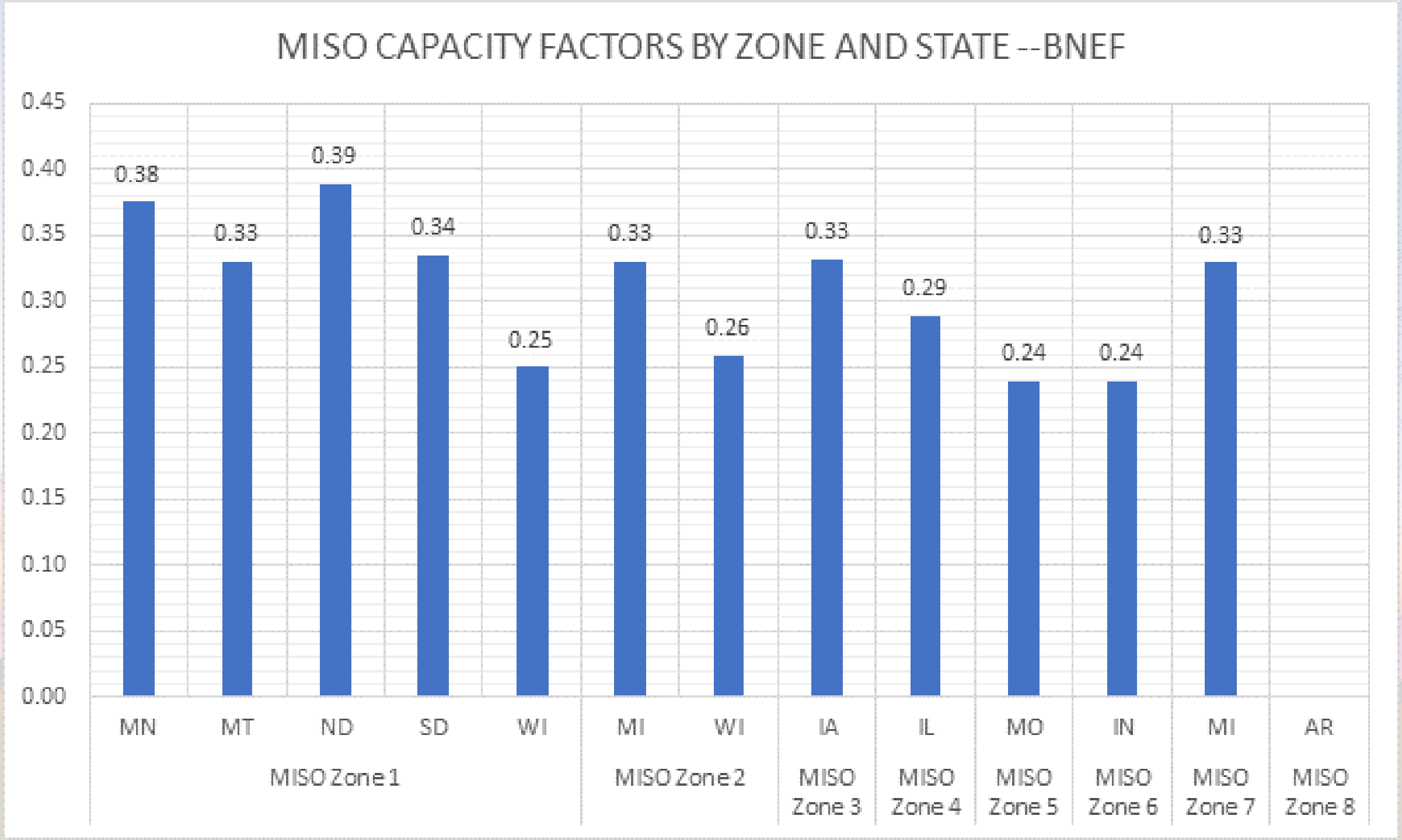


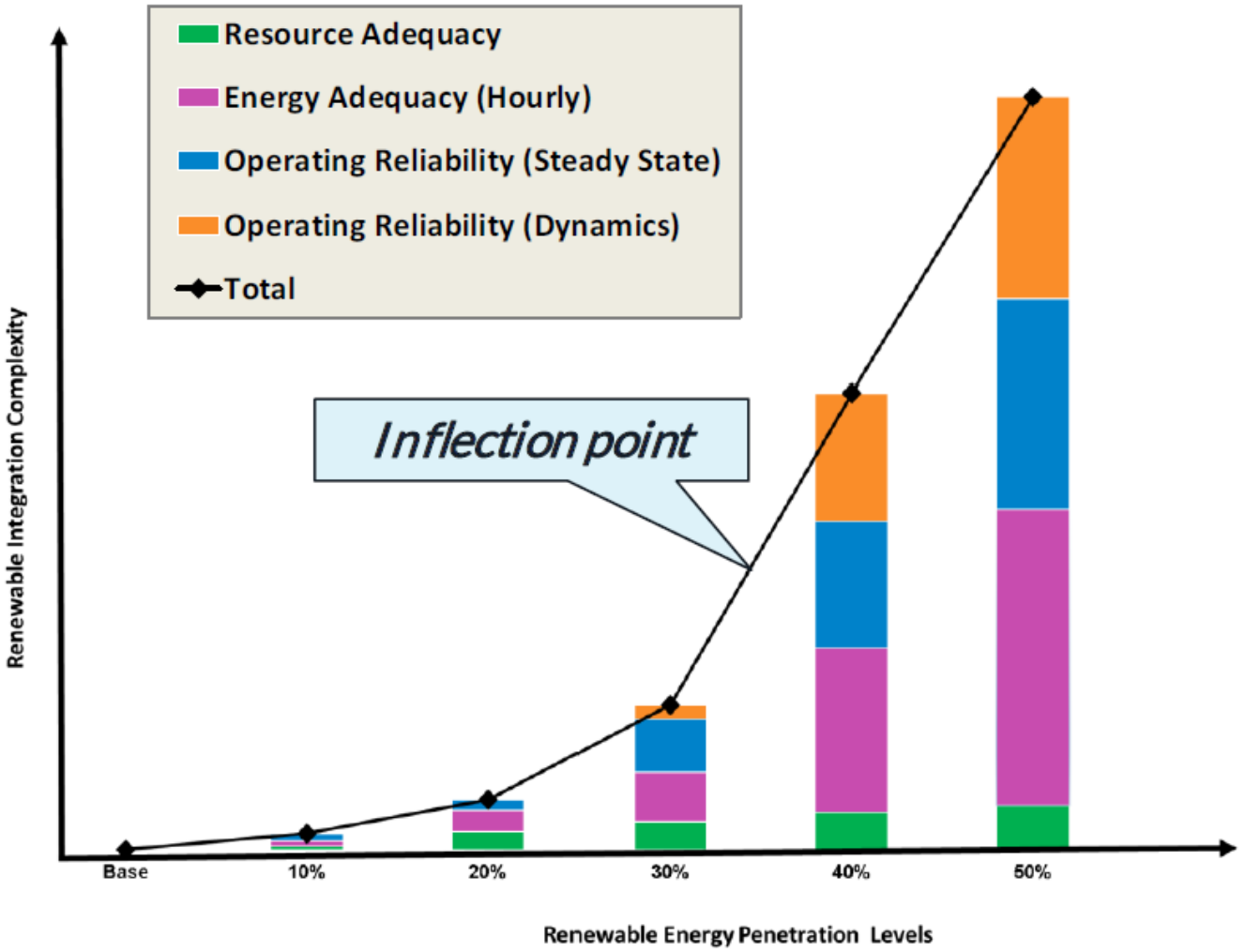
Figure 3-12: Leland Olds-Big Bend Basis Monthly On-Peak

Grid is full based on interconnect cost

- All interconnect requests in the last round for ND resulted in projects being cancelled due to high cost. This affected both projects with MISO and with SPP interconnects


MISO CAPACITY FACTORS BY ZONE AND STATE --BNEF
0.45
0.40
0.35
0.30
0.25
0.20
0.15
0.10
0.05
0.00
0.38
0.33
0.39
0.34
0.25
0.33
0.26
0.33
0.29
0.24
0.24
0.33
MN
MT
ND
SD
WI
MI
WI
IA
IL
MO
IN
MI
AR
MISO Zone 1
MISO Zone 2
MISO Zone 3
MISO Zone 4
MISO Zone 5
MISO Zone 6
MISO Zone 7
MISO Zone 8

MISO's Renewable Integration Impact Assessment (RIIA) indicates integration complexity increasing sharply beyond 30% renewable penetration



1. Risk of losing load compresses into a small number of hours and shifts into the evening
2. Existing infrastructure becomes inadequate for fully accessing the diverse resources across the MISO footprint
3. Regional energy transfer increases in magnitude and becomes more variable leading to a need for increased extra-high voltage line thermal capabilities
4. Power delivery from low short circuit areas may need transmission technologies equipped with dynamic support capabilities
5. Frequency response is stable up to 60% instantaneous renewable penetration, but may require additional planned headroom beyond
6. Grid technology needs evolve as renewable penetration increases, leading to an increased need for integrated planning
7. Diversity of technologies and geography improve the ability of renewables to serve load

Resource Availability and Need Drivers and *MISO Forward* Identified Needs

Key Industry Drivers	Direction	Availability	Flexibility	Visibility	Description
Baseload and Long Lead Resources Aging, Retiring	↓↓	↓	↓		Fewer Baseload Resources require greater reliance on more flexible resources
Reserve Margins (Shrinking Excess Capacity)	↓	↓	↓		Outage Correlation and tightening margins reduces availability and flexibility during non-peak seasons
Price (Fuel Costs, Zero Marginal Cost Resources)	↓	↓	↓	↓	Lower prices requires greater reliance on more flexible resources
Emergency Only Capacity (LMR, AME, Emergency Ranges)	↑	↓	↓	↓	Offers not available or limited availability to market. Market signals have been insufficient to incentivize demand participation.
Distributed Energy Resources	↑			↓	Offers not available or limited availability to market
Uncertainty (Load, Renewables, Interchange, and Resource Forecasts)	↑↑		↓		Load and Supply Uncertainty increases need for intra-day flexibility or availability
Variability (Load, Wind, Solar, Interchange)	↑↑		↓		Load and Supply Variability increases need for intra-day flexibility or availability

Fuel Price Sensitivity: High gas prices drive the switch to coal and increase the system average LMP

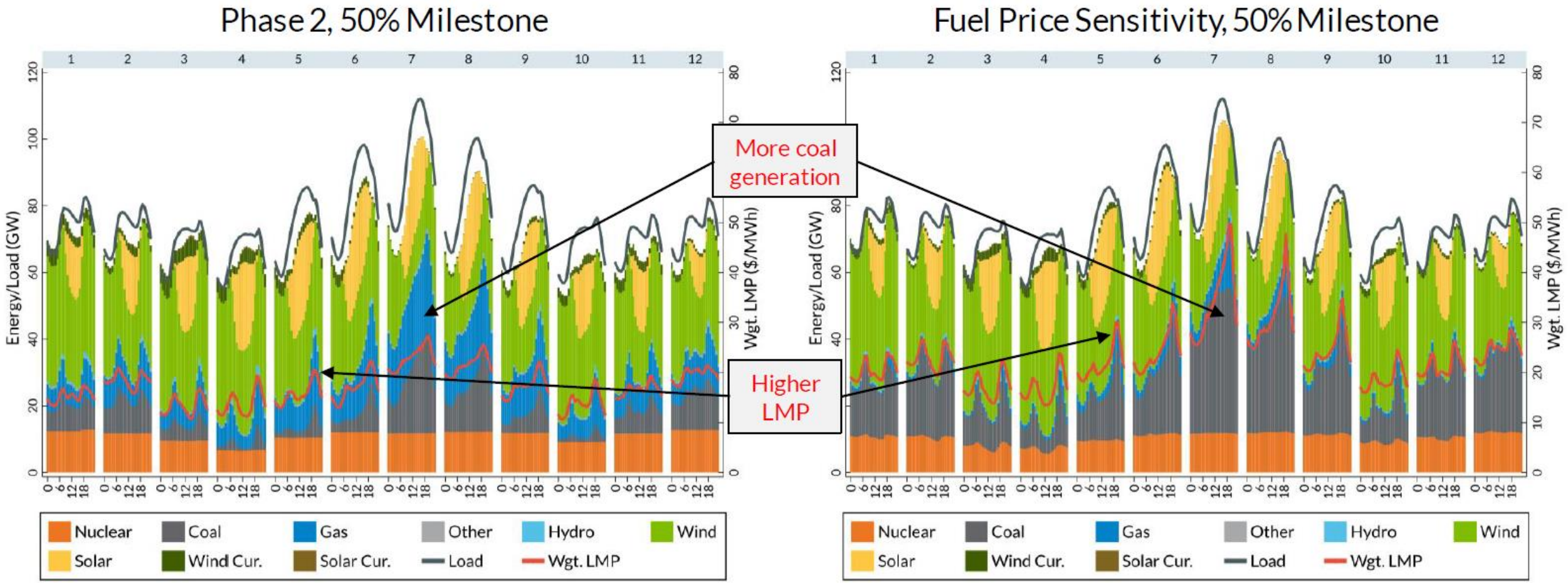
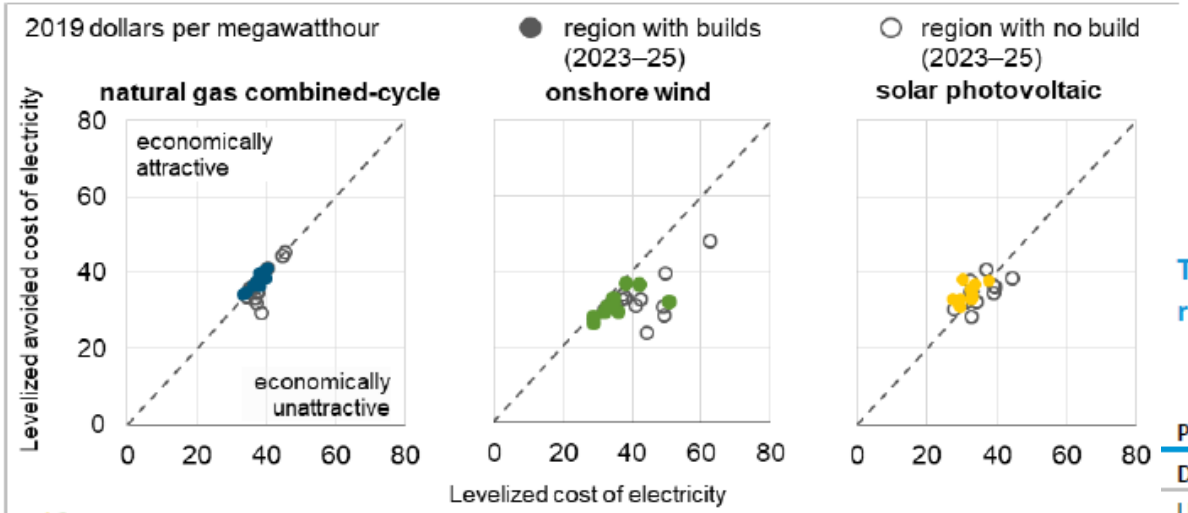


Figure 2. Levelized cost of electricity and levelized avoided cost of electricity by region for selected generation technologies, 2025 online year



Source: U.S. Energy Information Administration, *Annual Energy Outlook 2020*

Table 1b. Estimated levelized cost of electricity (LCOE, unweighted) for new generation resources entering service in 2025 (2019 dollars per megawatthour)

Plant type	Capacity factor (percent)	Levelized capital cost	Levelized fixed O&M[1]	Levelized variable O&M	Levelized transmis-sion cost	Total system LCOE	Levelized tax credit[2]	Total LCOE including tax credit
Dispatchable technologies								
Ultra-supercritical coal	85	47.57	5.43	22.27	1.17	76.44	*NA*	76.44
Combined cycle	87	8.40	1.59	26.88	1.20	38.07	*NA*	38.07
Combustion turbine	30	16.17	2.65	44.33	3.47	66.62	*NA*	66.62
Advanced nuclear	90	56.12	15.36	9.06	1.10	81.65	-6.76	74.88
Geothermal	90	20.38	14.48	1.16	1.45	37.47	-2.04	35.43
Biomass	83	39.92	17.22	36.44	1.25	94.83	*NA*	94.83
Non-dispatchable technologies								
Wind, onshore	40	29.63	7.52	0.00	2.80	39.95	*NA*	39.95
Wind, offshore	44	90.95	28.65	0.00	2.65	122.25	*NA*	122.25
Solar photovoltaic[3]	29	26.14	6.00	0.00	3.59	35.74	-2.61	33.12
Hydroelectric[4,5]	59	37.28	10.57	3.07	1.87	52.79	*NA*	52.79

[1]O&M = operations and maintenance.

[2]The tax credit component is based on targeted federal tax credits such as the production tax credit (PTC) or investment tax credit (ITC) available for some technologies. It reflects tax credits available only for plants entering service in 2025 and the substantial phaseout of both the PTC and ITC as scheduled under current law. Technologies not eligible for PTC or ITC are indicated as *NA*, or not available. The results are based on a regional model, and state or local incentives are not included in LCOE calculations. See text box on page 2 for details on how the tax credits are represented in the model.

[3]Costs are expressed in terms of net AC (alternating current) power available to the grid for the installed capacity.

[4]As modeled, EIA assumes that hydroelectric generation has seasonal storage so that it can be dispatched within a season, but overall operation is limited by resources available by site and season.

[5]Costs are for 2023 online year. See page 6 for details on the exception.

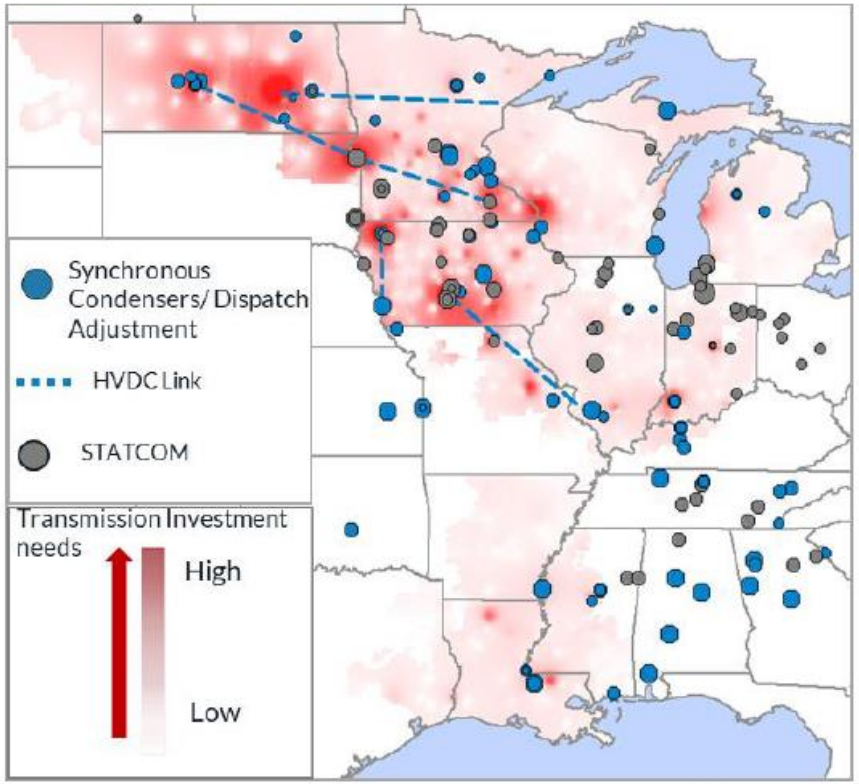
Source: U.S. Energy Information Administration, *Annual Energy Outlook 2020*

Independent Statistics & Analysis
U.S. Energy Information Administration

Transmission options

- Utilization of the CU line
  - At least 2 entities are seeking to buy the plant and the DC transmission line
    - Operate with existing units and enhancement is CO2, storage, wind, etc.
    - Brings additional investment up to $2B
    - Offer variety of “products” on the line
  - Other entities seeking to buy the line and reserve it for themselves with wind generation only
- Other “private line” options outside the CCS DC line
  - MISO planning map shows priorities
- MISO grid planning and tariffs
  - Long wait for tariff agreement as well as line justification

Work to date indicates expected portfolio changes will cause significant grid and stability issues requiring increased transmission investment



- Issues are driven by reduction in conventional generation and the increase in inverter based (i.e. wind/solar/battery) generation
- Regional energy transfer increases in magnitude and becomes more variable leading to a need for increased extra high-voltage line thermal capabilities
- Increase in renewable penetration causes different dispatch patterns of conventional generators, leading to several dynamic issues
- Power delivery from weaker areas may need transmission technologies equipped with dynamic-support capabilities

What can North Dakota do?

- Enable current generation resources through business-friendly environment and fair policy
- Remember that wind capacity factor will keep wind development coming back whenever transmission is available
- Loss of other generation resources will likely never return in kind
- Continue to be open to opportunities to build transmission to the west as well