



## NM &amp; SD BUSINESS LIGHTING SATURATION STUDY

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**RE:** Xcel Energy 2019 NM & SD Business Lighting Saturation Study – FINAL Results Memo

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## INTRODUCTION

This memo summarizes results of the 2019 Business Lighting Saturation Study conducted in New Mexico and South Dakota, by EMI Consulting and its partner, Mad Dash. The data collected for this study will help Xcel Energy understand the current saturation of lighting technologies among their business customers in these states, and it supplements data collected in 2018 in the states of Colorado and Minnesota. Altogether, the data collected in all four states will inform Xcel Energy's lighting forecast as it seeks to understand the remaining energy efficiency potential associated with non-residential lighting retrofits.

The remainder of this memo contains the following sections:

- Methods
- Results
- Conclusions

While the study methods largely remained the same as the 2018 study, the next section details methodology that is unique to the 2019 study.

## METHODS

This section includes a summary of methods used to complete the study, focusing on changes from the 2018 study.

For this study, 80 customer on-site visits were completed in New Mexico, and 30 on-site visits were completed in South Dakota. Recruiting took place from September through November 2019. Visits began in New Mexico in October and

## Memorandum NM &amp; SD BUSINESS LIGHTING SATURATION STUDY

were completed in November. In South Dakota, all visits took place in early December.

In general, the same types of data were collected in 2019 as in 2018, with a few minor changes:

- The 2019 study added:
  - data on lamp base size, fixture type, and whether the facility used an EMS (energy management system).
  - a requirement that all spaces observed have six illuminance measurements taken, rather than “up to 6” measurements as with the 2018 study.
- 2019 did not collect:
  - data measuring spillover for program participants.
  - data on reasons for partial retrofits among program participants.

Table 1 shows the number of completed on-sites for each facility type in New Mexico. The 80 completed on-sites included 3 lighting program participants. Actual completes were very similar to the targeted completes outlined in the sampling plan. There was one less site completed than planned for Ambulatory Health Care and Educational Services and one more site completed than planned for Food Services and Drinking Places and Real Estate. While the research team targeted four “large” customer sites in New Mexico (defined as having at least 400 kW peak demand), no large sites agreed to participate in the study. However, it is worth noting that among these facility types, less than 1% of the population is classified as large.

Table 1. Completes in New Mexico

Facility Type	Number of Sites	Participant Sites Included
Administrative and Support Services	10	0
Ambulatory Health Care	9	0
Educational Services	9	1
Food Services and Drinking Places	11	1
Merchant Wholesalers, Durable Goods	10	0
Professional, Scientific, and Technical Services	10	0
Real Estate	11	0
Religious, Grantmaking, Civic, Professional, and Similar Organizations	10	1
<b>Total</b>	<b>80</b>	<b>3</b>

Table 2 shows the number of completed on-sites for each facility type in South Dakota. Again, actual completes achieved in each category were very similar to the

## Memorandum NM &amp; SD BUSINESS LIGHTING SATURATION STUDY

number targeted in the sampling plan. There were two less sites completed than planned for Real Estate and one more site completed than planned for Ambulatory Health Care and Food Services and Drinking Places. Although we targeted up to two program participants in South Dakota, none were surveyed. Because Xcel Energy does not market programs differently based on customer size in South Dakota, there were no targets based on customer size. Similar to New Mexico, large customers are less than 1% of the population among the targeted facility types.

Table 2. Completes in South Dakota

Facility Type	Number of Sites	Participant Sites Included
Ambulatory Health Care	11	0
Food Services and Drinking Places	11	0
Real Estate	8	0
<b>Total</b>	<b>30</b>	<b>0</b>

In the next section, we provide detailed results of the data collected through the on-site visits.

## RESULTS

This section summarizes key results of the 2019 Xcel Energy Business Lighting Saturation Study conducted by EMI Consulting and its partner, MadDash. Results are presented in the following order:

- Lamp Saturation
- Lamps in Storage
- Lighting Controls Saturation
- Illuminance
- Lighting Forecast Inputs

### LAMP SATURATION

This section describes the lighting saturation results. Based on the data collected by on-site technicians, EMI Consulting computed lamp saturation as the percentage of each lamp type in a given facility type.

### LINEAR VS. NON-LINEAR LIGHTING

As shown in Table 3 (New Mexico) and Table 4 (South Dakota), all facility types except Food Services and Drinking Places had mostly linear lamps installed. In New Mexico, the Food Services and Drinking Places and Real Estate categories had the highest proportion of non-linear lamps installed, at 46% and 41%, respectively. This was similar to the 2018 results in Colorado and Minnesota.

## Memorandum NM &amp; SD BUSINESS LIGHTING SATURATION STUDY

Table 3. Linear &amp; Non-Linear Lighting, New Mexico

<b>Facility Type</b>	<b>% Linear Lamps</b>	<b>% Non-Linear Lamps</b>
Ambulatory Health Care	95%	5%
Educational Services	90%	10%
Merchant Wholesalers, Durable Goods	88%	12%
Professional, Scientific, and Technical Services	86%	14%
Religious, Grantmaking, Civic, Professional, and Similar Organizations	79%	21%
Administrative and Support Services	73%	27%
Real Estate	59%	41%
Food Services and Drinking Places	54%	46%

In South Dakota (Table 4), the Food Services and Drinking Places category had the highest proportion of non-linear lamps installed (65%), higher than the proportion observed in the facility type in the 2018 study (46%).

Table 4. Linear &amp; Non-Linear Lighting, South Dakota

<b>Facility Type</b>	<b>% Linear Lamps</b>	<b>% Non-Linear Lamps</b>
Ambulatory Health Care	68%	32%
Real Estate	67%	33%
Food Services and Drinking Places	35%	65%

Table 5 shows linear and non-linear lighting saturation combining all four states included in the 2018 and 2019 studies. Merchant Wholesalers had the highest linear lamp share with 91%. Similar to 2018, Food Services and Drinking Places and Real Estate had the highest proportions of non-linear lamps installed.

## Memorandum NM &amp; SD BUSINESS LIGHTING SATURATION STUDY

Table 5. Linear &amp; Non-Linear Lighting, NM, SD, CO &amp; MN Combined

Facility Type	% Linear Lamps	% Non-Linear Lamps
Merchant Wholesalers, Durable Goods	91%	8%
Educational Services	83%	17%
Ambulatory Health Care	74%	26%
Religious, Grantmaking, Civic, Professional, and Similar Organizations	73%	27%
Administrative and Support Services	67%	33%
Professional, Scientific, and Technical Services	64%	35%
Real Estate	52%	45%
Food Services and Drinking Places	50%	50%

Note: Values may not sum to 100% due to rounding.

## LINEAR LIGHTING

This sub-section shows saturation of linear lamps disaggregated into T12, T8, and T5 fluorescent lamps, as well as linear LEDs and fluorescent lamps for which size could not be identified by the on-site technicians.

Table 6 shows linear lighting saturation by facility type in New Mexico, sorted in descending order by proportion of Linear LEDs. Across facility types, T12 lamps were more common in New Mexico compared to South Dakota, Colorado, and Minnesota (where they ranged from 5% to 13%). T12s were particularly common among Professional, Scientific, and Technical Services and the Religious, Grantmaking, Civic, Professional, and Similar Organizations category. Meanwhile, the highest proportion of linear LEDs were observed in Educational Services (36%) and Food Services and Drinking Places (22%).<sup>1</sup> Linear LEDs were least common within the Administrative and Support Services and Merchant Wholesalers categories.

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<sup>1</sup> The high proportion of linear LEDs in the Education category was mostly driven by two sites that had a very high proportion of linear LEDs installed. For one site, 100% of their linear lamps were LED, while another site had 97% linear LEDs.

## Memorandum NM &amp; SD BUSINESS LIGHTING SATURATION STUDY

Table 6. Linear Lighting Saturation by Facility Type, New Mexico

Facility Type	% T12	% T8	% T5	% Linear LED	% Unknown Fluorescent
Educational Services	29%	26%		36%	10%
Food Services and Drinking Places	42%	36%		22%	
Professional, Scientific, and Technical Services	71%	16%		13%	
Real Estate	36%	37%		13%	14%
Ambulatory Health Care	37%	54%		9%	
Religious, Grantmaking, Civic, Professional, and Similar Organizations	53%	38%		9%	
Merchant Wholesalers, Durable Goods	36%	47%	10%	7%	<1%
Administrative and Support Services	37%	58%		5%	<1%

Given the high proportion of T12s observed in New Mexico, the research team examined particular sites with a high proportion of installed T12s to determine if these sites also had a high number of T12s in storage. Table 7 shows the proportion of stored T12s to installed T12s, among the 36 sites that had at least 50% of linear lamps that were T12s. Overall, seven sites had a surplus-to-active ratio for T12s that was 25% or greater (meaning of the T12s they had installed, there was an additional 25% or more in storage). About half of the facilities whose installed T12 saturation among linear lights was 100% had no T12 lamps in storage.

Memorandum NM & SD BUSINESS LIGHTING SATURATION STUDY

Table 7. T12 Lamps in Usage vs. In Storage, New Mexico (Individual Sites With At Least 50% T12s)

Facility Type	T12 Saturation of Linear Lighting %	T12 Lamps Active n	T12 Lamps in Storage n	Surplus to Active Ratio
Professional, Scientific, and Technical Services	100%	20	17	85%
Food Services and Drinking Places	100%	24	14	58%
Merchant Wholesalers, Durable Goods	100%	38	15	39%
Ambulatory Health Care Services	100%	28	7	25%
Real Estate	100%	54	12	22%
Ambulatory Health Care Services	100%	98	10	10%
Ambulatory Health Care Services	100%	156	14	9%
Religious, Grantmaking, Civic, Professional, and Similar Organizations	100%	80	7	9%
Food Services and Drinking Places	100%	148	10	7%
Educational Services	100%	162	10	6%
Professional, Scientific, and Technical Services	100%	72	1	1%
Professional, Scientific, and Technical Services	100%	172	0	0%
Educational Services	100%	148	0	0%
Religious, Grantmaking, Civic, Professional, and Similar Organizations	100%	120	0	0%
Administrative and Support Services	100%	113	0	0%
Merchant Wholesalers, Durable Goods	100%	92	0	0%
Merchant Wholesalers, Durable Goods	100%	74	0	0%
Real Estate	100%	30	0	0%
Food Services and Drinking Places	100%	24	0	0%
Real Estate	100%	8	0	0%
Professional, Scientific, and Technical Services	100%	2	0	0%
Professional, Scientific, and Technical Services	97%	126	0	0%
Educational Services	94%	67	0	0%
Ambulatory Health Care Services	94%	118	0	0%
Religious, Grantmaking, Civic, Professional, and Similar Organizations	94%	86	25	29%
Merchant Wholesalers, Durable Goods	88%	96	10	10%
Merchant Wholesalers, Durable Goods	88%	58	8	14%
Professional, Scientific, and Technical Services	86%	68	0	0%
Religious, Grantmaking, Civic, Professional, and Similar Organizations	78%	232	0	0%
Administrative and Support Services	73%	32	0	0%
Real Estate	68%	17	15	88%
Food Services and Drinking Places	67%	24	0	0%
Religious, Grantmaking, Civic, Professional, and Similar Organizations	64%	132	30	23%
Food Services and Drinking Places	61%	41	11	27%
Religious, Grantmaking, Civic, Professional, and Similar Organizations	56%	20	0	0%
Administrative and Support Services	51%	173	0	0%

Table 8 shows the breakdown of installed linear lighting observed in South Dakota, where T12s were less common than in New Mexico (where they ranged from 29%

## Memorandum NM &amp; SD BUSINESS LIGHTING SATURATION STUDY

to 71%). Linear LEDs in South Dakota were found in higher proportions at Real Estate facilities (31%) and Food Services and Drinking Places (29%), compared to 2018 study (12% and 1%, respectively). No linear LEDs were observed in the Ambulatory Health Care category.

Table 8. Linear Lighting Saturation by Facility Type, South Dakota

Facility Type	% T12*	% T8	% T5	% Linear LED	% Unknown Fluorescent
Real Estate	9%	60%		31%	<1%
Food Services and Drinking Places	10%	55%		29%	7%
Ambulatory Health Care		83%	14%		4%

Table 9 shows T12 saturation for all four states included in the 2018 and 2019 studies, illustrating the high proportion of T12s in New Mexico.

Table 9. T12 Saturation, NM, SD, CO and MN

Facility Type	% of Linear Lamps (T12)			
	NM	SD	CO (2018)	MN (2018)
Educational Services	29%		22%	1%
Professional, Scientific, and Technical Services	71%		21%	2%
Ambulatory Health Care	37%	0%	20%	3%
Food Services and Drinking Places	42%	10%	18%	8%
Real Estate	36%	9%	16%	0%
Merchant Wholesalers, Durable Goods	36%		12%	4%
Administrative and Support Services	37%		5%	9%
Religious, Grantmaking, Civic, Professional, and Similar Organizations	53%		2%	11%

## NON-LINEAR LIGHTING

Table 10 shows non-linear lighting by facility type in New Mexico, sorted in descending order by proportion of LEDs. The facility types that most commonly had LEDs installed in non-linear sockets included Administrative and Support Services and Merchant Wholesalers; both categories had higher saturation compared to the Colorado and Minnesota 2018 study where saturation was 38% and 32%, respectively. The greatest areas of opportunity appear to be in the Real Estate category, where CFLs were 58% on non-linear lamps, Professional, Scientific, and



## Memorandum NM &amp; SD BUSINESS LIGHTING SATURATION STUDY

Technical Services (69% Halogen/Incandescent), and Ambulatory Health Care (64% Halogen/Incandescent). All three of these facility types had lower proportions of installed non-linear LEDs compared to the Colorado and Minnesota 2018 study.

Table 10. Non-Linear Lighting by Facility Type, New Mexico

Facility Type	% CFL	% Halogen / Incandescent	% HID	% Non-Linear LED
Administrative and Support Services	1%	10%		88%
Merchant Wholesalers, Durable Goods	22%	9%	9%	60%
Food Services and Drinking Places	25%	17%		57%
Religious, Grantmaking, Civic, Professional, and Similar Organizations	16%	27%	5%	52%
Educational Services	18%	30%		52%
Professional, Scientific, and Technical Services	14%	69%		17%
Real Estate	58%	39%		3%
Ambulatory Health Care	34%	64%		2%

Table 11 shows that the Real Estate category in South Dakota had a relatively high proportion of HID lamps installed (29%), which was higher than any of the facility types in New Mexico.<sup>2</sup> Both the Ambulatory Health Care (44%) and Real Estate (36%) categories in South Dakota had a greater proportion of non-linear LEDs installed compared to installations in New Mexico (2% and 3%, respectively). Both Food Services and Drinking Places (33%), and Ambulatory Health Care (24%), had a higher proportion of halogen/incandescent lamps installed compared to the Minnesota and Colorado 2018 study, which found 11% among Food Services and Drinking Places and 9% among Ambulatory Health Care facilities. In contrast, in 2018, Food Services and Drinking Places in Minnesota (66%) and Colorado (76%) had a higher non-linear LED share compared to South Dakota. The Real Estate category in South Dakota had a higher share of HID than all the facilities in the 2018 Minnesota and Colorado study.<sup>3</sup>

<sup>2</sup> All of the HID lamps installed were in high bay fixtures.

<sup>3</sup> Except for the Fabricated Metal Product Manufacturing category in Colorado (87%); however, this category was not included in the 2019 study.

## Memorandum NM &amp; SD BUSINESS LIGHTING SATURATION STUDY

Table 11. Non-Linear Lighting by Facility Type, South Dakota

Facility Type	% CFL	% Halogen / Incandescent	% HID	% Non-Linear LED
Food Services and Drinking Places	15%	33%		52%
Ambulatory Health Care	32%	24%		44%
Real Estate	33%	3%	29%	36%

**ALL LAMPS**

Saturation results across all lamp types are shown for New Mexico in Table 12. Results are sorted in descending order by proportion of fluorescent tubes installed. Across facility types, fluorescent tubes were the most commonly observed type of lamp in all facilities and represented at least half of all lamps observed for all but the Food Services and Drinking Places category. Including both linear and non-linear LEDs, the Real Estate and Ambulatory Health Care categories had the lowest saturation of LEDs. Linear LEDs were most commonly installed at Educational Services sites (32%), while non-linear LEDs were most common among Food Services and Drinking Places (27%).<sup>4</sup> CFLs were most common among Real Estate customers, where they represented nearly one-quarter of all installed lamps. Real Estate also had the highest proportion of installed halogen/incandescent lamps (16%).

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<sup>4</sup> The high proportion of linear LEDs in the Education category was mostly driven by two sites that had a very high proportion of linear LEDs installed. For one site, 100% of their linear lamps were LED, while another site had 97% linear LEDs.

## Memorandum NM &amp; SD BUSINESS LIGHTING SATURATION STUDY

Table 12. Lamp Saturation by Facility Type, New Mexico

Facility Type	% CFL	% Fluorescent Tube	% Halogen/ Incandescent	% HID	% Linear LED	% Non-Linear LED
Ambulatory Health Care	2%	86%	3%		9%	<1%
Merchant Wholesalers, Durable Goods	3%	82%	1%	1%	6%	7%
Professional, Scientific, and Technical Services	2%	75%	10%		11%	2%
Religious, Grantmaking, Civic, Professional, and Similar Organizations	3%	72%	6%	1%	7%	11%
Administrative and Support Services	<1%	70%	3%		3%	24%
Educational Services	2%	58%	3%		32%	5%
Real Estate	24%	52%	16%		8%	1%
Food Services and Drinking Places	12%	42%	8%		12%	27%

As shown in Table 13, Food Services and Drinking Places had the highest proportion of LEDs installed in South Dakota, with fewer fluorescent tubes (25%) and more halogen/incandescent lamps (21%) compared to the 2018 study, when these values were 53% and 5%, respectively. Ambulatory Health Care had the highest percentage of fluorescent tubes, and no linear LEDs.

## Memorandum NM &amp; SD BUSINESS LIGHTING SATURATION STUDY

Table 13. Lamp Saturation by Facility Type, South Dakota

Facility Type	% CFL	% Fluorescent Tube	% Halogen/ Incandescent	% HID	% Linear LED	% Non-Linear LED
Ambulatory Health Care	10%	68%	8%			14%
Real Estate	11%	48%	<1%	10%	19%	12%
Food Services and Drinking Places	10%	25%	21%		10%	34%

**FIXTURE TYPES**

Table 14 shows fixture types observed in New Mexico, sorted in descending order by proportion of linear tubes. Linear tubes and troffers were the two most common fixture types in most of the facility type categories. Recessed downlights were relatively common at Real Estate sites, while task lighting was relatively common at Administrative and Support Services facilities and Food Services and Drinking Places.

PUBLIC  
Memorandum NM & SD BUSINESS LIGHTING SATURATION STUDY

Table 14. Proportion of Lamps Installed by Fixture Type, New Mexico

Facility Type	Proportion of Lamps Installed by Fixture Type									
	Decorative Lighting	Exit Sign	Exterior Lighting	High Bay Lighting	Linear Tubes (Not Troffers)	Other	Recessed Downlights	Task Lighting	Troffers	Unknown
Professional, Scientific, and Technical Services	1%				47%			14%	37%	<1%
Real Estate					41%	6%	24%	19%	10%	<1%
Merchant Wholesalers, Durable Goods	3%		<1%		30%			9%	57%	
Ambulatory Health Care Services	<1%			5%	21%			4%	69%	1%
Administrative and Support Services			<1%		20%			27%	53%	
Religious, Grantmaking, Civic, Professional, and Similar Organizations	1%	<1%		<1%	17%	<1%	3%	18%	58%	<1%
Food Services and Drinking Places	3%		<1%		7%	2%	6%	35%	44%	2%
Educational Services	<1%				6%	<1%	<1%	7%	84%	1%

Table 15 shows the fixture types observed in South Dakota. Linear tubes were the most common across all three facility types. Decorative lighting, recessed downlights, and troffers were also relatively common.

Memorandum NM & SD BUSINESS LIGHTING SATURATION STUDY

Table 15. Proportion of Lamps Installed by Fixture Type, South Dakota

Facility Type	Proportion of Lamps Installed by Fixture Type									
	Decorative Lighting	High Bay Lighting	Linear Tubes (Not Troffers)	Other	Recessed Downlights	Refrigeration Case Lighting	Stairwell/Passageway Lighting	Task Lighting	Troffers	Unknown
Real Estate	18%	9%	61%	4%	4%		2%			<1%
Ambulatory Health Care Services	5%		54%	2%	18%	<1%		7%	14%	<1%
Food Services and Drinking Places	26%		22%	12%	20%	<1%		5%	14%	1%

## Memorandum NM &amp; SD BUSINESS LIGHTING SATURATION STUDY

## STORED LAMPS

This section describes lamps found in storage in New Mexico, followed by lamps found in storage in South Dakota.

## STORED LAMPS IN NEW MEXICO

Across the 80 sites visited in New Mexico, 56% of sites had at least one lamp in storage (i.e., not installed), with a total of 1,390 lamps in storage. Table 16 shows that most lamps in storage were fluorescent tubes, and 46% of sites had at least one fluorescent tube in storage, with an average of 25 tubes in storage. There were fewer CFLs in storage (5%) compared to the 2018 study in Colorado and Minnesota (13%).

Table 16. Lamps in Storage, New Mexico

Lamp Type	Number of Lamps	% of Lamps	<i>n</i> Sites	% Sites	<i>M</i> Number of Lamps
Fluorescent Tube	915	66%	37	46%	24.7
Non-Linear LED	196	14%	15	19%	13.1
Halogen / Incandescent	153	11%	11	14%	13.9
CFL	74	5%	6	8%	12.3
Linear LED	50	4%	3	4%	16.7
HID	2	<1%	1	1%	2.0

In addition to assessing the overall number of lamps in storage, we examined stored lamps relative to installed lamps at each site. Table 17 shows the number of sites in New Mexico where each type of lamp was installed, the mean number of installed lamps, mean number of stored lamps, and the stored-to-installed lamp ratio. Halogen/incandescent lamps and non-linear LEDs (both screw-in bulbs) had the highest stored-to-installed ratios, whereas linear LEDs had the lowest stored-to-installed ratio.

## Memorandum NM &amp; SD BUSINESS LIGHTING SATURATION STUDY

Table 17. Ratio of Lamps in Storage to Installed Lamps, New Mexico

Stored Lamp Type	<i>n</i> Sites Installed	<i>M</i> Number of Installed Lamps	<i>M</i> Number of Stored Lamps	Stored to Installed Ratio
Halogen / Incandescent	49	10.9	2.9	27%
Non-Linear LED	34	30.6	5.2	17%
Fluorescent Tube	71	93.4	12.5	13%
CFL	30	15.4	1.2	8%
HID	2	16.0	1.0	6%
Linear LED	21	54.0	2.4	4%

## STORED LAMPS IN SOUTH DAKOTA

Across the 30 sites visited in South Dakota, 60% of sites had at least one lamp in storage (i.e., not installed), with a total of 573 lamps in storage. As in New Mexico, Table 18 shows that most lamps in storage in South Dakota were fluorescent tubes. Also similar to New Mexico, 47% of sites in South Dakota had fluorescent tubes in storage, with an average of 24 tubes in storage. There were more non-linear LEDs (26%) in storage compared to the 2018 study in Colorado and Minnesota (9%). And there were fewer CFLs in storage (6%) compared to the 2018 study (13%). Linear LEDs and HID lamps were not observed in storage in South Dakota.

Table 18. Lamps in Storage, South Dakota

Lamp Type	Number of Lamps	% of Lamps	<i>n</i> Sites	% Sites	<i>M</i> Number of Lamps
Fluorescent Tube	341	60%	14	47%	24.4
Non-Linear LED	151	26%	9	30%	16.8
Halogen / Incandescent	47	8%	6	20%	7.8
CFL	34	6%	3	10%	11.3
Linear LED					
HID					

Table 19 shows the number of sites in South Dakota where each type of lamp was installed, the mean number of installed lamps, mean number of stored lamps, and the stored-to-installed lamp ratio. Fluorescent tubes and non-linear LEDs had the highest stored-to-installed ratio. There were no HID lamps or linear LEDs in storage.



## Memorandum NM &amp; SD BUSINESS LIGHTING SATURATION STUDY

Table 19. Ratio of Lamps in Storage to Installed Lamps, South Dakota

Stored Lamp Type	<i>n</i> Sites Installed	<i>M</i> Number of Installed Lamps	<i>M</i> Number of Stored Lamps	Stored to Installed Ratio
Fluorescent Tube	27	49.8	12.6	25%
Non-Linear LED	22	26.7	6.6	25%
CFL	20	13.8	1.7	12%
Halogen / Incandescent	13	23.7	2.2	9%
HID	1	40.0	0.0	0%
Linear LED	2	89.0	0.0	0%

## LIGHTING CONTROLS SATURATION

This section displays results related to saturation of lighting controls. Results are first shown by facility type, then by space use.

## LIGHTING CONTROLS BY FACILITY TYPE

Table 20 and Table 21 show the distribution of lighting controls for each of the targeted facility types, in New Mexico and South Dakota, respectively. The proportions shown indicate the percentage of lamps controlled. The tables are sorted in descending order of Manual On/Off switches. Note that "Always On" does not necessarily indicate that lamps were on 24 hours a day; this designation was used when the on-site technician was unable to locate a control, and this could indicate the lamp is controlled via EMS or by turning off the breaker. We interpret the "Always On" designation to mean always on during business hours.

Across facility types and across states, the most common type of lighting control was a manual on/off switch, indicating a great deal of opportunity for increasing the uptake of efficient lighting controls. In New Mexico, Merchant Wholesalers (6%), and Educational Services (9%) had a small proportion of lamps controlled by occupancy sensors. All other efficient controls represented less than 5% of lamps controlled.

## Memorandum NM &amp; SD BUSINESS LIGHTING SATURATION STUDY

Table 20. Lighting Controls by Facility Type (Lamps Controlled), New Mexico

Facility Type	% Always On	% Manual On/Off	% Manual Dimmer	% Timer	% Occupancy Sensor	% Photocell	% Other
Administrative and Support Services		100%					
Ambulatory Health Care Services		100%					
Religious, Grantmaking, Civic, Professional, and Similar Organizations	<1	99%	<1				<1
Professional, Scientific, and Technical Services	2%	98%					
Real Estate		98%					2%
Food Services and Drinking Places		95%	4%				<1
Merchant Wholesalers, Durable Goods		90%			9%	<1	1%
Educational Services		88%	3%		6%		3%

In South Dakota, manual dimmers were relatively frequent among Food Services and Drinking Places. As in New Mexico, there appears to be a great deal of opportunity for increasing the uptake of efficient lighting controls, with most lamps controlled by manual on/off switches.

Table 21. Lighting Controls by Facility Type (Lamps Controlled), South Dakota

Facility Type	% Always On	% Manual On/Off	% Manual Dimmer	% Timer	% Occupancy Sensor	% Photocell	% Other
Ambulatory Health Care		98%	1%				<1%
Real Estate	24%	74%			2%		
Food Services and Drinking Places		73%	26%		<1%		

## LIGHTING CONTROLS BY SPACE USE

In addition to assessing the proportion of lighting controls in each target facility type, EMI Consulting also computed the proportion of lighting controls found in each space type across facility types. As shown in Table 22, several space types have a great deal of opportunity for efficient lighting controls in New Mexico; in particular, lobbies, inactive storage spaces, and restrooms may be good targets as they were found at a variety of facility types (see Attachment, "Spaces Sampled by Facility Type"). Efficient controls were less common across a variety of space types

## Memorandum NM &amp; SD BUSINESS LIGHTING SATURATION STUDY

in New Mexico, compared to the 2018 Minnesota and Colorado study. Most of the facilities in Minnesota and Colorado had some proportion of efficient lighting controls (most commonly occupancy sensors), and very few had 100% manual on/off switches.

Table 22. Lighting Controls by Space Use (Lamps Controlled), New Mexico

Space Type	% Always On	% Manual On/Off	% Manual Dimmer	% Timer	% Occupancy Sensor	% Photocell	% Other
Bar (n = 3)		100%					
Dressing or Locker Room (n = 5)		100%					
General Dining (n = 45)		100%					
Laundry (n = 2)		100%					
Living Space (n = 17)		100%					
Lobby (n = 65)	<1%	100%					
Medical (n = 12)		100%					
Refrigerated Storage (n = 5)		100%					
Retail Sales Floor (n = 32)		100%					
Server Room (n = 3)		100%					
Stairs (n = 1)		100%					
Storage - Inactive (n = 78)	4%	96%					
Workshop / Production Facility (n = 24)		100%					
Lounge or Recreation (n = 31)		99%					1%
Office (n = 185)		99%					1%
Restroom (n = 106)		99%					1%
Corridor (n = 54)		99%	2%				
Classroom (n = 47)		97%	<1%				3%
Chapel (n = 17)	3%	93%	5%				
Other (n = 9)		95%					5%
Food Preparation (n = 53)		91%	9%				
Conference (n = 30)		89%	11%				
Gymnasium (n = 9)		82%			18%		
Storage - Active (n = 24)		81%			20%		
Exterior (not Parking) (n = 4)		10%				30%	60%

Note: the following space types were coded from open-ended "Other" space types: Bar, Chapel, Laundry, and Medical.

Table 23 shows that manual on/off switches were by far the most common type of control across space types in South Dakota, although efficient lighting controls were generally more common in South Dakota compared to New Mexico. In South Dakota, two space types (bars and laundry spaces) had manual on/off switches controlling less than 50% of lamps. The greatest opportunity for efficient lighting

## Memorandum NM &amp; SD BUSINESS LIGHTING SATURATION STUDY

controls in South Dakota may be inactive storage spaces and corridors as they were found across all three facility types (see Attachment, "Spaces Sampled by Facility Type"). As with New Mexico, South Dakota had fewer efficient controls across a variety of space types compared to the 2018 Minnesota and Colorado study. In particular, occupancy sensors were much more common in the 2018 study.

Table 23. Lighting Controls by Space Use (Lamps Controlled), South Dakota

Space Type	% Always On	% Manual On/Off	% Manual Dimmer	% Timer	% Occupancy Sensor	% Photocell	% Other
Food Preparation (n = 17)		100%					
Other (n = 16)		100%					
Storage - Inactive (n = 16)		100%					
Workshop / Production Facility (n = 5)		100%					
Conference (n = 1)		100%					
Gymnasium (n = 1)		100%					
Storage - Active (n = 1)		100%					
Mechanical Room (n = 19)	2%	98%					
Atrium (n = 5)	11%	89%					
Corridor (n = 31)	8%	91%	1%				
Stairs (n = 14)	81%	18%			1%		
Medical (n = 40)		98%	2%				
Lobby (n = 39)		96%					4%
Office (n = 27)		94%	6%				
Restroom (n = 31)		93%			7%		
Retail Sales Floor (n = 11)		73%	27%				
General Dining (n = 30)		68%	32%				
Lounge or Recreation (n = 5)		61%	39%				
Bar (n = 8)		47%	54%				
Laundry (n = 3)		25%			75%		

Note: the following space types were coded from open-ended "Other" space types: Bar, Chapel, and Medical.

## ILLUMINANCE

Six illuminance measurements were collected for each space inventoried. Results are displayed first by facility and then by space type.

## Memorandum NM &amp; SD BUSINESS LIGHTING SATURATION STUDY

**ILLUMINANCE BY FACILITY TYPE**

Table 24 and Table 25 show the average and median site illuminances in foot candles for each of the 10 target facility types in New Mexico and South Dakota respectively. Results are shown in descending order by average illuminance.

In New Mexico, Professional, Scientific, and Technical Services showed the highest average illuminance (51.87 fc), followed by Religious, Grantmaking, Civic, Professional, and Similar Organizations (44.46 fc). In these cases, energy efficiency could be achieved by removing lamps, while still maintaining adequate light levels. Both of these facility types had higher illuminance compared to the 2018 study in Colorado and Minnesota. Categories where the average is significantly higher than the median suggest that some sites are outliers with very high illuminance measurements, which means some facilities in these categories may be over-lit.

Table 24. Illuminance by Facility Type, New Mexico

<b>Facility Type</b>	<b>Average Site Illuminance (fc)</b>	<b>Median Site Illuminance (fc)</b>
Professional, Scientific, and Technical Services	51.87	34.62
Religious, Grantmaking, Civic, Professional, and Similar Organizations	44.46	32.00
Educational Services	40.17	38.35
Ambulatory Health Care Services	34.72	37.40
Merchant Wholesalers, Durable Goods	34.40	32.36
Food Services and Drinking Places	32.32	26.08
Administrative and Support Services	29.68	28.62
Real Estate	27.16	29.17

In South Dakota, both Real Estate and Food Services and Drinking Places had lower illuminance compared to these facility types in the 2018 study in Colorado and New Mexico.

Table 25. Illuminance by Facility Type, South Dakota

<b>Facility Type</b>	<b>Average Site Illuminance (fc)</b>	<b>Median Site Illuminance (fc)</b>
Ambulatory Health Care Services	34.50	31.87
Real Estate	19.00	13.10
Food Services and Drinking Places	14.22	15.38

## Memorandum NM &amp; SD BUSINESS LIGHTING SATURATION STUDY

**ILLUMINANCE BY SPACE TYPE**

In addition to analyzing illuminance by facility type, EMI Consulting also conducted analysis on the illuminance measurements at the space type level. We present results first for New Mexico, followed by South Dakota.

**ILLUMINANCE BY SPACE TYPE IN NEW MEXICO**

Table 26 displays average and median illuminance levels (in foot candles, fc) and the number of spaces for space types observed across facility types in New Mexico. IES (Illuminating Engineering Society) publishes recommended light levels by space, and the table shows the recommended lighting levels for spaces included in the IES Guidelines. EMI Consulting compared the average illuminance observed to the IES guidelines in order to determine if any spaces appear to be over or under the range of average recommended values.

In New Mexico, several space types appear to be consistently above the recommended range of average illuminance values, including classrooms, conference rooms, and restrooms.

## Memorandum NM &amp; SD BUSINESS LIGHTING SATURATION STUDY

Table 26. Illuminance by Space Type, New Mexico

Space Type	<i>n</i> Spaces	Average Space Illuminance (fc)	Median Space Illuminance (fc)	IES Guidelines (fc)
Laundry	2	58.07	34.68	
Retail Sales Floor	17	51.75	35.23	40-50
<b>Classroom</b>	<b>36</b>	<b>47.37</b>	<b>29.17</b>	<b>15-25</b>
Living Space	8	46.69	29.10	
Medical	11	46.12	32.72	
Food Preparation	34	44.19	30.50	
Workshop / Production Facility	17	43.57	35.58	
<b>Conference</b>	<b>22</b>	<b>42.65</b>	<b>45.87</b>	<b>30</b>
Server Room	3	41.31	43.00	
Office	166	39.36	38.12	40
Lounge or Recreation	24	38.68	29.33	
Lobby	41	34.96	30.25	
General Dining	23	33.81	26.33	
Dressing or Locker Room	5	30.67	35.67	
Storage - Inactive	68	28.96	25.67	
Refrigerated Storage	4	28.79	30.68	
<b>Restroom</b>	<b>91</b>	<b>25.70</b>	<b>19.65</b>	<b>5-15</b>
Corridor	41	23.90	19.74	
Gymnasium	8	23.02	20.67	30-100
Storage - Active	14	22.93	18.55	10-30
Other	8	21.12	21.56	
Stairs	1	19.33	19.33	5
Chapel	7	16.50	13.33	
Bar	1	6.17	6.17	4-50

Note. While six exterior spaces were included in the sample, illuminance was not measured in exterior spaces.

The team also examined the proportion of square footage by space type with “above average” illuminance per IES guidelines. Table 27 shows, for New Mexico, the proportion of square footage with above average illuminance for spaces with IES guidelines. The spaces containing the greatest proportion of “above average” square footage were: stairs (100%, although there was only one of these spaces sampled), conference rooms (79%), classrooms (74%), and restrooms (61%).

## Memorandum NM &amp; SD BUSINESS LIGHTING SATURATION STUDY

Table 27. Proportion of Square Footage with Above-Average Illuminance, by Space Type, New Mexico

Space Type	<i>n</i> Spaces	Average Space Illuminance (fc)	Median Illuminance (fc)	IES Guidelines (fc)	% of Square Footage Above IES Guideline Value
Stairs	1	19.33	19.33	5	100%
Conference	19	39.72	46.67	30	79%
Classroom	31	37.12	30.50	15-25	74%
Restroom	85	27.12	19.50	5-15	61%
Office	155	37.23	37.50	40	48%
Storage - Active	14	21.59	20.53	10-30	36%
Retail Sales Floor	17	63.34	31.83	40-50	35%
Gymnasium	8	21.78	21.67	30-100	0%

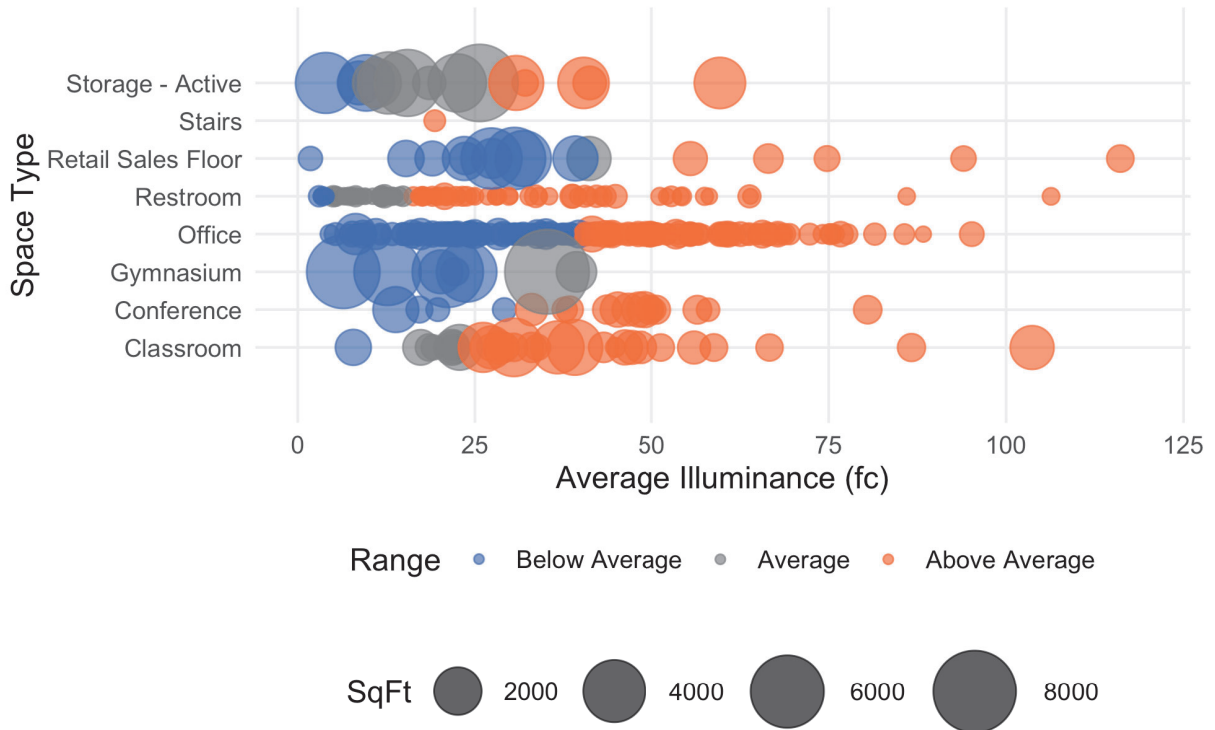
The ranges of illuminance values for individual spaces by space type are shown graphically in Figure 1 for New Mexico. In this figure, each dot represents an individual space, with larger dots representing spaces with greater square footage. Blue dots show spaces that are lit below IES guidelines; grey dots show spaces that are equal to the guidelines; and orange dots show spaces that are above the guidelines.

In New Mexico, restrooms, offices, conference rooms, and classrooms include spaces with a wide range of illuminance values that are much higher than the upper bound of average values included in the IES guidelines. One outlying illuminance observation (a retail sales floor with an average of 382 fc) was removed from the figure to make the figure more readable.



Memorandum NM & SD BUSINESS LIGHTING SATURATION STUDY

Figure 1. Range of Illuminance for Individual Spaces, New Mexico



Note: "Storage-Active" denotes active storage rooms with installed lamps.

ILLUMINANCE BY SPACE TYPE IN SOUTH DAKOTA

Table 28 displays average and median illuminance levels (in foot candles, fc) and the number of spaces for space types observed across facility types in South Dakota. EMI Consulting compared the average illuminance observed to the IES guidelines in order to determine if any spaces appear to be over or under the range of average recommended values.

In South Dakota, for most of the spaces with IES guidelines present, average space illuminance was either within the range or slightly above the IES guidelines. Restrooms and stairs were the two space types where more than one space was sampled that had average space illuminance above IES guidelines.

## Memorandum NM &amp; SD BUSINESS LIGHTING SATURATION STUDY

Table 28. Illuminance by Space Type, South Dakota

Space Type	<i>n</i> Spaces	Average Space Illuminance (fc)	Median Space Illuminance (fc)	IES Guidelines (fc)
Atrium	4	137.50	72.50	
Gymnasium	1	105.67	105.67	30-100
Workshop / Production Facility	2	51.25	43.67	
Medical	31	44.91	33.64	
Food Preparation	10	43.40	43.25	
Office	23	38.25	32.00	40-50
Conference	1	35.17	35.17	30
Lobby	25	26.82	29.64	
Lounge or Recreation	5	25.43	12.67	
General Dining	16	23.03	14.00	
Corridor	27	21.71	24.08	
<b>Restroom</b>	<b>27</b>	<b>21.60</b>	<b>20.00</b>	<b>5-15</b>
Laundry	3	20.71	20.60	
Other	13	14.71	14.08	
<b>Stairs</b>	<b>9</b>	<b>12.99</b>	<b>9.79</b>	<b>5</b>
Storage - Active	1	12.83	12.83	10-30
Storage - Inactive	11	12.49	6.17	
Mechanical Room	18	10.52	7.17	
Retail Sales Floor	4	8.05	8.50	40-50
Chapel	5	6.40	6.00	

The team also examined the proportion of square footage by space type with “above average” illuminance per IES guidelines. Table 29 shows the proportion of square footage in South Dakota with above average illuminance for spaces with IES guidelines.

In South Dakota, the spaces containing the greatest proportion of “above average” square footage were stairs (88%) and restrooms (65%). Only one conference room and gymnasium were measured; therefore, no conclusions can be drawn for these two space types.

## Memorandum NM &amp; SD BUSINESS LIGHTING SATURATION STUDY

Table 29. Proportion of Square Footage with Above-Average Illuminance, by Space Type, South Dakota

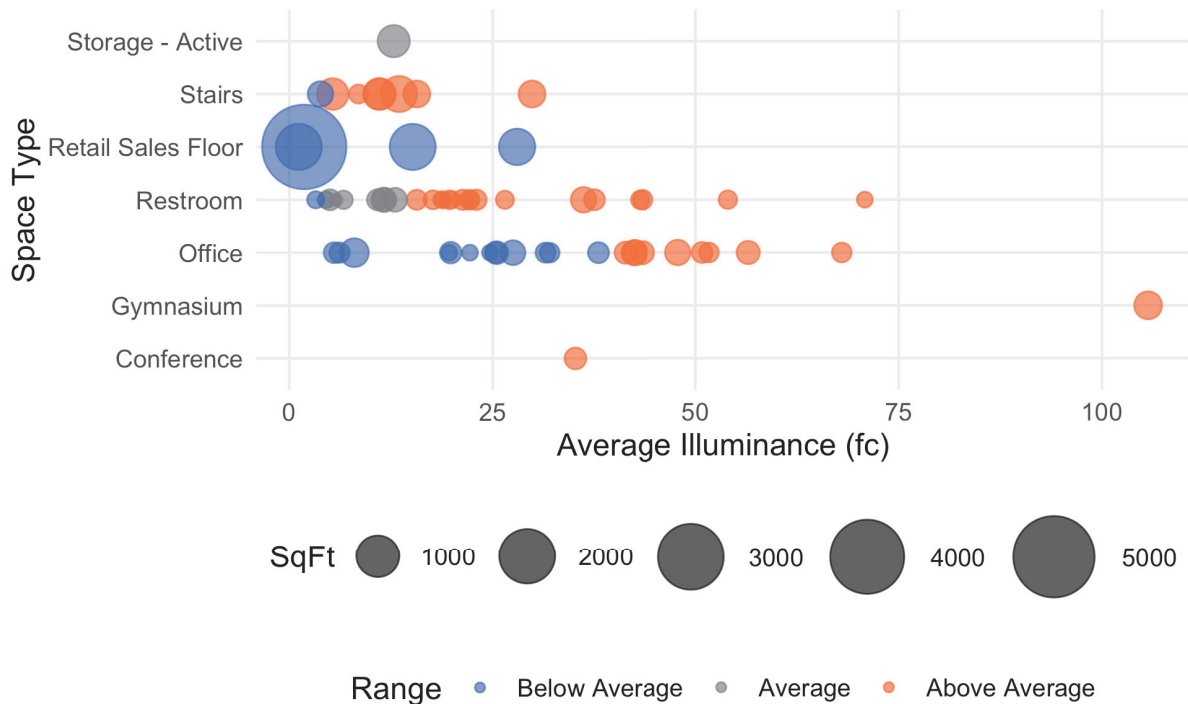
Space Type	<i>n</i> Spaces	Average Space Illuminance (fc)	Median Illuminance (fc)	IES Guidelines (fc)	% of Square Footage Above IES Guideline Value
Conference	1	35.17	35.17	30	100%
Gymnasium	1	105.67	105.67	30-100	100%
Stairs	8	12.31	11.08	5	88%
Restroom	26	21.88	19.25	5-15	65%
Office	22	33.27	31.75	40	41%
Retail Sales Floor	4	5.54	8.50	40-50	0%
Storage - Active	1	12.83	12.83	10-30	0%

The ranges of illuminance values for individual spaces by space type are shown graphically in Figure 2 for South Dakota. In this figure, each dot represents an individual space, with larger dots representing spaces with greater square footage. Blue dots show spaces that are lit below IES guidelines; grey dots show spaces that are equal to the guidelines; and orange dots show spaces that are above the guidelines.

In South Dakota, Stairs, Restrooms, and Offices had a wide range of illuminance values that are higher than the upper bound of average values included in the IES guidelines.

Memorandum NM & SD BUSINESS LIGHTING SATURATION STUDY

Figure 2. Range of Illuminance for Individual Spaces, South Dakota



Note: "Storage - Active" denotes active storage rooms with installed lamps.

LIGHTING FORECAST INPUTS

This section details results specifically required for Xcel Energy’s lighting forecast. This includes a breakdown, by proportion of square footage, of the four most common space use types for each facility type category.

MOST COMMON SPACE USES, BY FACILITY TYPE

For each facility type, EMI Consulting computed the most frequently observed space types and the proportion of square footage that space type accounted for, across each of the targeted facility types, combining all data collected for the 2018 and 2019 studies (and only showing the eight facility types that were surveyed in all four states).

Table 30 shows that, adding the 2019 New Mexico and South Dakota data to the 2018 Colorado and Minnesota data resulted in few changes in the overall distribution of space types contained within each facility type. Notable changes include:

- The Administrative and Support Services category now has Classrooms as the third most common space type in terms of square footage. This is due to a large facility that has classrooms in support of a museum.

Memorandum NM & SD BUSINESS LIGHTING SATURATION STUDY

- Workshop/Production spaces are no longer among the top four spaces in the Ambulatory Healthcare category; instead, Medical spaces are the fourth most common space.
- The Professional, Scientific, and Technical Services category now has Retail Sales Floor as the fourth most common space type; Lobby spaces are no longer in the top four space types.
- Real Estate now has Lounge or Recreation spaces as the fourth most common space type; Mechanical Rooms are no longer in the top four space types.

Table 30. Most Common Space Uses by Facility Type, NM, SD, CO and MN Combined

Facility Type	Space 1	Space 2	Space 3	Space 4	% Sq. Ft. 1	% Sq. Ft. 2	% Sq. Ft. 3	% Sq. Ft. 4
Administrative and Support Services	Parking Garage	Office	Classroom	Retail Sales Floor	39%	18%	9%	8%
Ambulatory Health Care Services	Lobby	Office	Lounge or Recreation	Medical	21%	19%	8%	8%
Educational Services	Gymnasium	Chapel	Corridor	Classroom	22%	14%	14%	12%
Food Services and Drinking Places	General Dining	Food Preparation	Refrigerated Storage	Storage - Active	31%	26%	18%	6%
Merchant Wholesalers, Durable Goods	Workshop / Production Facility	Storage - Active	Retail Sales Floor	Office	56%	32%	6%	3%
Professional, Scientific, and Technical Services	Office	Parking Garage	Workshop / Production Facility	Retail Sales Floor	20%	17%	13%	6%
Real Estate	Storage - Active	Parking Garage	Corridor	Lounge or Recreation	28%	14%	9%	8%
Religious, Grantmaking, Civic, Professional, and Similar Organizations	Parking Garage	Gymnasium	Chapel	Lobby	43%	11%	10%	5%

## CONCLUSIONS

The 2019 Business Lighting Saturation Study conducted in New Mexico and South Dakota resulted in eight key conclusions, summarized below. Overall, the results of this study suggest substantial opportunity for efficient lighting upgrades exist for the facility types observed.

## Memorandum NM &amp; SD BUSINESS LIGHTING SATURATION STUDY

1. **The greatest opportunity for linear LEDs in New Mexico appears to be in the following business types: 1) Merchant Wholesalers and 2) Administrative & Support Services.** These facility types had a high percentage of installed fluorescent tubes (82% and 70% of all installed lamps, respectively), and low percentages of linear LEDs (6% and 3%, respectively).
2. **The greatest opportunity for linear LEDs in South Dakota appears to be in the Ambulatory Health Care Services category.** In this facility type, 68% of lamps were fluorescent tubes, and no linear LEDs were observed.
3. **Saturation of T12s was high across facility types in New Mexico.** T12 saturation ranged from 29% to 71% of linear lamps in New Mexico. On the other hand, T12 saturation in South Dakota was more similar to the 2018 Minnesota and Colorado study (in the 10% range). Among sites with a high proportion of installed T12s in New Mexico, about half had at least some T12s in storage.
4. **The greatest opportunity for non-linear LEDs appears to lie in the Real Estate category in New Mexico.** Real estate businesses had a high proportion of installed non-linear lamps (41%), and only 3% of non-linear lamps were LED, while 58% were CFLs.
5. **Most lamps in storage are fluorescent tubes, with non-linear LEDs second most common.** Across both states, nearly half of sites had fluorescent tubes in storage (similar to 2018). Compared to 2018, there were fewer CFLs in storage in New Mexico and South Dakota, and an increased storage of non-linear LEDs – especially in South Dakota, where they represented 26% of stored lamps (9% in the 2018 study).
6. **Opportunities for efficient controls span across facility types in New Mexico and South Dakota.** As a proportion of lamps controlled, between 73% and 100% of the lighting across facility types was controlled by manual on/off switches.
7. **Inactive storage spaces have opportunity for efficient controls in both New Mexico and South Dakota.** Lamps installed within this space type had manual on/off switches for nearly 100% of their controls, and this space use was surveyed many times throughout the study, across facility types, and across states. In New Mexico, lobbies and restrooms also have good opportunity for controls. In South Dakota, corridors also have good opportunity.
8. **In New Mexico, Conference rooms, classrooms, and restrooms appear to be commonly over-lit, while stairs and restrooms are commonly over-lit in South Dakota.** Illuminance measurements taken in

Memorandum NM & SD BUSINESS LIGHTING SATURATION STUDY

these space types found light output at higher-than-recommended levels for a majority of the square footage observed.

**ATTACHED:** Spaces Sampled by Facility Type  
Sample Design Memo  
Data Collection Protocols