



Memo: Canadian Ambient Air Quality Standards (CAAQS) – Changes to Nitrogen Dioxide (NO₂) Management Levels

1. BACKGROUND

Canadian Ambient Air Quality Standards (CAAQS) are the driver for air quality management across Canada. In 2012, the Canadian Council of Ministers of the Environment (CCME, Appendix A), with the exception of Quebec, agreed to implement an Air Quality Management System (AQMS) to guide work on air emissions across Canada. The AQMS is intended to provide a comprehensive approach for improving air quality in Canada and to publicly report on Canada's air quality. The CAAQS are established as air quality objectives under the *Canadian Environmental Protection Act, 1999*.

CAAQS have also been developed for other criteria air contaminants (CAC), sulphur dioxide (SO₂), fine particulate matter (PM_{2.5}) and ozone (O₃). Industry associations, non-governmental organizations and Indigenous organizations participate in the development and review of CAAQS. CAAQS are reviewed every five years to ensure they are stringent enough to protect human health and the environment.

CAAQS for nitrogen dioxide (NO₂) were recently endorsed by the ministers. The most recent standards published by CCME for NO₂ are shown on Table 1.

Table 1 Canadian Ambient Air Quality Standards

Canadian Ambient Air Quality Standards				
Averaging Time	Standard Limit (ppb)			Statistical Form
	2015	2020	2025	
1-hour	—	60	42	The 3-year average of the annual 98th percentile of the daily maximum 1-hour average concentrations
Annual	—	17	12	The average over a single calendar year of all 1-hour average concentrations

2. OBJECTIVE

The objective of this memo was to review the upcoming change to the CAAQS NO₂ limits and compare to the historical CRAZ NO₂ levels to see if there is a potential for CRAZ to exceed the new standards in the future. Following the review and analysis, the second object was to make recommendations to the CRAZ Board about the findings of the review and analysis.

3. HISTORICAL CRAZ NO₂ AND NO_x LEVELS

The historical NO₂ levels (2015 to 2017) recorded at the Calgary Regional Airshed Zone (CRAZ) Calgary northwest station are shown on Table 2 and Figure 1.

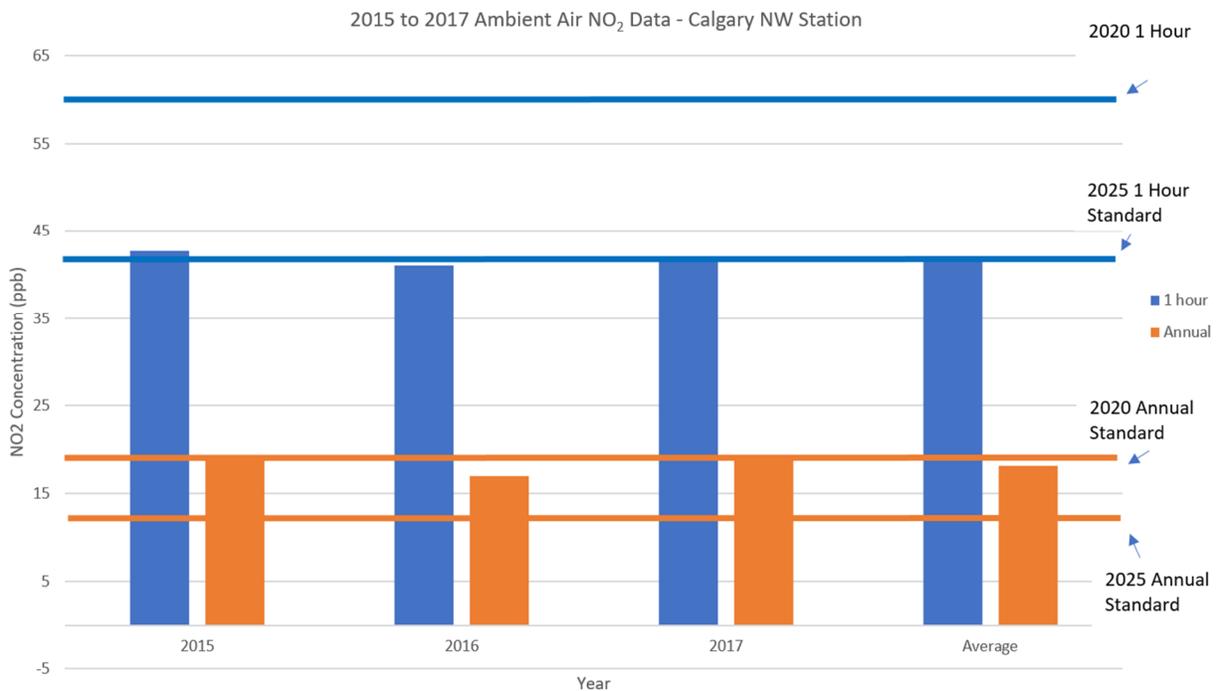
Table 2 NO₂ Results CRAZ Calgary Northwest Station

NO ₂ - Calgary NW Station		
Year	Averaging Period	
	1 hour ¹ (ppb)	Annual ² (ppb)
2015	42.7	18.8
2016	41	16.9
2017	41.4	19
Average of 2015 to 2017	41.7	18.2

¹90th percentile of hourly measurements

²Average over a single calendar year of all 1-hour average concentrations

Figure 1 NO₂ Results CRAZ Calgary Northwest Station



Note: The Average column is the 3-year average of annual 90th percentile of daily maximum 1 hour average concentrations. This is a close comparison with the CAAQS requirement of the 3-year average of the annual 98th percentile of the daily maximum 1-hour average concentrations.

4. HOW THE NEW NO₂ CAAQS WILL AFFECT THE CRAZ

Table 3 presents a comparison the of new 1-hour and annual NO₂ CAAQS criteria to CRAZs historical NO₂ measurements. Based on 2015 to 2017 CRAZ NO₂ data, 1-hour NO₂ levels just meet the new 2020 1-hour criteria. The 2015-2017 NO₂ CRAZ annual data exceed the new 2020 annual NO₂ criteria.

Table 3 Comparison of Calgary NW Station NO₂ Measurement Data to New 2020 and 2025 NO₂ CAAQS Criteria

NO ₂ Levels at Calgary NW Station			2020 NO ₂ CAAQS Limits [ppb]		2025 NO ₂ CAAQS Limits [ppb]	
Year	1 hour [ppb] ¹	Annual [ppb] ²	1 hour ³	Annual ²	1 hour ³	Annual ²
2015	42.7	18.8	60	17	42	12
2016	41	16.9				
2017	41.4	19				
Average ⁴	41.7	18.2				

¹90th percentile of hourly measurements

²Average over a single calendar year of all 1-hour average concentrations

³3-year average of the annual 98th percentile of the daily maximum 1-hour average concentrations

⁴Average over 3 calendar years of all 1-hour average concentrations

4.1 Current Contributors to NO_x within the CRAZ

Within CRAZ, the greatest contributor to nitrogen oxides (NO_x) is transportation (61%) shown on Table 4 and 5. Within the transportation sector, the greatest contributor to NO_x is off road vehicles and equipment (65%). The second greatest contributor to NO_x in the CRAZ region is Upstream Oil and Gas (19.5 %). Within upstream oil and gas, the greatest contributor to NO_x is internal combustion equipment unclassified (75.3%). These include emissions from equipment such as diesel generators and small combustion sources etc.¹

Table 4 2008 CRAZ Emissions by Sector – Tons per Year¹

Main Sector		Unit: ton/yr				Region: CRAZALL			
SECTOR	AREA	CO	NOX	VOC	NH3	SO2	PM25	PM10	
AGR	CRAZALL	250	121	20,272	20,748	94	1,012	13,607	
COMM	CRAZALL	12,147	6,266	1,838	54	1,049	2,039	2,024	
EGU	CRAZALL	899	2,904	64	442	157	94	140	
UOG	CRAZALL	14,929	17,509	11,742	203	17,193	251	263	
SOL	CRAZALL	0	0	11,834	0	0	2	2	
GAS	CRAZALL	0	0	6,897	0	0	0	0	
CEM	CRAZALL	669	3,733	136	0	3,112	498	945	
OTHERS	CRAZALL	19,556	4,169	4,221	1,265	226	3,696	5,648	
CONS	CRAZALL	0	0	0	0	0	13,586	68,416	
TRANS	CRAZALL	352,927	54,775	22,165	593	1,181	8,848	43,365	
BIOG	CRAZALL	9	256	52,026	0	0	0	0	
Total	Total	401,386	89,733	131,196	23,307	23,011	30,025	134,409	

Table 5 2008 CRAZ Emissions by Sector – Percentage¹

Main Sector		Unit: % CRAZALL						
SECTOR	AREA	CO	NOX	VOC	NH3	SO2	PM2_5	PM 10
AGR	CRAZALL	0.1%	0.1%	15.5%	89.0%	0.4%	3.4%	10.1%
COMM	CRAZALL	3.0%	7.0%	1.4%	0.2%	4.6%	6.8%	1.5%
EGU	CRAZALL	0.2%	3.2%	0.0%	1.9%	0.7%	0.3%	0.1%
UOG	CRAZALL	3.7%	19.5%	8.9%	0.9%	74.7%	0.8%	0.2%
SOL	CRAZALL	0.0%	0.0%	9.0%	0.0%	0.0%	0.0%	0.0%
GAS	CRAZALL	0.0%	0.0%	5.3%	0.0%	0.0%	0.0%	0.0%
CEM	CRAZALL	0.2%	4.2%	0.1%	0.0%	13.5%	1.7%	0.7%
OTHERS	CRAZALL	4.9%	4.6%	3.2%	5.4%	1.0%	12.3%	4.2%
CONS	CRAZALL	0.0%	0.0%	0.0%	0.0%	0.0%	45.2%	50.9%
TRANS	CRAZALL	87.9%	61.0%	16.9%	2.5%	5.1%	29.5%	32.3%
BIOG	CRAZALL	0.0%	0.3%	39.7%	0.0%	0.0%	0.0%	0.0%
Total	Total	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%

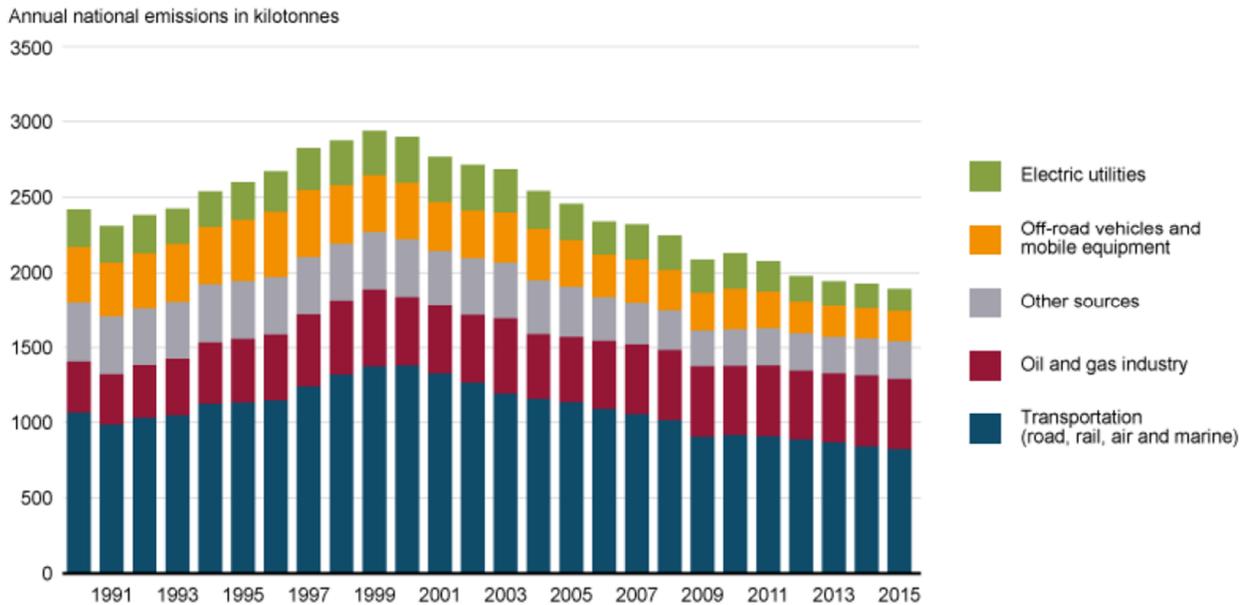
Trends seen in the CRAZ region are similar to those seen within the province of Alberta. 2014 data shows the greatest contributors to NO_x includes upstream oil and gas industry (50.1%) and diesel vehicles (off-road and heavy-duty) (15.7%) as shown in Table 6.³

Table 6 Ten Largest Sources of NO_x Emissions in Alberta for 2014³

Rank	Sector Category	2014 AB NO _x Emissions (kt)	% of 2014 AB Anthropogenic Total
1	Upstream Petroleum Industry (Including Oil Sands)	343.3	50.1%
2	Electric Power Generation	82.1	12.0%
3	Off-road Use of Diesel	56.7	8.3%
4	Heavy-duty Diesel Vehicles	51.0	7.4%
5	Rail Transportation	50.9	7.4%
6	Light-duty Gasoline Trucks	17.2	2.5%
7	Chemicals Industry	13.5	2.0%
8	Petroleum Product Transportation and Distribution	10.2	1.5%
9	Air Transportation	9.4	1.4%
10	Light-duty Gasoline Vehicles	8.9	1.3%

Figure 2 presents 2015 NO_x emissions (Figure 2) results for Canada. NO_x emission sources included transportation (44%) and oil and gas (25%) being the first and second greatest contributors of total national NO_x emissions.⁴

Figure 2 Total NO_x Emissions by Source in Canada⁴



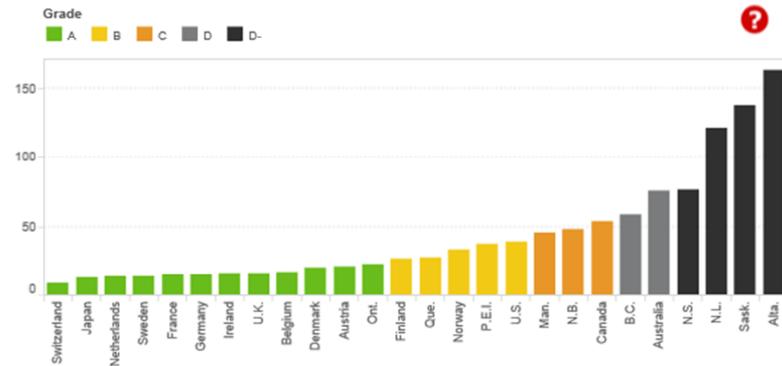
4.2 Current Trends in NO_x in Alberta

In Canada, overall NO_x emissions have been trending downward. This is due to improvements in vehicle emissions standards, technological advances in engines, and public transit improvements in major centres, largely driven by California emission standards, such as catalytic converter improvements, fuel efficiency improvements, and turbochargers have resulted in a 28% decrease in NO_x. However, Alberta remains the number one contributor to NO_x in Canada; with per capita NO_x emissions roughly double that of Australia (see Figure 3). Development of oil and gas resources has been suggested to be the driver of these high overall NO_x concentrations. Recent federal regulations have targeted emission from this sector—including the Multi Sector Air Pollution Regulation (MSAPR). Within the CRAZ, however, trends have been relatively stable. Though transportation remains the key contributor to NO_x, potential increases may arise from policy shifts to more localized power generation, and increased transportation.

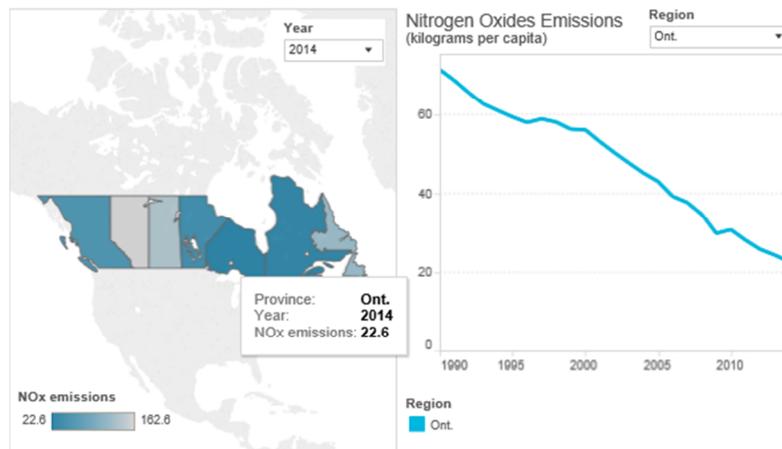
Municipal, provincial, and federal programs that are in place to control NO_x emissions are presented in Appendix B.

Figure 3 NO_x Emissions Provinces and international Peers¹

Nitrogen Oxides Emissions, Provinces and International Peers, 2014 or Most Recent Year (kilograms per capita)



Sources: The Conference Board of Canada; Environment and Climate Change Canada; OECD.



5. CONCLUSIONS AND RECOMMENDATIONS

To conclude, the current NO₂ levels recorded within the CRAZ will just meet or exceed the future CAAQS if the NO₂ emissions remain constant. Current programs to reduce NO₂ emissions that are in place locally, provincially, federally and globally are presented in Appendix B.

As the CRAZ is unlikely to meet the future CAAQS the Policy Committee recommends sending CRAZ members a presentation or communication with the following content:

- information from this memorandum outlining what CAAQS is and its potential to impact businesses and economic development within the CRAZ
- how CRAZ can support businesses and municipalities within the CRAZ by measuring the results of efforts to reduce NO₂

The recipients of this communication should target economic development boards/committees within the CRAZ. The policy committee believes that with this information, these boards will ask for more information for their members and regenerate interest, monitoring and funding for CRAZ.

The policy committee also recommends engagement with the Calgary Growth Management Board to inform and offer monitoring guidance and data for future development in the Calgary region and to demonstrate usefulness as a resource in assessing the impact of regulatory shifts, such as the CAAQS, to the CRAZ region.

APPENDIX A: WHO AND WHAT ARE THE CCME?

From the following website: <https://www.ccme.ca/en/about/index.html>

CCME (Canadian Council of Ministers of the Environment) is the primary minister-led intergovernmental forum for collective action on environmental issues of national and international concern.

CCME is composed of the environment ministers from the federal, provincial and territorial governments. The role of President of CCME rotates among the 14 ministers of environment on an annual basis. These 14 ministers normally meet at least once a year to discuss national environmental priorities and determine work to be carried out under the auspices of CCME. The Council seeks to achieve positive environmental results, focusing on issues that are Canada-wide in scope and that require collective attention by a number of governments. Since environment is constitutionally an area of shared jurisdiction, it makes sense to work together to promote effective results.

Ministers set the strategic direction for the Council, setting out the broad outcomes they seek to achieve. Senior officials establish working groups of experts from the federal, provincial, and territorial environmental ministries to work collaboratively to accomplish specific goals, with the support of a permanent secretariat. In most cases, group membership may include experts from other relevant government departments (such as Health). Depending on the nature of the work, expertise from the private sector, academia, Indigenous groups, environmental and health public interest groups may be sought.

CCME is supported financially and in kind by the environment departments of the governments of Alberta, British Columbia, Canada, Manitoba, New Brunswick, Newfoundland and Labrador, Northwest Territories, Nova Scotia, Nunavut, Ontario, Prince Edward Island, Québec, Saskatchewan and Yukon.

Our current working groups are

- Air Management Committee
- Climate Change Committee
- Contaminated Sites Working Group
- Cumulative Effects Working Group
- Environmental Emergencies Working Group
- Waste Reduction and Recovery Committee
- Water Management Committee

APPENDIX B: CURRENT PROGRAMS IN PLACE TO ADDRESS NO₂ EMISSIONS

The following programs are in place to control NO_x emissions locally, provincially and federally (CASA 2018).

1. TRANSPORTATION:

CASA’s 2018 report entitled *Recommendations to Reduce Non-Point Source Air Emissions in Alberta* (CASA 2018) states that there are “many national, provincial, and municipal initiatives aimed at reducing emissions via increased carpooling, active transportation, fuel efficient driver education, purchase of fuel efficient vehicles, and others”. These include:

National:

- *Buying a Fuel-Efficient Vehicle (Natural Resources Canada – Office of Energy Efficiency)*
- *Eco Driving, Fuel-Efficient Driving Techniques (Natural Resources Canada – Office of Energy Efficiency)*
- *Mobile Sources Working Group under the national Air Quality Management System (Canadian Council of Ministers of the Environment [CCME])*
- *Pan-Canadian Framework on Clean Growth and Climate Change*
- *Strategy on Short-Lived Climate Pollutants – 2017 (Environment and Climate Change Canada)*

Provincial:

- *Clean Air Strategy (Government of Alberta)*
- *Climate Leadership Plan (Government of Alberta)*
- *Green Transit Incentives Program (GreenTRIP) (Alberta Transportation)*
- *Draft Provincial Public Transportation Strategy (Alberta Transportation)*

Municipal:

- *2016 Edmonton Metropolitan Growth Plan*
- *Calgary Parking Authority Carpool Parking Program (City of Calgary)*
- *Calgary Transportation Plan (City of Calgary)*
- *Edmonton Community Energy Transition Strategy (City of Edmonton)*
- *Pedestrian Strategy (City of Calgary)*
- *The Way We Green (City of Edmonton)*
- *The Way We Move, City of Edmonton*
- *Transportation Master Plan (City of Edmonton)*

- *Various vehicle idling reduction bylaws and initiatives; e.g., Be Idle Be Free (City of Edmonton), Idle Free (City of Red Deer)*

Other:

- *Carpool.ca (Trans-Canada Carpool.ca)*
- *Commuter Challenge (annual event), <https://commuterchallenge.ca/>*
- *Smart Drive Challenge (Scout Environmental, Government of Ontario, Canadian Fuels Association, Natural Resources Canada)*
- *Smart Fuelling (Canadian Fuels Association, Canadian Independent Petroleum Marketers Association, Canadian Convenience Stores Association, Canadian Automobile Association)*

Other Jurisdictions:

Because CRAZ is unique within Alberta in regards to the primary contributor of NO_x and other CAC's, other jurisdictions that demonstrated a similar profile were briefly reviewed to identify initiatives aimed at reduction. Within Canada, two of these systems involved regulated vehicle emission testing.

- In British Columbia, a program called AirCare was initiated through ICBC, requiring vehicles to be inspected to ensure emission control devices were in operation every two years. The program was estimated to reduce heavy-duty vehicle emissions by 24% and was cancelled in 2014, suggested to have fulfilled its purpose.
- In Ontario, a similar program was known as Drive Clean. This program is still in operation albeit by another name; effectiveness metrics are not readily available.
- Globally, many countries employ similar strategies, including the United Kingdom (Ministry of Transport Test) and New Zealand (Warrant of Fitness).

In Alberta, many tools were proposed to address air quality issues stemming from transportation, including a similar program in 2007, in a document titled "*Air Quality Management Policy Tools Leading Practice Research*"; however this program was never implemented.

2. RESIDENTIAL HOMES AND LAND USE PLANNING²

Initiatives to reduce NO_x in the residential homes and land use planning sector include:

- EPA and CSA high efficiency standards for residential home heating
- Many provincial and municipal programs in place to encourage mixed use, transit, active mobility oriented neighborhoods (eg. Healthy Community by Design Guidance Document, Alberta Health Services; Municipal Development Plans)

3. POWER GENERATION

ENMAX Energy Corporation owns and/or operates the following natural gas generation assets within the CRAZ:

- Calgary Energy Centre (320MW)
- Cavalier Energy Centre and Balzac Facility (120MW)
- Crossfield Energy Centre (120MW)
- Shepard Energy Centre (860MW)
- Downtown District Energy (3.3MW)

Policies and regulations are in place that limit the amount of NO₂ emissions natural gas power plants can emit to the atmosphere. Such policy and regulations include:

- *Base Level Industrial Emission Requirements (BLIERs)*
- *Proposed Guidelines for the Reduction of Nitrogen Oxide Emissions from Natural Gas-fuelled Stationary Combustion Turbines* (Environment and Climate Change Canada, May 2016).
- Emissions Management Framework for the Alberta Electricity Sector
 - *Alberta Air Emission Standards for Electricity Generation and Alberta Air Emission Guidelines for Electricity Generation* (Alberta Environment, December 2005)
 - *Emission Trading Program*
 - *Mercury Emissions from Coal Fired Power Plants Regulation (Alberta Regulation 34/2006)*
 - *Guide for Responding To Potential “Hot Spots” Resulting From Air Emissions from the Thermal Electric Power Generation Sector*
 - Standards/Approval Clauses

As well, the *Alberta Ambient Air Quality Guidelines* (AAAQO) limit the amount of impact these emissions can have to ground-level concentrations (through the *Environmental Protection and Enhancement Act (EPEA)* approval process).

Other options operators have to reduce NO₂ emissions are through technology. The two common technologies ENMAX uses include:

- dry-low emissions (DLE), or
- selective catalytic reduction (SCR).

These leading technologies in emissions controls are found at the Shepard Energy Centre and the Calgary Energy Centre, ENMAX’s two largest generators. These generation plants operate well below the allowable NO_x limits.

The government of Alberta has been implementing programs and regulations to incent coal-fueled power plants to convert to natural gas, generate more renewable alternatives and to decentralize electricity infrastructure (bring the generation closer to the customer). While these initiatives can greatly reduce the amount of emissions of NO₂ and other criteria air pollutants, certain airsheds can be negatively impacted. In urban areas and some rural areas, unregulated sources of NO₂ (transportation and home heating) are very large contributors of this pollutant. No amount of reduction to electricity infrastructure will help to reduce the increasing impacts from transportation. Albertans want security in knowing their electricity and heat comes from environmentally responsible sources and that the cost of these is reasonable. To keep in line with what Albertans want, replacing coal-fueled electricity with natural gas fueled electricity close to customers, is currently the best option. This reduces the amount of NO₂ being emitted by electricity generation (using low carbon, low NO_x replacing natural gas in place of coal) and prevents the need for building new transmission infrastructure (keeping generation close to the customer). The significant, and over-arching reduction of ambient NO₂ levels being implemented by CCME, could inhibit some natural gas-fueled electricity generators from developing or operating due to the decrease in allowable ground-level concentrations.