

## Greenhouse Gas Emission Reductions & The Air We Breathe

House Energy and Climate Finance and Policy Division

Greta Gauthier | Assistant Commissioner of Legislative & Intergovernmental Relations

Frank Kohlasch | Air Assessment Manager

1/22/2019

January 22, 2019

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## Overview

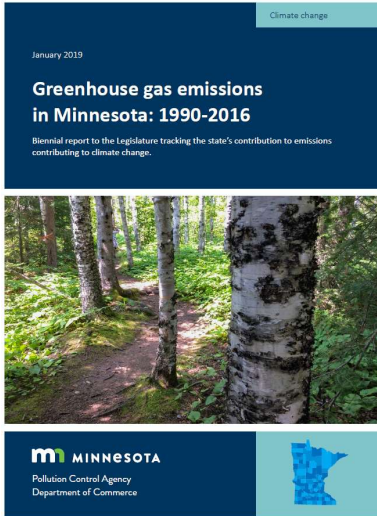
- Greenhouse gas emissions in Minnesota: 1990-2016
  - Takeaway: While Minnesota's overall GHG emissions declined 12% relative to 2005 levels, we missed the Next Generation Energy Act's goal of a 15% emissions reduction by 2015
- The air we breathe
  - Takeaway: Minnesota's air quality is good, but not for everyone



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## Greenhouse gas emissions in Minnesota

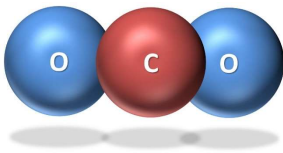


### Legislative charge:

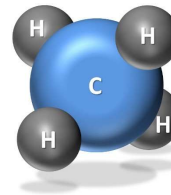
- Minn. Stat. § 216H.02 – Establishes progressively stringent greenhouse gas emission reduction goals
- Minn. Stat. § 216H.07 — Requires a biennial report on “the most recent and best available evidence identifying the level of reductions already achieved and the level necessary to achieve the reductions” in the above statute

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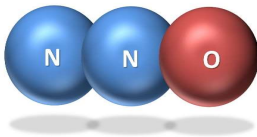
## Introduction to greenhouse gases



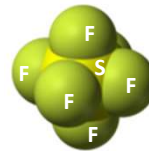
Carbon Dioxide  
(CO<sub>2</sub>)



Methane  
(CH<sub>4</sub>)



Nitrous oxide  
(N<sub>2</sub>O)

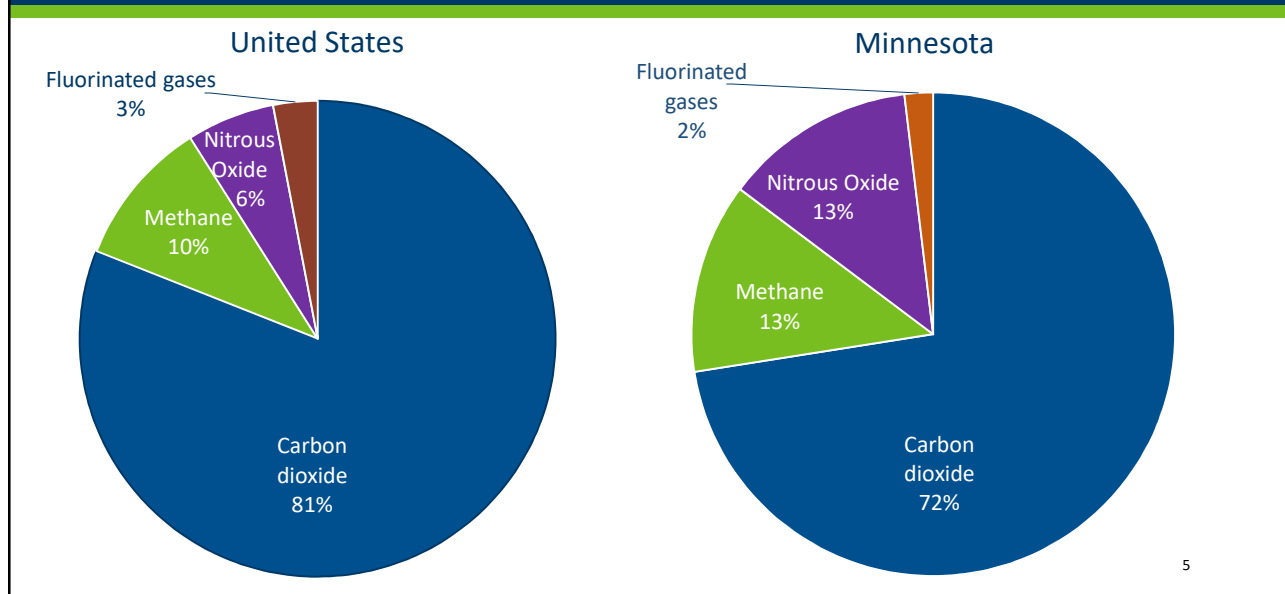


Fluorinated gases  
*sulfur hexafluoride (shown here), hydrofluorocarbons, perfluorocarbons*

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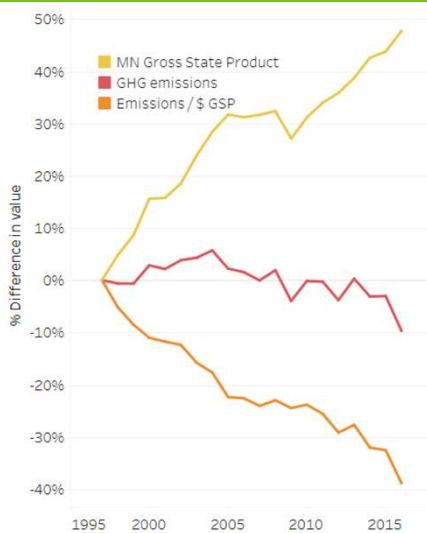
4

## Greenhouse gas emissions



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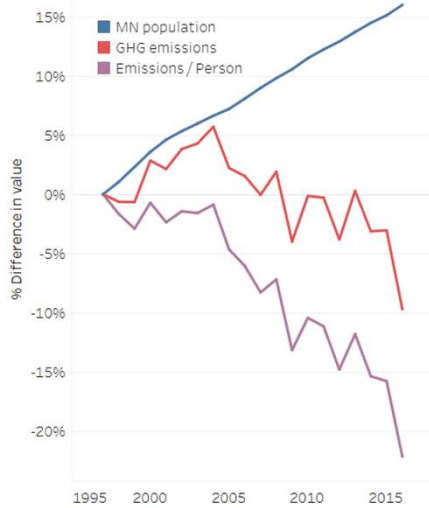
## GHG emissions decreased while the economy expanded



- Since 1995, gross state product has increased dramatically while greenhouse gas emissions declined, due to:
  - Improved energy efficiency
  - Increased fuel efficiency
  - Cleaner fuels
  - Renewable energy

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## GHG emissions decreased while population grew



- Since 1995, Minnesota's population rose more than 15%, and greenhouse gas emissions decreased, due to:
  - Lower carbon emissions from generating electricity
  - More fuel-efficient cars
  - Renewable energy

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## Next Generation Energy Act of 2007

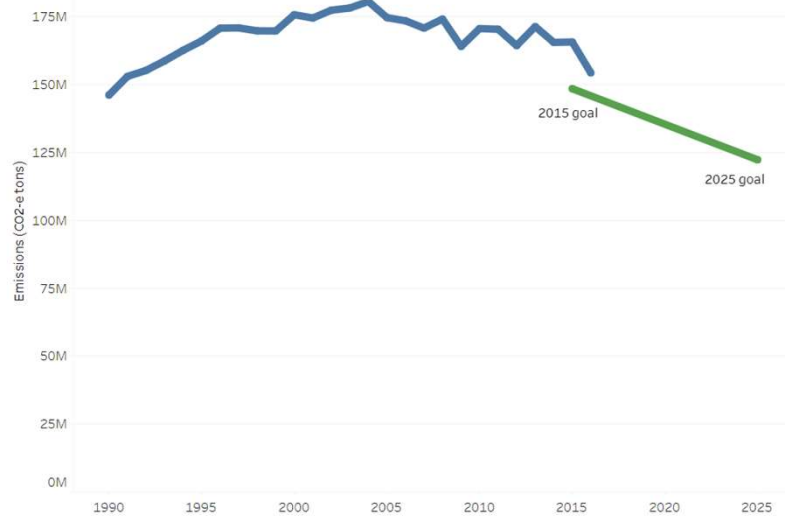
- Minn. Stat. § 216H.02
- Requires progressive reductions in GHG emissions (from 2005 levels):
  - 15% reduction by 2015
  - 30% reduction by 2025
  - 80% reduction by 2050



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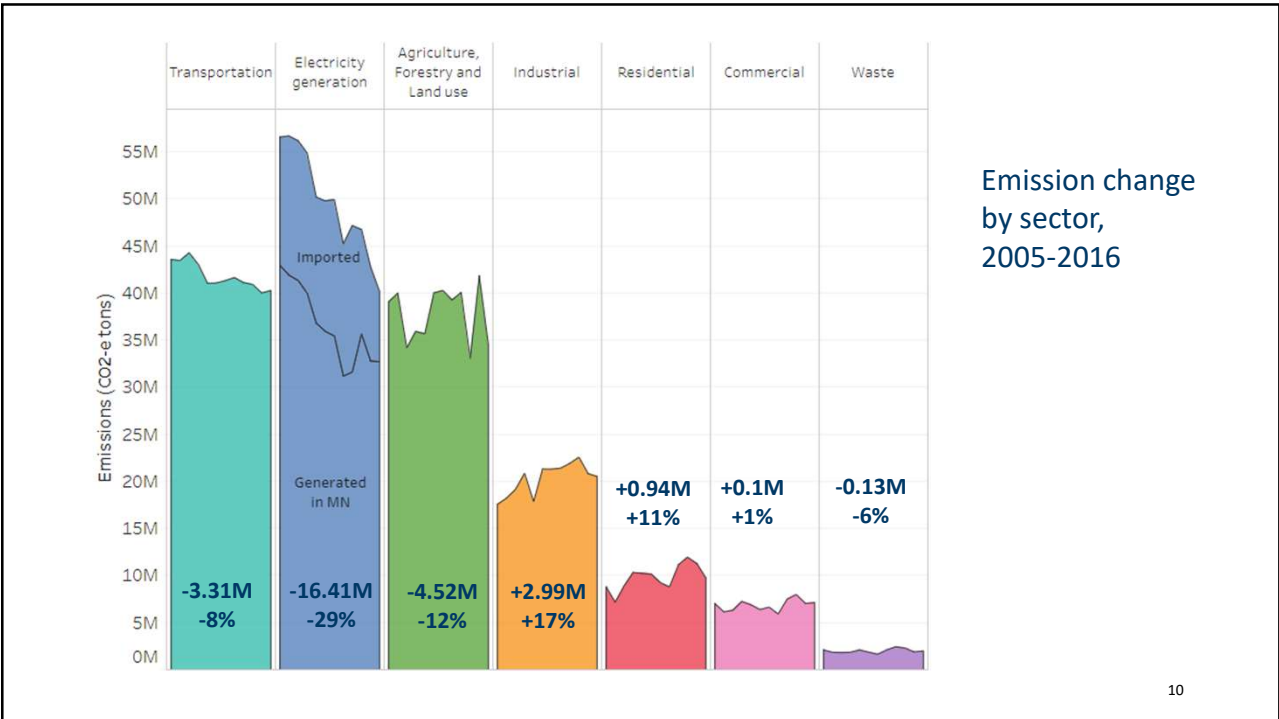
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# Progress toward Next Generation Act GHG reduction goals



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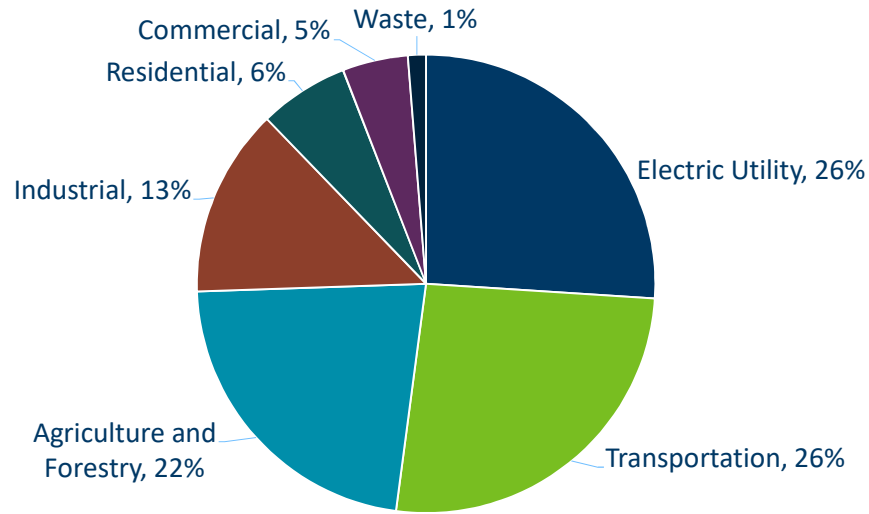
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Emission change by sector, 2005-2016

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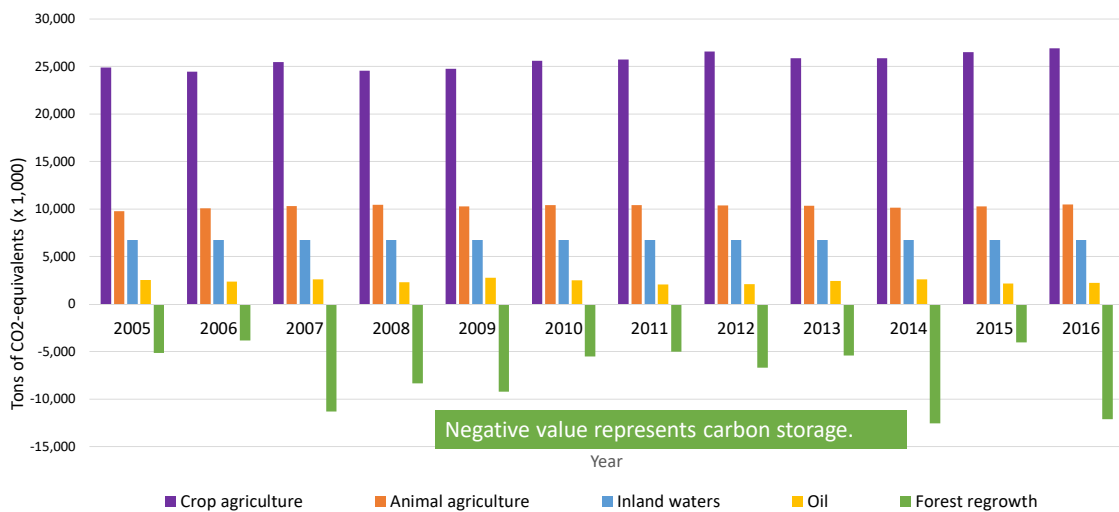
## Greenhouse gas emissions by sector, 2016



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## GHG emissions: Agriculture, forestry, and land use



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See page 1 in MPCA data table handout of January 22, 2019

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## GHG emissions: Agriculture, forestry, and land use

### Agriculture, forestry and land use in tons of CO2-equivalents (x 1,000)

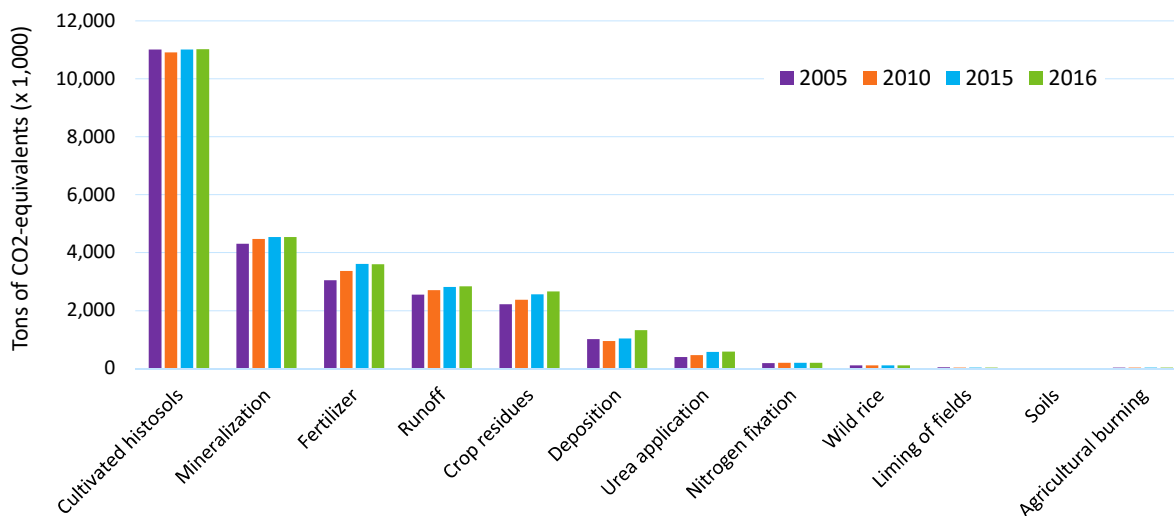
Subcategory	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016
Crop agriculture	24,873	24,441	25,434	24,529	24,746	25,573	25,711	26,548	25,849	25,846	26,478	26,905
Animal agriculture	9,776	10,066	10,289	10,416	10,280	10,392	10,384	10,365	10,328	10,138	10,249	10,483
Inland waters	6,731	6,732	6,733	6,734	6,735	6,735	6,736	6,737	6,737	6,737	6,737	6,737
Oil	2,519	2,348	2,602	2,300	2,768	2,487	2,056	2,074	2,404	2,593	2,153	2,234
Forest regrowth	-5,150	-3,838	-11,301	-8,344	-9,234	-5,528	-5,012	-6,690	-5,422	-12,549	-4,043	-12,115

This data table corresponds to page 1 in MPCA data table handout of January 22, 2019

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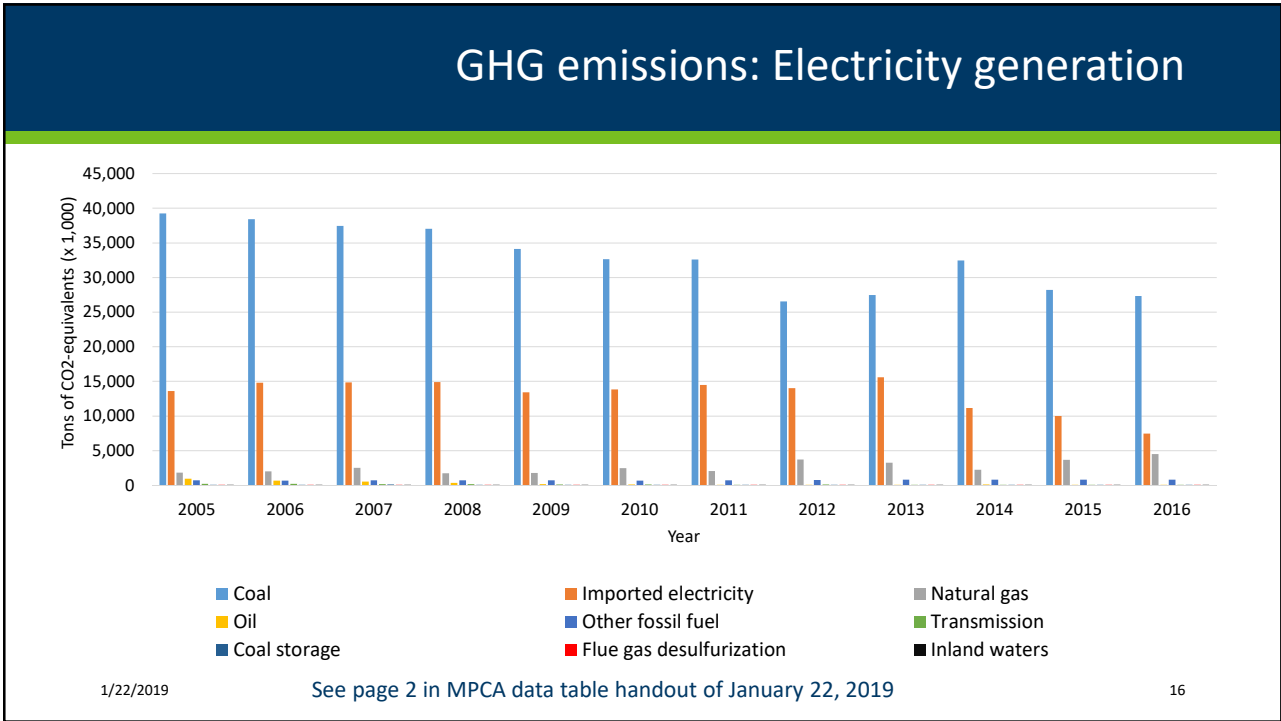
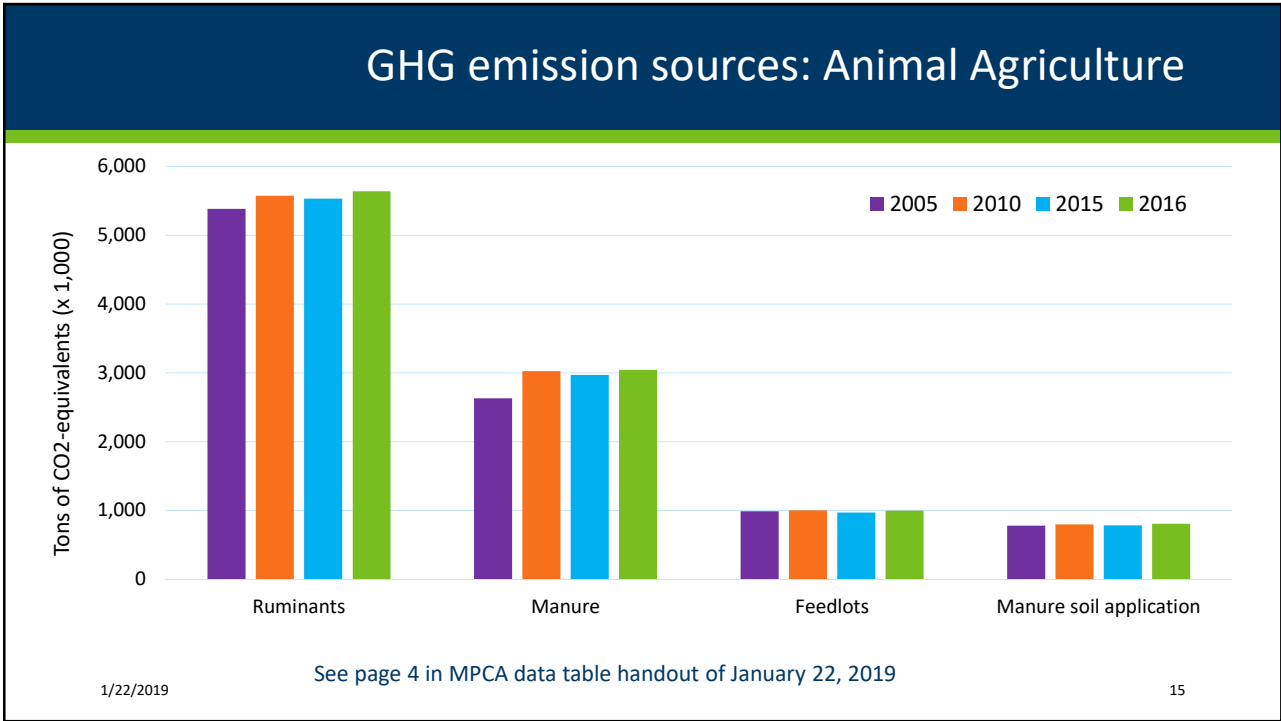
## GHG emission sources: Crop Agriculture



See page 4 in MPCA data table handout of January 22, 2019

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## GHG emissions: Electricity generation

**Electricity generation in tons of CO2-equivalents (x 1,000)**

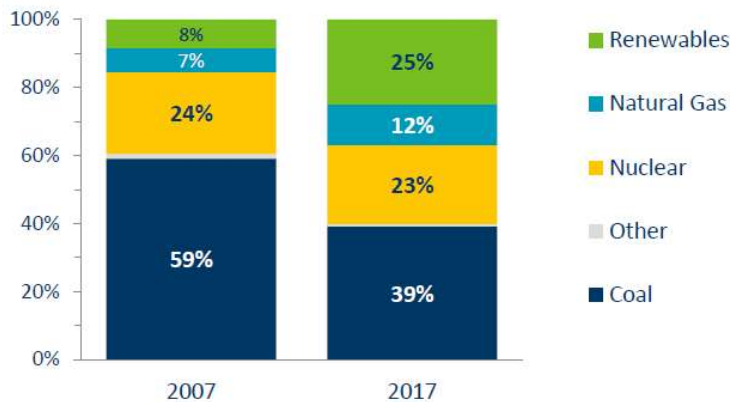
Subcategory	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016
Coal	39,234	38,401	37,418	37,029	34,084	32,621	32,560	26,532	27,454	32,459	28,206	27,306
Imported electricity	13,602	14,771	14,839	14,874	13,389	13,831	14,450	14,025	15,559	11,124	9,980	7,422
Natural gas	1,803	1,967	2,506	1,714	1,764	2,460	2,026	3,694	3,227	2,196	3,661	4,490
Oil	940	629	487	342	116	71	39	46	47	80	39	38
Other fossil fuel	686	646	690	689	674	646	706	748	761	768	766	795
Transmission	196	183	156	129	101	72	45	84	50	46	47	22
Coal storage	63.1	62.1	67.9	65.6	58.0	56.8	59.6	45.2	45.6	57.9	58.4	42.1
Flue gas desulfurization	6.2	5.9	5.8	6.0	6.1	6.4	5.9	5.1	5.1	5.2	4.9	5.2
Inland waters	5.4	5.4	5.4	5.4	5.4	5.4	5.4	5.4	5.4	6.5	6.5	6.5

This data table corresponds to page 2 in MPCA data table handout of January 22, 2019

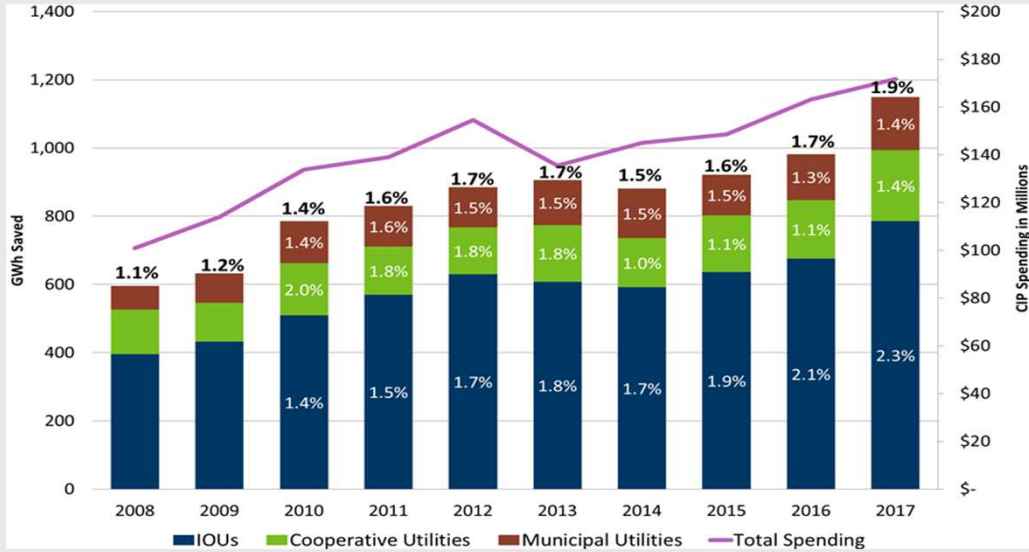
## Electricity generation by fuel type

**Minnesota's Electricity Generation Mix**

(% Megawatthours, source: U.S. EIA)

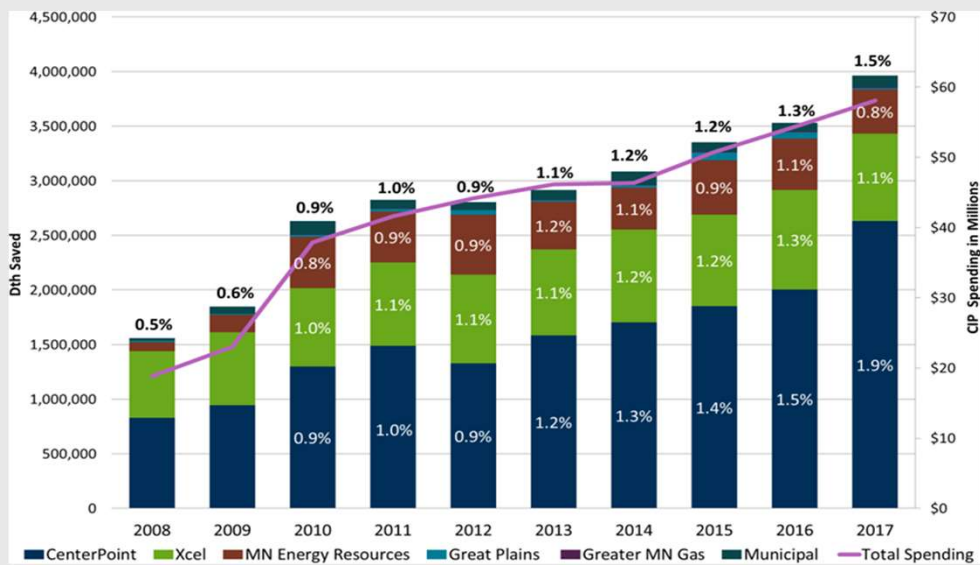


## MN Energy Efficiency Achievements - Electric



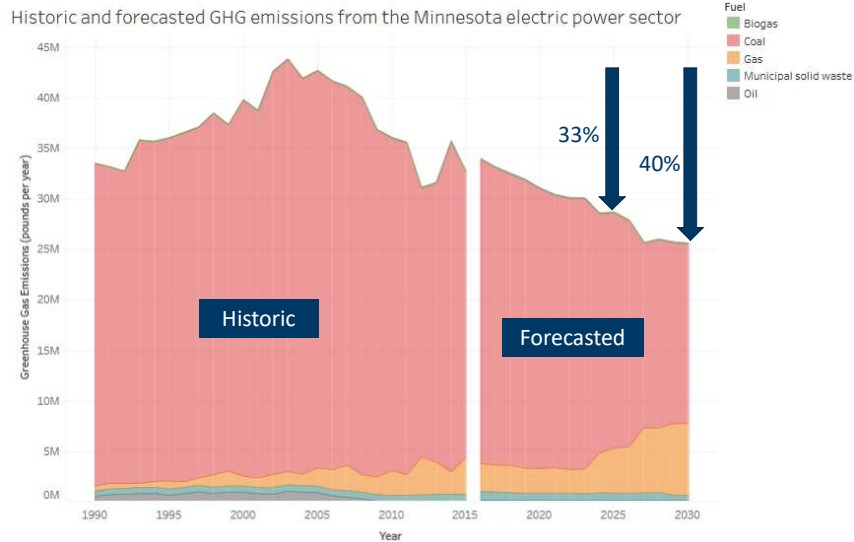
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## MN Energy Efficiency Achievements – Natural Gas



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## Projected GHG emissions: Electricity generation



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## Planned in-state electric generating unit closures

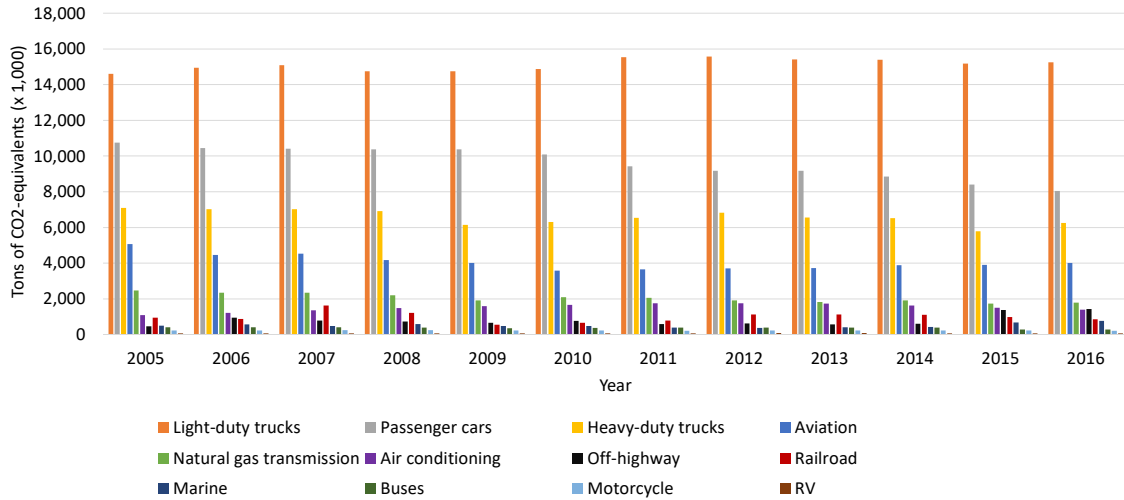
Facility	Fuel type	% of MN 2016 coal generation*	Size	Retirement date	2016 GHG emissions (tons)
<b>Minnesota Power</b>					
Boswell Energy Center 1	Coal	2.0%	67 MW	2018	631,357
Boswell Energy Center 2	Coal	2.0%	67 MW	2018	547,724
Taconite Harbor Energy Center 1	Coal	1.2%	76 MW	2020	390,781
Taconite Harbor Energy Center 2	Coal	1.1%	83 MW	2020	307,431
Silver Bay Power: 2 units	Coal	1.4%	130 MW	2021	488,294
<b>Otter Tail Power Company</b>					
Hoot Lake Coal Steam Units	Coal	0.9%	141 MW	2020	274,550
<b>Great River Energy</b>					
Stanton Station (North Dakota)	Coal		187 MW	2018	252,391
<b>Xcel Energy</b>					
Benson Power Biomass Plant	Biomass	1.5%	55 MW	2018	551,723
Sherburne County 1	Coal	17.8%	680 MW	2026	4,728,922
Sherburne County 2	Coal	10.9%	682 MW	2023	2,919,425
<b>Total</b>		<b>38.8%</b>	<b>2,168 MW</b>		

\* For statewide Investor Owned Utilities (IOU) generation capacity

Source: MN Department of Commerce

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## GHG emissions: Transportation



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See page 3 in MPCA data table handout of January 22, 2019

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## GHG emissions: Transportation

**Transportation: Tons of CO2-equivalents (x 1000)**

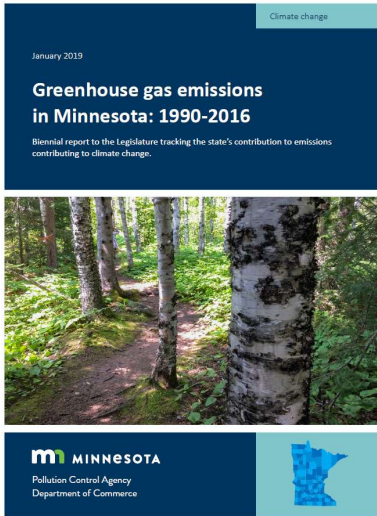
Subcategory	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016
Light-duty trucks	14,593	14,941	15,082	14,742	14,750	14,869	15,537	15,559	15,402	15,381	15,165	15,246
Passenger cars	10,736	10,438	10,397	10,366	10,374	10,082	9,423	9,166	9,161	8,851	8,399	8,030
Heavy-duty trucks	7,082	7,019	7,010	6,907	6,134	6,296	6,537	6,820	6,555	6,513	5,777	6,251
Aviation	5,068	4,445	4,526	4,159	4,002	3,570	3,643	3,700	3,720	3,880	3,901	4,007
Natural gas transmis	2,453	2,340	2,334	2,199	1,901	2,079	2,048	1,895	1,819	1,906	1,716	1,774
Air conditioning	1,074	1,208	1,342	1,469	1,576	1,652	1,745	1,749	1,721	1,619	1,489	1,383
Off-highway	453	931	771	720	656	749	572	605	564	589	1,373	1,420
Railroad	929	871	1,625	1,198	549	651	778	1,108	1,111	1,104	974	845
Marine	487	567	476	582	474	471	374	361	395	417	662	756
Buses	398	394	393	385	347	356	375	386	371	372	270	272
Motorcycle	225	226	228	227	217	216	208	213	215	216	211	207
RV	58.6	59.4	60.3	60.9	56.0	60.5	59.7	67.7	66.0	60.6	54.5	55.6

This data table corresponds to page 3 in MPCA data table handout of January 22, 2019

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## Web references



Greenhouse Gas Emissions in Minnesota: 1990-2016  
<https://www.pca.state.mn.us/air/state-and-regional-initiatives>

GHG emissions in Minnesota data  
<https://www.pca.state.mn.us/air/greenhouse-gas-emissions-data>

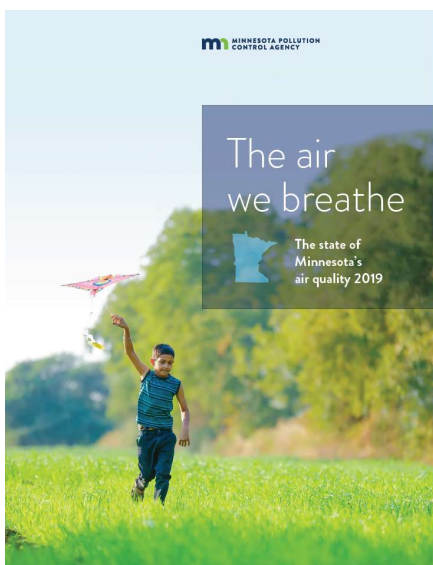
Climate Solutions and Economic Opportunities report (2016)  
<https://www.eqb.state.mn.us/content/climate-change>

Adapting to Climate Change in Minnesota report (2017)  
<https://www.pca.state.mn.us/air/adapting-changing-climate>

Climate-Vulnerable Population Reports  
<http://palebluedot.llc/mpca-vulnerable-population-assessments>

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## The air we breathe



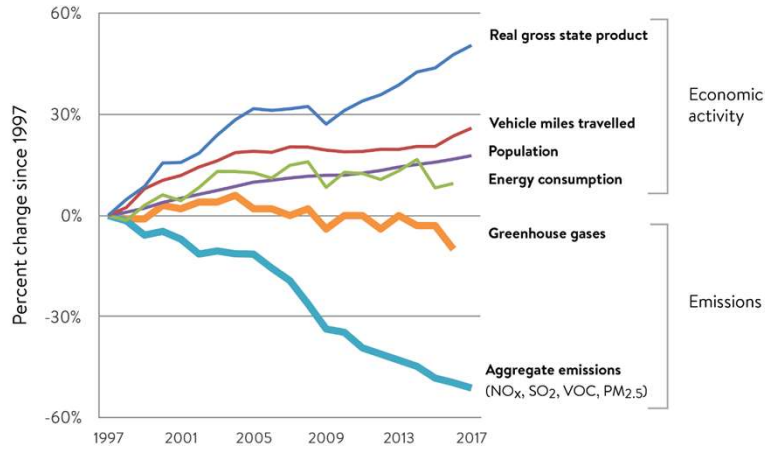
### Legislative charge:

- Minn. Stat. § 116.925 and § 116.925 require MPCA to report to the Legislature biennially on:
  - The status of toxic air contaminants
  - MPCA's strategies to reduce the emissions of air pollutants

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## We can grow our economy and reduce pollution

Emissions in Minnesota have declined significantly in the past 20 years, while the state's economy has continued to grow.

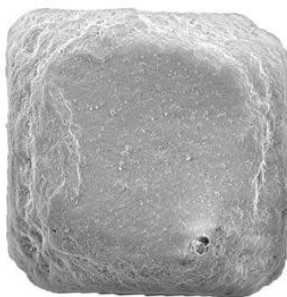


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## Three pollutants of concern in Minnesota

### Particulate matter/ fine particles (PM 2.5)

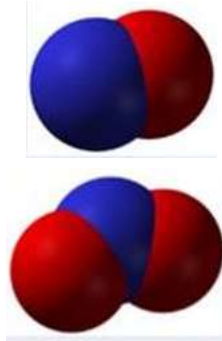


Average grain of table salt  
330 microns / .33 mm



PM2.5  
2.5 microns

### Nitrogen Oxides (NO<sub>x</sub> or Nox)



### Volatile organic compounds (VOCs)

- Benzene
- Formaldehyde
- 1,3-Butadiene
- Chloroform

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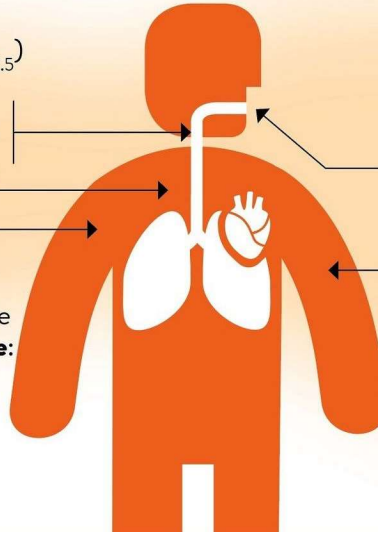
## Air pollution and your health

### Fine particles (PM<sub>2.5</sub>) pollution can cause:

- Shortness of breath
- Wheezing, coughing
- Chest pain
- Fatigue

Fine particles can make these conditions **worse**:

- Cardiovascular and heart disease
- Asthma and COPD



### Ground-level ozone pollution can cause:

- Difficulty breathing deeply
- Shortness of breath
- Sore throat
- Wheezing, coughing
- Fatigue

Ozone can make these conditions **worse**:

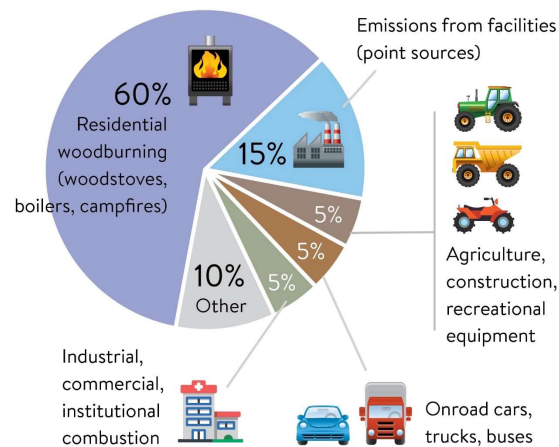
- Asthma and COPD
- Emphysema

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## Sources of fine particle air pollution

### Fine particles (PM<sub>2.5</sub>) directly emitted from combustion sources<sup>1</sup>



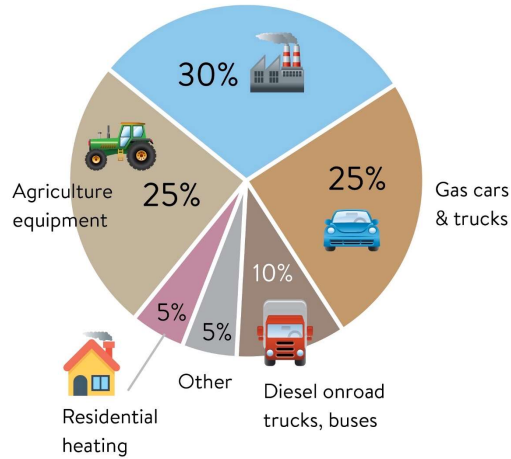
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# Sources of nitrogen oxides air pollution

## Nitrogen Oxides (NO<sub>x</sub>)

Emissions from facilities (point sources)

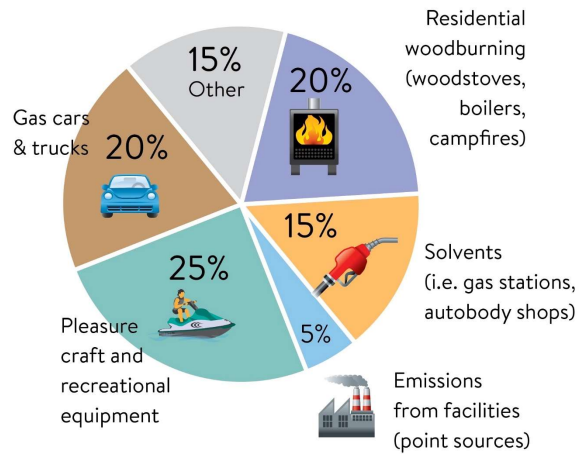


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# Sources of volatile organic compounds

## Volatile Organic Compounds (VOCs)

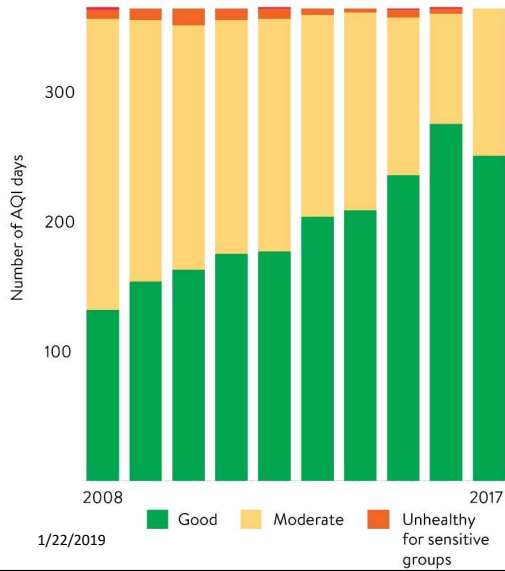


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## Air Quality Index: Trends in Minnesota

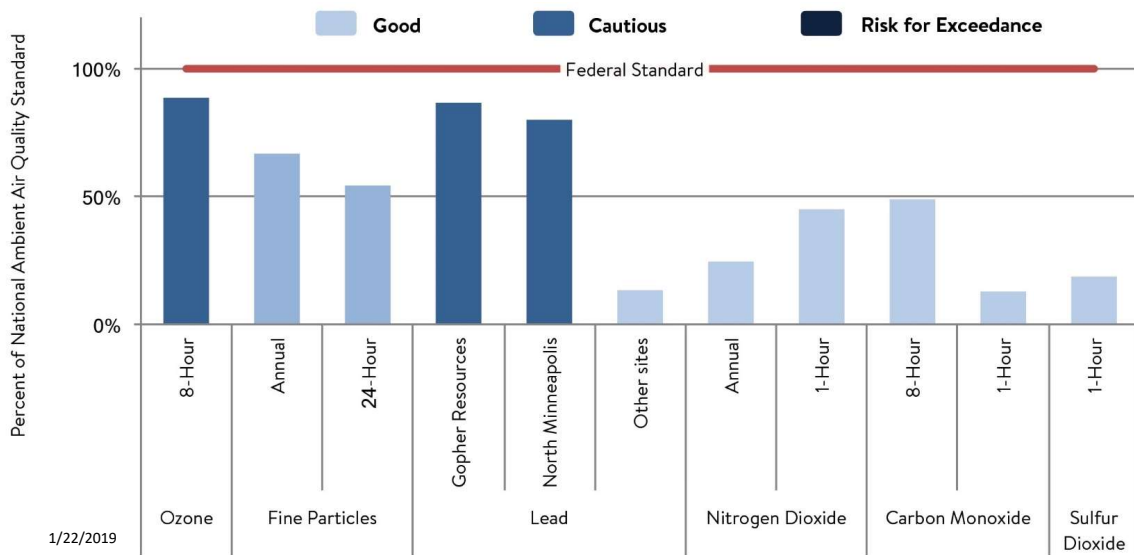


- The annual number of bad air days is declining in Minnesota.
- Bad air days most often result of:
  - Large fires outside Minnesota
  - Weather conditions that prevent pollution from dispersing normally

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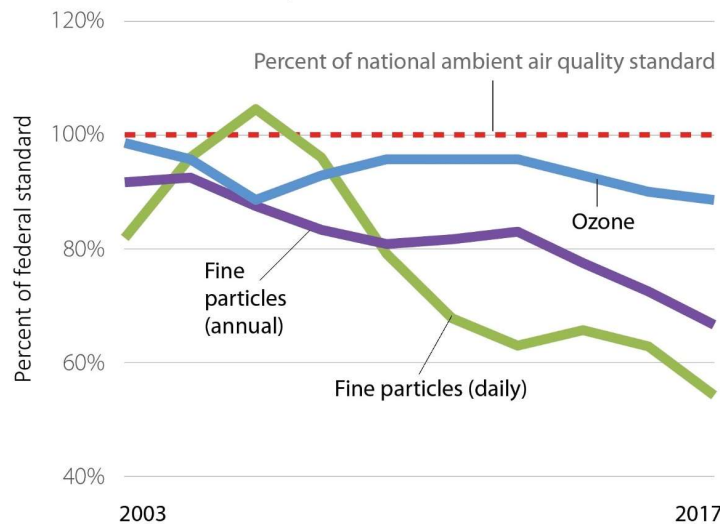
## Minnesota's air quality vs. national standards



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## Twin Cities ozone and fine particle pollution, 2003-2017



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## Estimated annual health impacts: Fine particles

Health impact	Age range	Attributable incidences	Percent of total incidences	Total value
Premature death	25 and older	1,900 - 4,100	4.7 - 10.2%	\$16 - \$35 billion
Respiratory hospitalizations	18 - 64	64	1.9%	\$2.0 million
Respiratory hospitalizations	65 and older	250	1.7%	\$8.6 million
Cardiovascular hospitalizations	65 and older	140	0.6%	\$4.6 - \$7.5 million
Asthma hospitalizations for children	Under 18	15	1.7%	\$240,000 - \$270,000
Asthma emergency department visits	All ages	530	2.4%	\$220,000 - \$270,000

Source: MPCA and Minnesota Department of Health

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## Estimated annual health impacts: Ozone

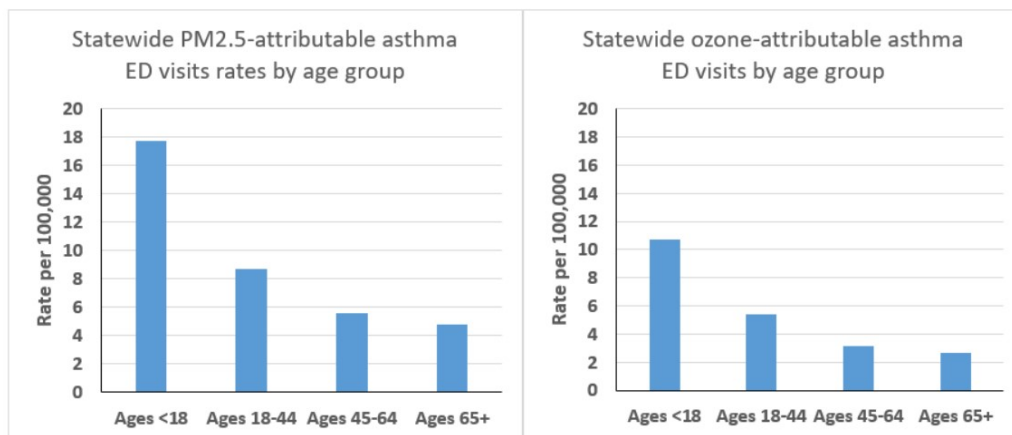
Health impact	Age range	Attributable incidences	Percent of total incidences	Total value
Premature death from cardiopulmonary causes	All ages	57	1.1%	\$490 million
Asthma hospitalizations	All ages	56	4.8%	\$1.0 million
Asthma emergency department visits	All ages	300	3.2%	\$130,000 - \$150,000

Source: MPCA and Minnesota Department of Health

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## Air pollution impacts and age

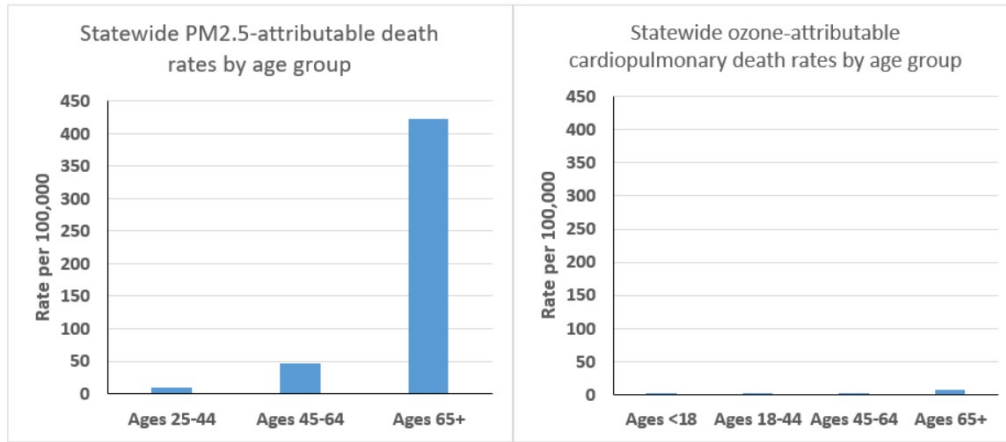


Source: MPCA and Minnesota Department of Health

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## Air pollution impacts and age

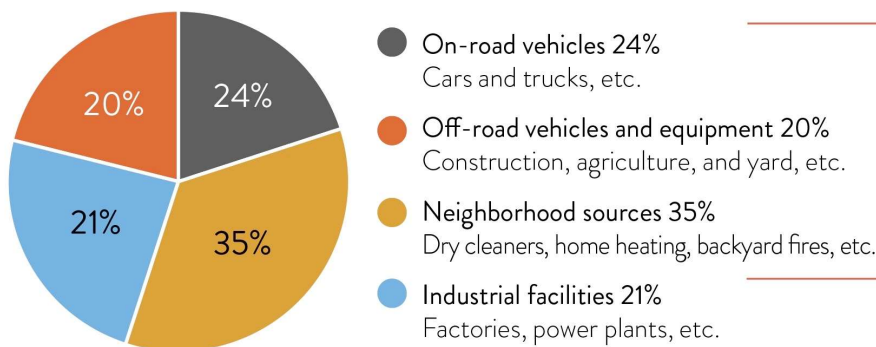


Source: MPCA and Minnesota Department of Health

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## Largest source of air pollution: Small, widespread sources



**Small and widespread sources are the largest portion of overall air pollution emissions in Minnesota.**

Includes PM2.5, SO2, NOX, VOCs.  
Source: MPCA 2014 emissions inventory

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## More Minnesotans are driving large vehicles

Heavier vehicles such as pickup trucks, SUVs, and crossovers now make up the majority of passenger vehicles in Minnesota and pollute more per mile.

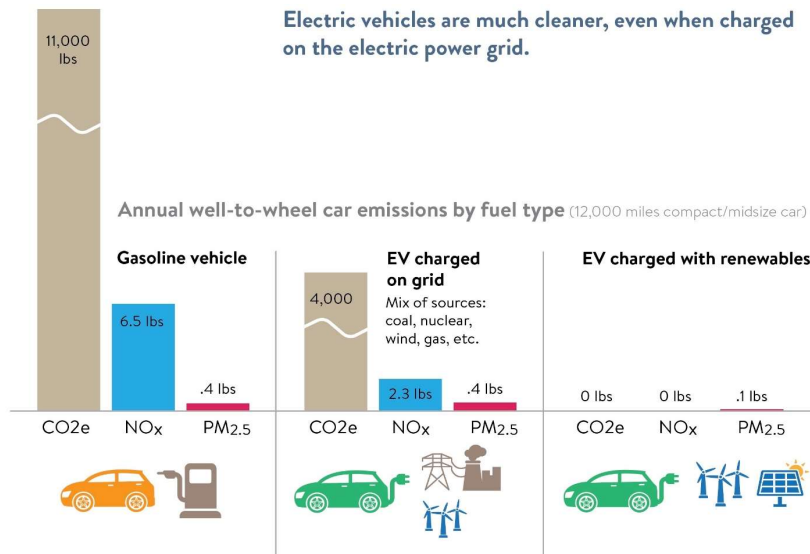


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## Benefits of electric vehicles

Electric vehicles are much cleaner, even when charged on the electric power grid.



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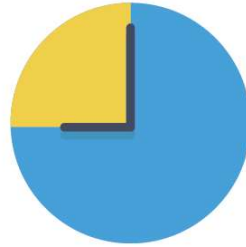
## Factors affecting community air quality



**Location**



**Temperature**



**Time of day**



**Weather**

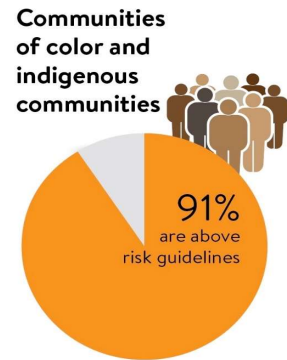
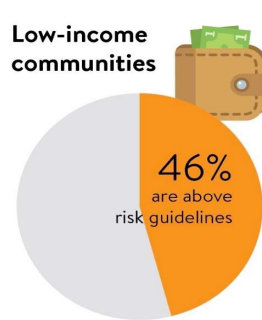
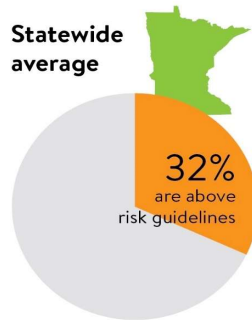
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## Those disproportionately affected by air pollution

### Air quality risk

These communities are more likely to be near higher levels of air pollution.



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## Those disproportionately affected by air pollution

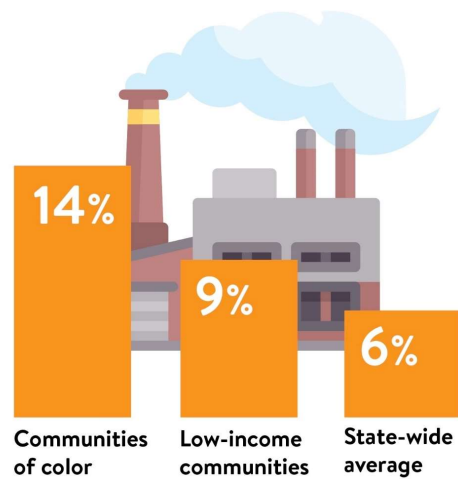
- Sources of pollution differ by community
- Common sources of concern include emissions from:
  - Boilers used in many buildings
  - Gasoline combustion
  - Wood-burning for heat
  - Facilities within communities with air emissions permits



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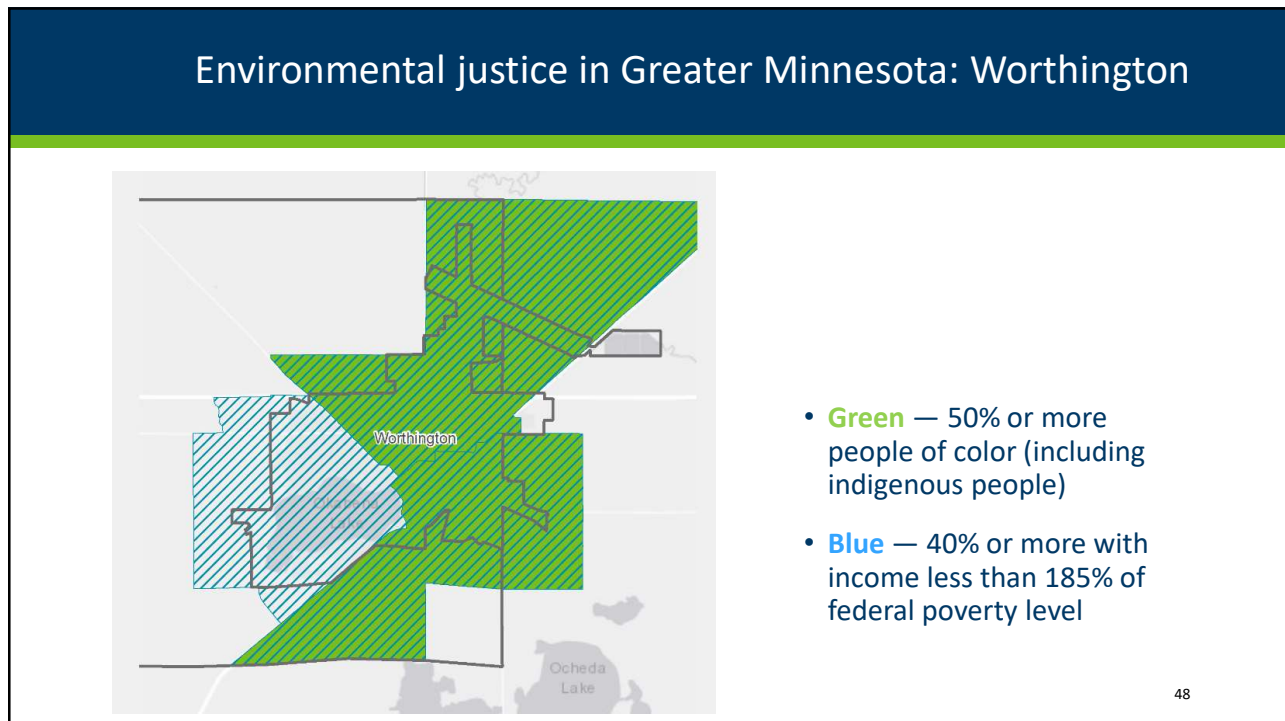
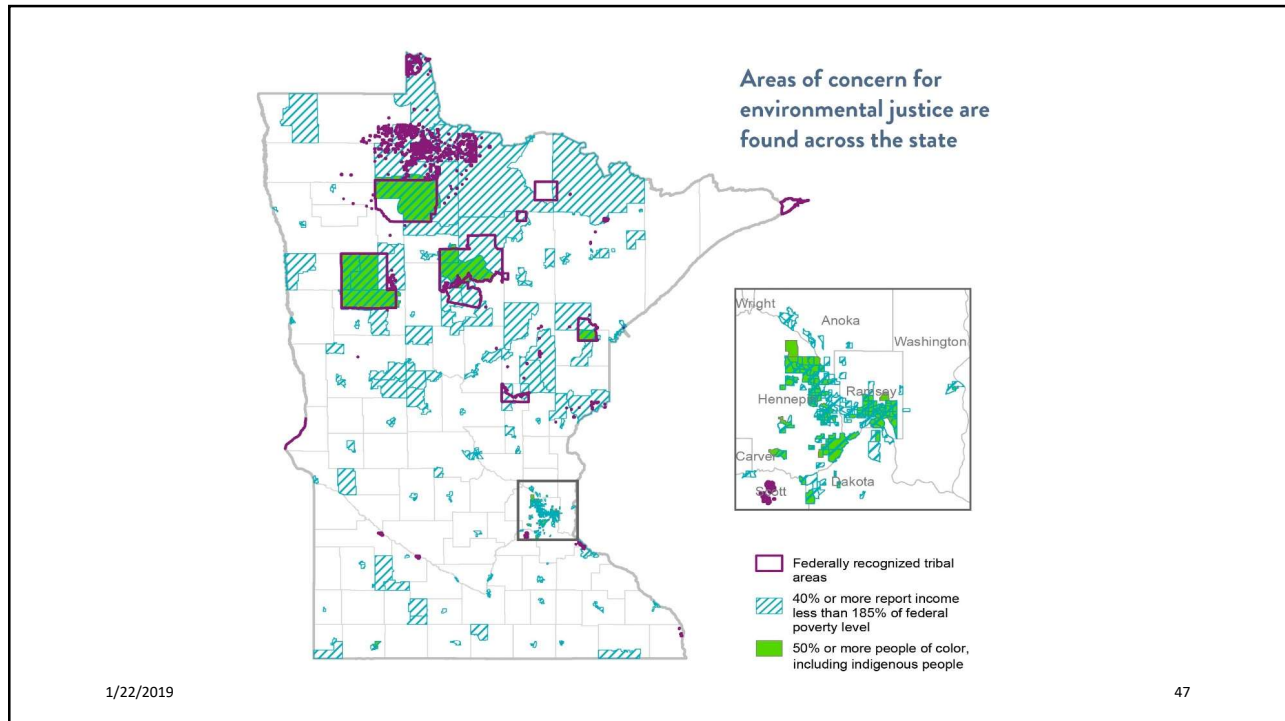
## Those disproportionately affected by air pollution



If you are a person of color or have a low income, you are more likely to live near a facility permitted to emit pollutants.

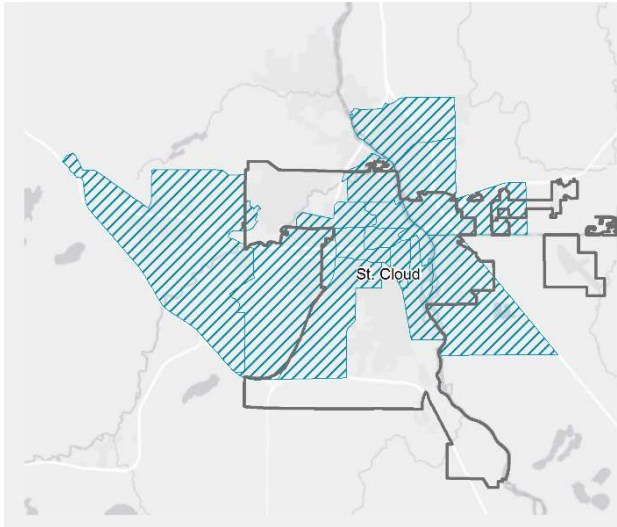
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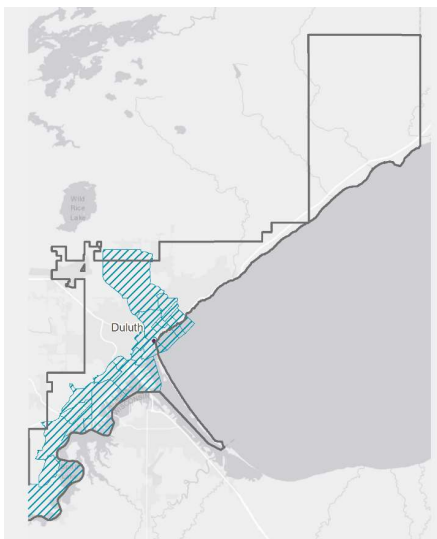
## Environmental justice in Greater Minnesota: St. Cloud



- **Green** — 50% or more people of color (including indigenous people)
- **Blue** — 40% or more with income less than 185% of federal poverty level

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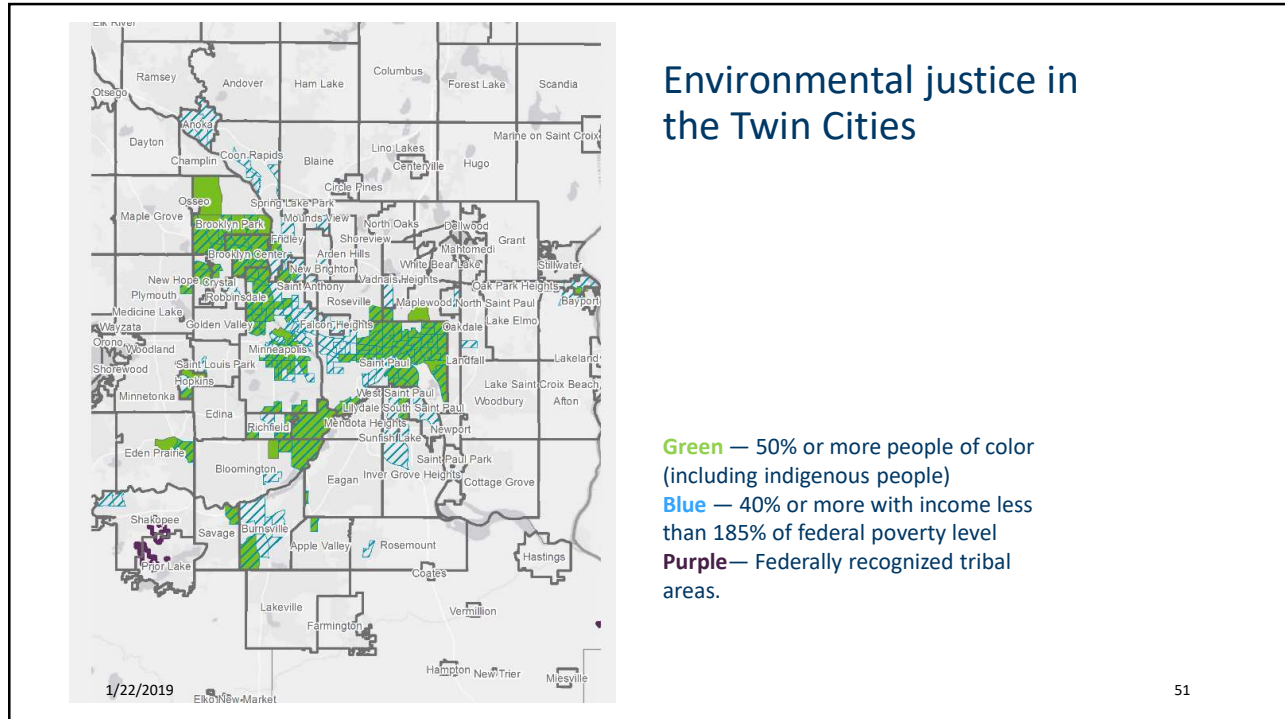
## Environmental justice in Greater Minnesota: Duluth



- **Green** — 50% or more people of color (including indigenous people)
- **Blue** — 40% or more with income less than 185% of federal poverty level

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## Web references

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The air we breathe

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**The Air We Breathe: The State of Minnesota's Air Quality 2019**  
[www.pca.state.mn.us/air-we-breathe](http://www.pca.state.mn.us/air-we-breathe)

**Air data for Minnesota**  
<https://www.pca.state.mn.us/air-data-and-tools>

**MPCA and environmental Justice**  
<https://www.pca.state.mn.us/about-mpca/mpca-and-environmental-justice>

**Areas of Environmental Justice Concern Story Map**  
<http://mpca.maps.arcgis.com/apps/MapSeries/index.html?appid=f5bf57c8dac24404b7f8ef1717f57d00>

# Questions?

**Greta Gauthier**

*greta.gauthier@state.mn.us*

651-757-2031



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