POWER FORECAST 2012

WILLISTON BASIN
OIL AND GAS RELATED
ELECTRICAL LOAD GROWTH FORECAST

NORTH DAKOTA SUMMARY

KLJ

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1. Williston Basin Oil and Gas Related Electrical Load Growth Forecast

The North Dakota Transmission Authority (NDTA), which facilitates the development of transmission infrastructure in North Dakota, requested KLJ, an employee-owned firm that delivers multi-disciplinary planning and engineering-based solutions, to develop the *Williston Basin Oil and Gas Related Electrical Load Growth Forecast* (PF 12) to assist in electrical infrastructure assessment and planning. The findings contained in the PF 12 report forecasts electrical load growth and demand related to oil and gas development in the Williston Basin and Bakken Formation (Figure 1) for the next 20 years (2012 to 2032). The study area spans three regions across North Dakota, South Dakota and Montana (Figure 2).

Information in the PF 12 report related specifically to the 22 key oil-producing counties in the western and north central regions of North Dakota indicates that over the next 20 years, electrical demand is expected to nearly triple. This estimated growth is primarily due to expansion of oil and gas related infrastructure, in addition to a correlating increase of workforce population in the oilfield services industry.

Figure 1: The Williston Basin and Bakken Formation
Source: KLJ

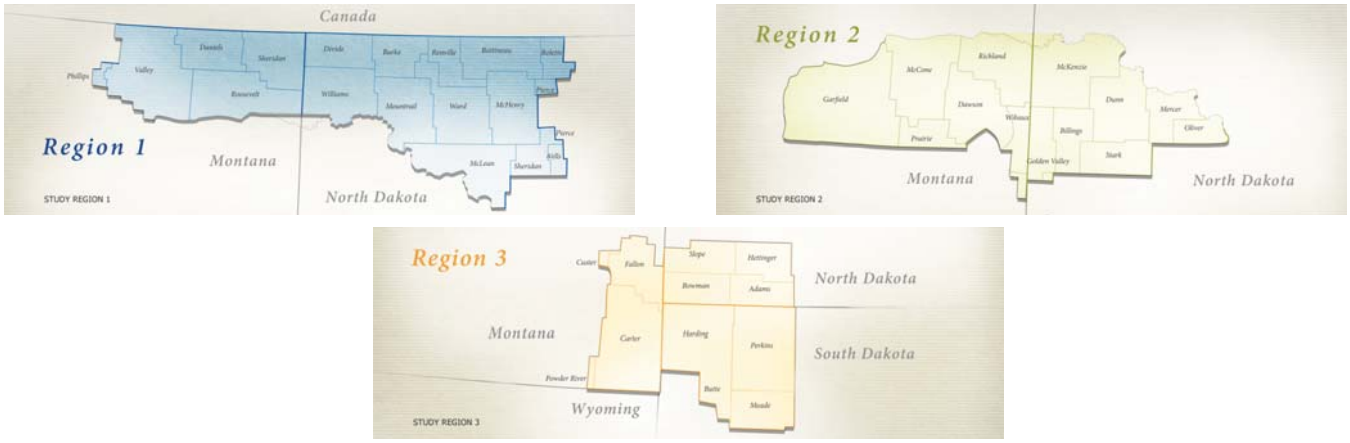

Figure 2: The Three Study Regions in PF 12
Source: North Dakota Transmission Authority

2. PF 12 Methodology

The methodology of developing the PF 12 report consists of a modeling process (Figure 3), which includes information relevant to development in the Williston Basin shale formations. Assumptions created from industry stakeholder interviews and research were validated through industry experts, government officials and the NDTA. Following validation, the process of electrical load growth modeling began through a GIS-based modeling process that factored key information from employment, population, housing, future infrastructure needs and existing electrical power loads.

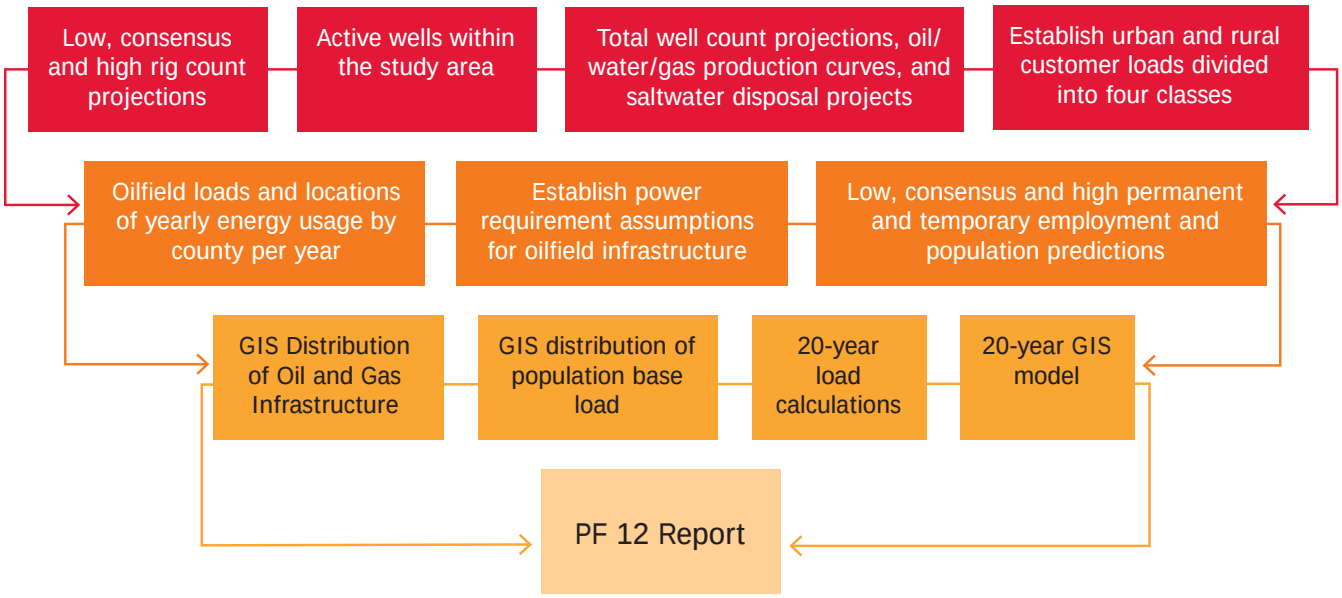

Figure 3: Modeling Process Methodology
Source: KLJ

2.1. Employment

The 20-year oilfield development projections were used to develop future employment estimates, which, in turn, established the PF 12 population growth metrics that outlined year-by-year housing demand. These factors are critical components of the PF 12 model and of extreme relevance to the North Dakota portion of the study area.

Total employment is divided into two categories: temporary workforce and permanent workforce. Temporary workforce is regarded as workers who are likely residents of other states, and will be employed at a single location until their specific job is complete and then move to a different job site. Permanent workforce is defined as employees who are established residents of North Dakota.

Results indicate temporary and permanent employment in North Dakota's petroleum-sector will continue to climb over the next 10 years until 2022, when development begins to decrease, resulting in a steady decline of temporary employment. As the industry pulls back on drilling and hydraulic fracturing activities and gathering system build-out, it removes temporary jobs. Further, well operations are expected to increase in efficiency, and require less onsite maintenance and service labor than current requirements.

2.2. Population growth

Population forecasts of the 22 western and north central North Dakota counties were calculated from the estimates of employment demand. These population forecasts indicate a 52 percent increase over the next 20 years for North Dakota. The sharpest increase of permanent population growth in the oil-producing counties is expected between 2012 and 2022, in response to increasing demand for oilfield services.

Temporary population in the 22 counties is forecasted to remain steady for the next 10 years, then decrease. The decline is due to the expectation that the temporary workforce will be leaving North Dakota as the majority of the oilfield infrastructure construction nears completion.

2.3. Housing demand

Petroleum-sector housing requirements in North Dakota has quickly outstripped supply, leaving many permanent and temporary workers either without housing or in housing that requires traveling a considerable distance to work sites. Population projections indicate that housing in the 22-county region will continue to remain just as constrained for nearly 10 more years, as new workers entering the area continue to exhaust the supply of existing homes and apartments.

The greatest demand for housing in North Dakota is temporary housing, where employment projections indicate substantial levels will be needed for nearly a decade. Figure 4 indicates that after a decade, temporary housing demand will decline, then level off, while permanent housing demand will continue on a gradual increase.

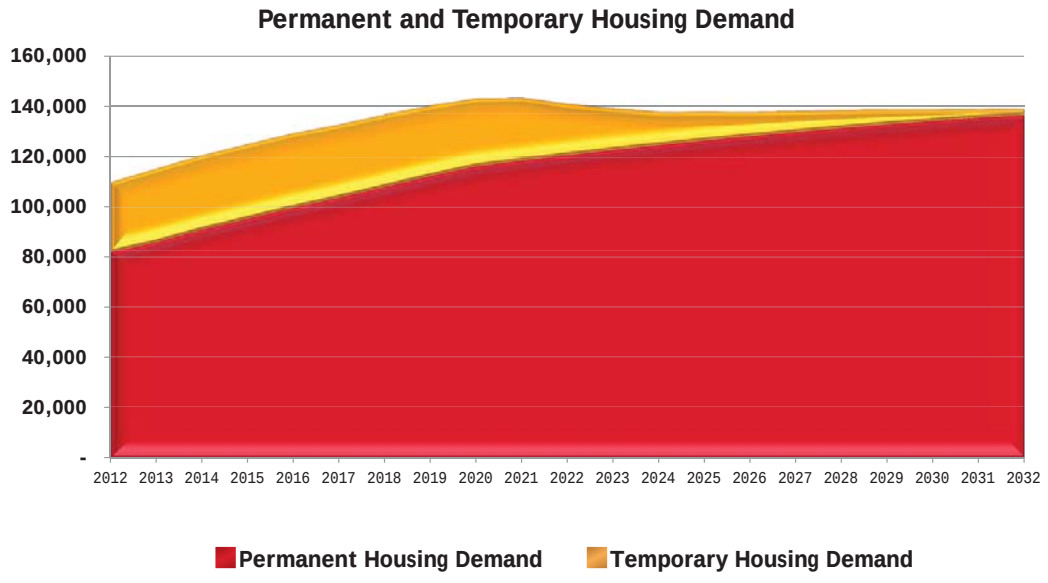

Figure 4: Permanent and Temporary Housing Demand
Source: North Dakota State University

3. PF 12 Results

With all factors combined into the model, electrical demand can be determined and modeled over a 20-year period. This information, when broken down by megawatt (MW) demand by county in North Dakota, serves as an extremely useful planning tool (Table 1).

North Dakota Forecasted Electric Load Demand					
	Demand (MW)				
County	2012	2017	2022	2027	2032
Williams	186	397	504	569	617
McKenzie	122	288	404	483	535
Mountrail	74	175	243	291	322
Ward	190	235	257	264	276
Dunn	39	121	190	239	270
Stark	85	141	187	213	235
Divide	31	94	149	187	212
Burke	22	59	86	106	118
Billings	22	57	84	103	115
McLean	25	39	52	61	66
Bottineau	40	49	51	51	52
Bowman	26	34	37	37	39
Mercer	22	24	25	26	27
Renville	17	26	26	26	27
Rolette	18	20	21	23	25
Golden Valley	8	14	19	22	24
McHenry	19	22	23	23	23
Hettinger	8	13	17	19	20
Slope	4	7	9	10	11
Adams	7	9	10	10	10
Oliver	5	5	5	5	5
Sheridan	1	1	1	1	1
TOTALS	**971**	**1,830**	**2,400**	**2,769**	**3,030**

Table 1: North Dakota Forecasted Electric Load Demand
Source: KLJ

Current 2012 estimated demand for the 22 North Dakota counties is 971 MW. This capacity needs to be available to power oil wells, homes and large and small businesses. By 2032, electrical demand for the same 22 counties is forecasted to reach 3,030 MW.

The number of wells alone significantly impacts the electrical demand. In addition, the infrastrucure associated with the wells, which includes compressor stations, saltwater disposal sites, booster pumps and well pads, each has its own power requirements. Each well pad also needs electricity for the transfer unit, the vapor recovery unit, transfer pumps, the separator, lighting, heating and instrumentation.

Although the number of wells continues to rise over the 20-year study period, the rise starts to decelerate after 2022. During the five-year period between 2022 to 2027, an additional 6,412 wells are expected to be added. This compares with the 9,687 new wells between 2012 and 2017 and 9,259 additional wells between 2017 and 2022. The decline continues during the five years between 2017 and 2032, with only 3,997 new wells added (Figure 5).

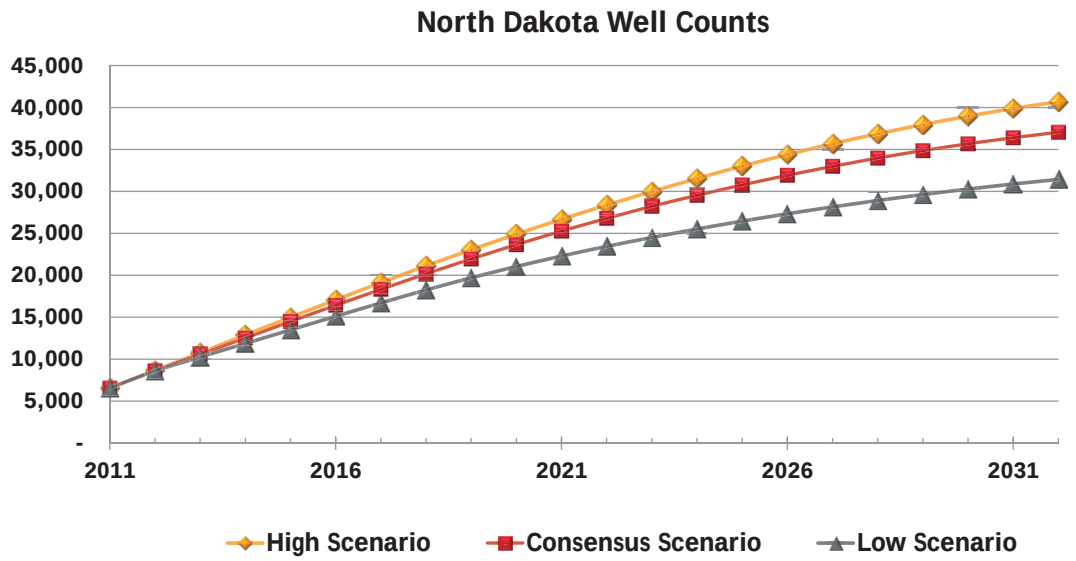

Figure 5: North Dakota Well Counts
Source: University of North Dakota

Rig efficiencies are expected to increase, eventually allowing newer rigs to drill 12 wells per year, by the end of the study period, versus the 10 wells per rig being drilled today. Rigs drilling on multi-well pads could drill as many as 16 holes per year, however, that will be rare. Rig efficiency will be limited by relocation time, maintenance, crew rotation and complexity.

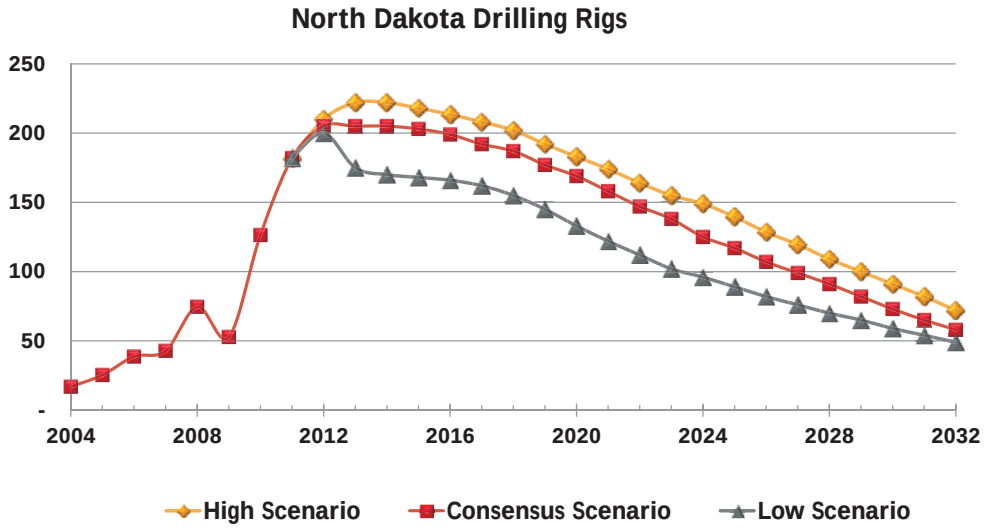

Figure 6: North Dakota Drilling Rigs
Source: University of North Dakota

An average of 175 oil rigs are located throughout the countryside of the 22 North Dakota counties in the study. McKenzie County currently has the most with 40 rigs, followed by Williams County with 30. After 2017, rig counts are forecasted to steadily decrease throughout the next 15 years (Figure 6).

Variability in the oil and gas industry will require an update to the PF 12 model every 12 to 18 months to capture changes to development information and power loads. As new factors are identified, this method will serve to validate longevity of the oil and gas related growth in North Dakota. Although there is not enough conclusive data to forecast the location, timing, or magnitude of any of these factors with any reasonable certainty, these factors can add significant power demand and need to be monitored. Significant factors anticipated for future PF 12 model updates include:

- **Enhanced oil recovery methods (EOR):** New recovery techniques, such as $C0_2$ injection, will become more commonplace and will add to the power demand load.
- **Gas processing facilities:** In addition to processing plants already planned or in construction that have been included in the forecast model, up to two additional large gas processing facilities are expected to be built between 2015 and 2019.
- **Production water treatment facilities:** If and when production water treatment facilities are developed, an appropriate demand load will be applied to the model.
- **Oil transmission pipelines:** There is an increasing possibility of up to two major oil transmission pipelines, with a capacity of at least 100,000 barrels of oil per day each being constructed between 2015 and 2017.

4. PF 12 Conclusions for North Dakota

Williams County can expect a 232 percent increase in electrical demand by 2032

Projected energy demand in North Dakota is depicted through the PF 12 model (Figure 7), highlighting where substantial demand requirements will be located. By the end of the study period in 2032, the entire 43 counties within the full study region will require an additional 2,512 MW of electrical demand, related to oil and gas development to accommodate population growth, new ancillary business development and more than 30,000 additional wells. North Dakota specifically will require 2,059 MW of additional electrical demand.

McKenzie County can expect a 339 percent increase in electrical demand by 2032

The PF 12 report validates and supports growth opportunities and significant investment needed by the state, as well as, public and private electric companies who often must substantiate investments to lenders and shareholders. The results of the PF 12 report confirm many opportunities, current and future, for the state of North Dakota. The favorable economy in North Dakota has the opportunity to continue and prosper further as the forecasted electrical demand will require significant investments in electrical generation, transmission and distribution infrastructure to support the regional growth brought on by the oil and gas development.

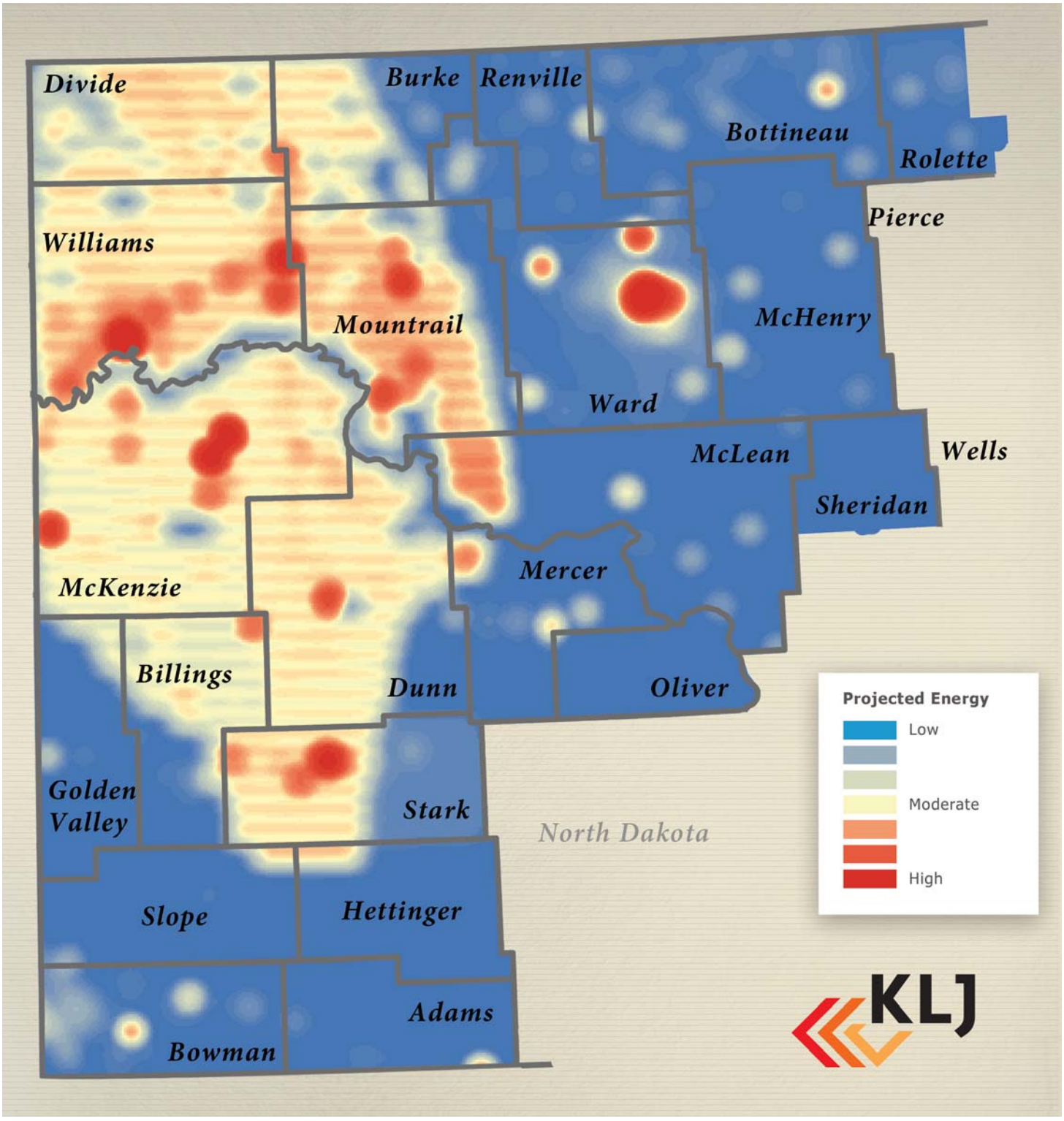

Figure 7: Electrical Load Forecast 2032 – Relative Energy
Source: KLJ

Acknowledgements

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Aux Sable

Denbury Resources, Inc.

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