



Climate Change
and Air Quality

Industrial Emissions Management: The Good, The Bad and The Ugly



environmental affairs

Department:
Environmental Affairs
REPUBLIC OF SOUTH AFRICA

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Presentation Overview

- Introduction
- Overview of Selected Industrial Processes
 - Power Generation Industry
 - Metallurgical and Mineral Processing Industry
 - Petroleum Industry
- Emissions Inventory Analysis
- Discussions
- Conclusions

Introduction

- The discovery of gold in 1886 ignited the mining industry and its associated beneficiation processes. The country moved from agricultural based economy to mining economy
- The industry became a seed for accelerated economic development
- The country is now globally recognised as one of major producers of Gold, Platinum Group Metals, Iron, base metals, Vanadium, Aluminium and others metals
- The beneficiation of these minerals involves mining, crushing, milling, smelting, roasting and calcining. These processes are energy intensive and thus resulting in high energy demand

Introduction

- To respond to the growing energy demand, South Africa looked at coal as primary source of energy. Over 90% of our electricity is generated from coal
- Petroleum industry also contributes to meet our energy demand. South Africa has several facilities producing petroleum products like kerosene, diesel, gasoline etc. We are respected globally as pioneers in coal to liquid technology
- The Cement industry was developed to meet the growing infrastructural projects

Introduction

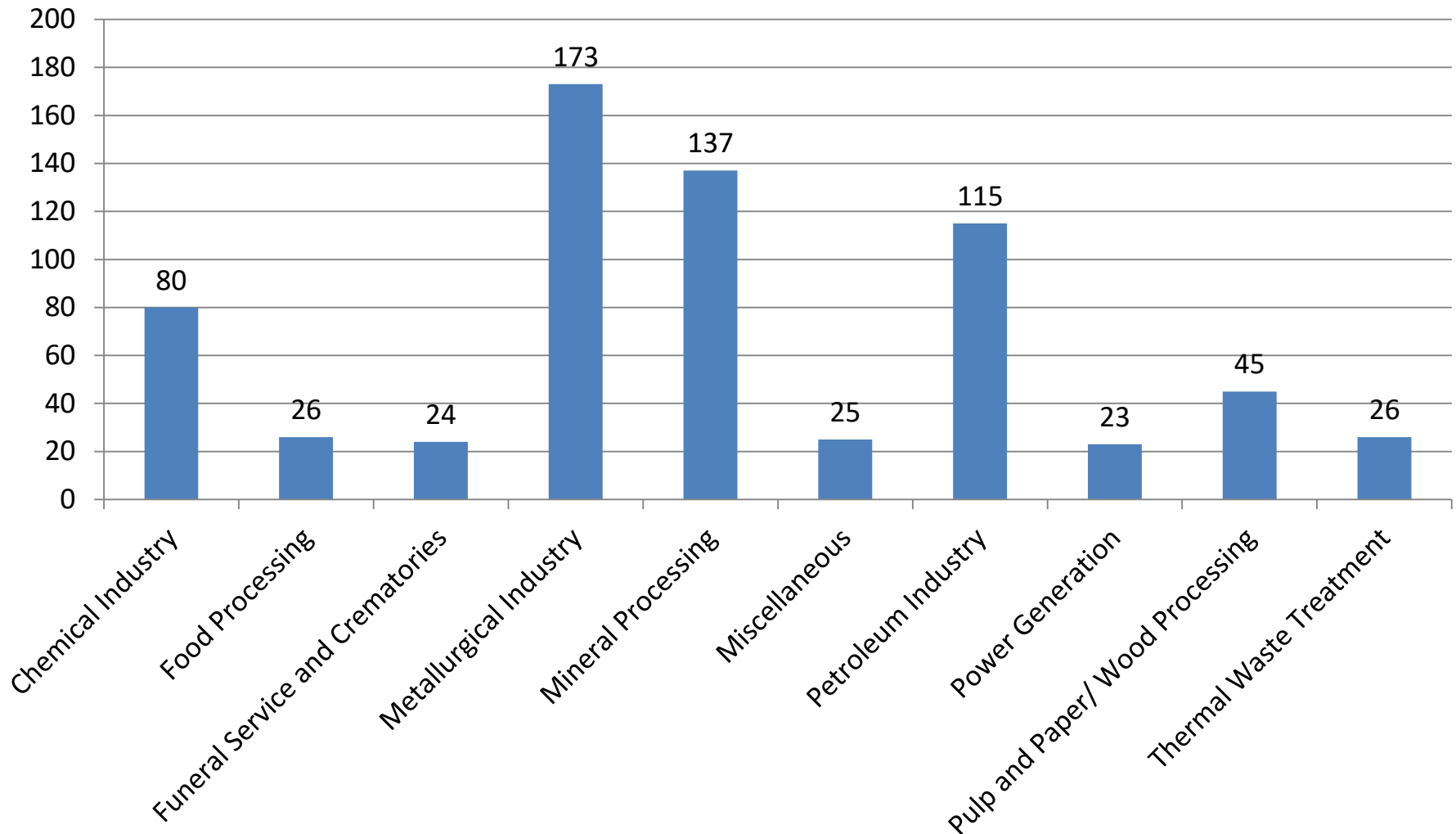
- Although these industries contribute immensely to the economy and well being of the country, there are environmental challenges associated with these activities
 - The industrial processes inherently result in atmospheric emissions
 - Most of these facilities were built in the 70s hence their technology is very old
 - The facilities are densely located and thus resulting in localised air pollution or hot spots
 - People migrated from other parts of the country and settled in the vicinity of these facilities

Emissions Management

- The objectives of this presentation are as follows:
 - To provide an overview of industrial sources,
 - To analyse the emissions profile,
 - Identify processes which are major source of emissions, and
 - To present the expected emission reduction from 2020 MES

Facilities with AEL

- Overview of number of facilities per sector



Power Generation

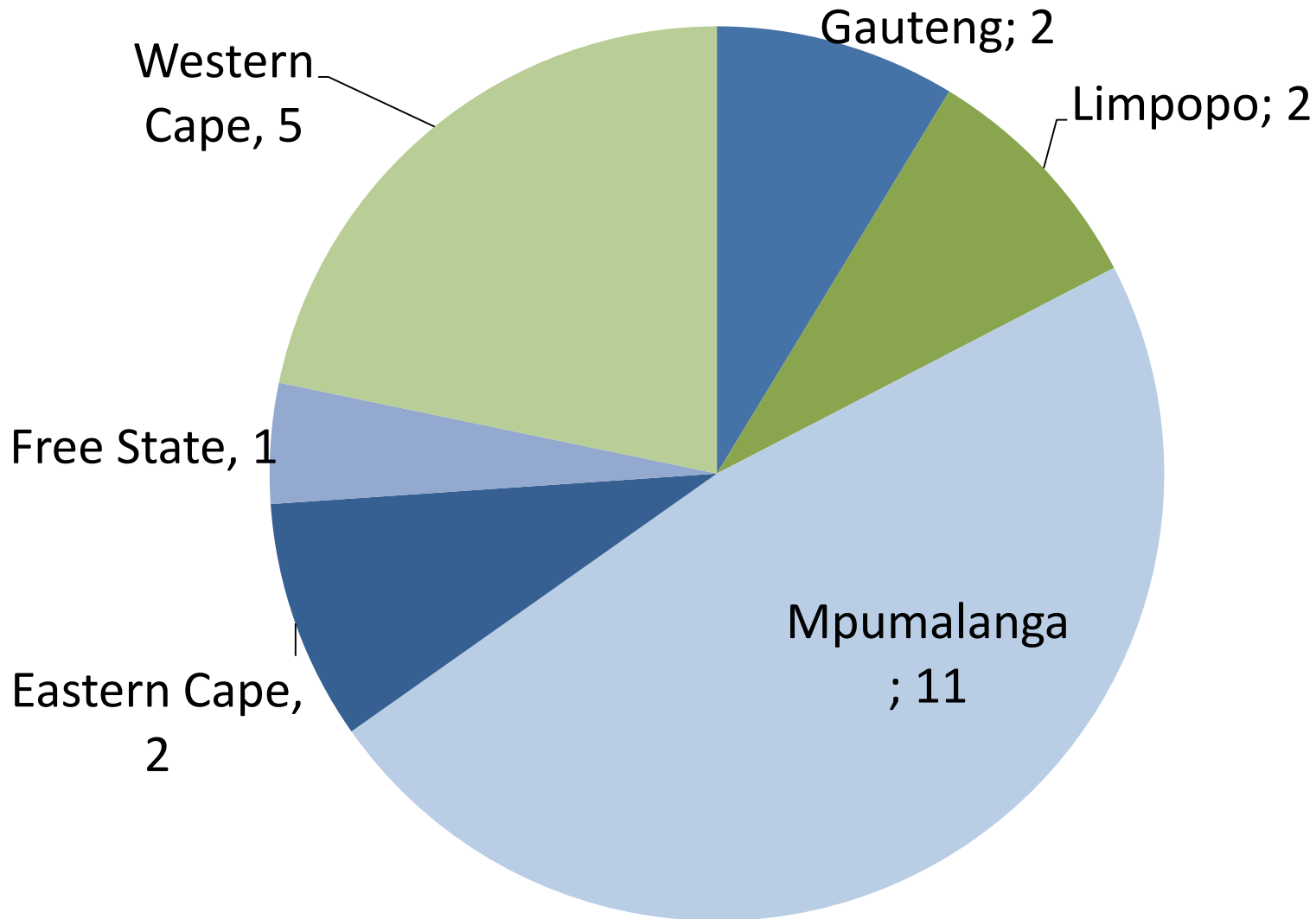
Fossil fuel fired Power Stations

- Energy is released from fuel through a combustion processes where carbon rich material or hydrocarbon is oxidized produce **heat**
 - The complete reaction with 100% yield will form CO_2 and H_2O (**Perfect world**)
 - Incomplete combustion can form intermediate product like CO , CH_4 (VOCs), soot (black carbon), NH_3
- Fossil fuel has other impurities like sulphur, heavy metals and ash

	S (%)	Ash (%)
Coal	1.47	26 - 30
Oil	6.0	very low
Natural gas	low	Very low

Power Generation

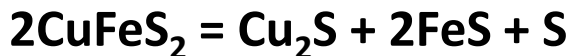
- The distribution of fossil fuel fired power stations in South Africa



Metallurgical and Mineral Processing

- The mining process and material handling activities generate considerable amount of mechanically generated dust
- The downstream pyrometallurgical processes which use processing units like kilns, calciners, roaster, furnaces and converters that operate at very high temperature
- Smelting implies chemical reactions, not just 'melting the metal out of its ore'. The furnace operate between 1400 °C to 1500 °C

Decomposition reaction Furnace

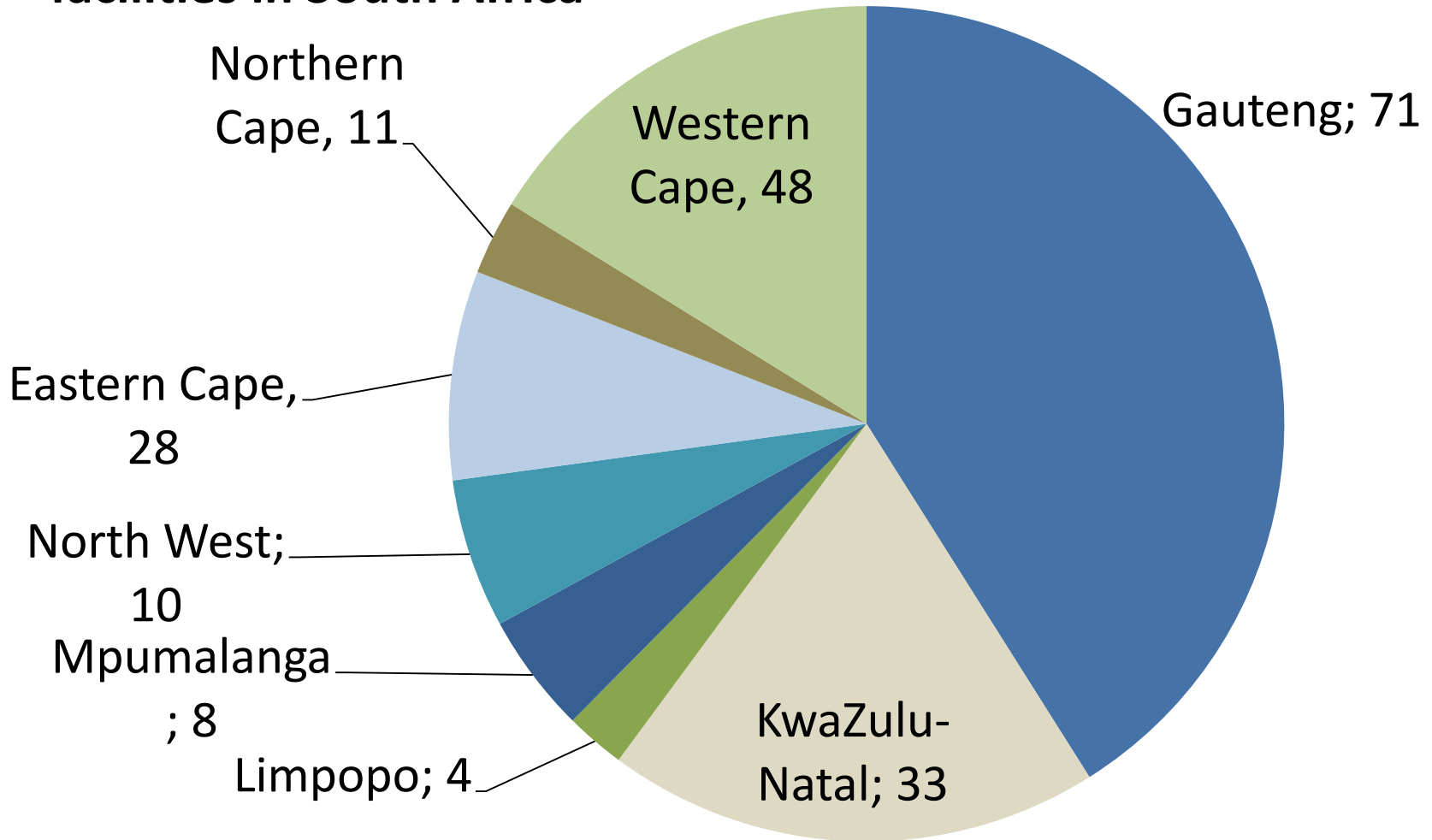


Metallurgical and Mineral Processing

- The SO_2 emissions are significantly high in the PGM and base metal smelters. This is mainly because the smelter feed (concentrate) has high sulphite minerals ($> 6\%$)
- The Ferrometals smelters operate reducing furnaces which generate H_2S in addition to SO_2 . The formation of H_2S is favoured in the reducing environment however; inherent oxygen presence does result in SO_2 formation as well
- The smelters also generate significant amount of fugitive emissions during the **taping process**

Metallurgical and Mineral Processing

- The distribution of metallurgical and mineral processing facilities in South Africa



Petroleum Industry

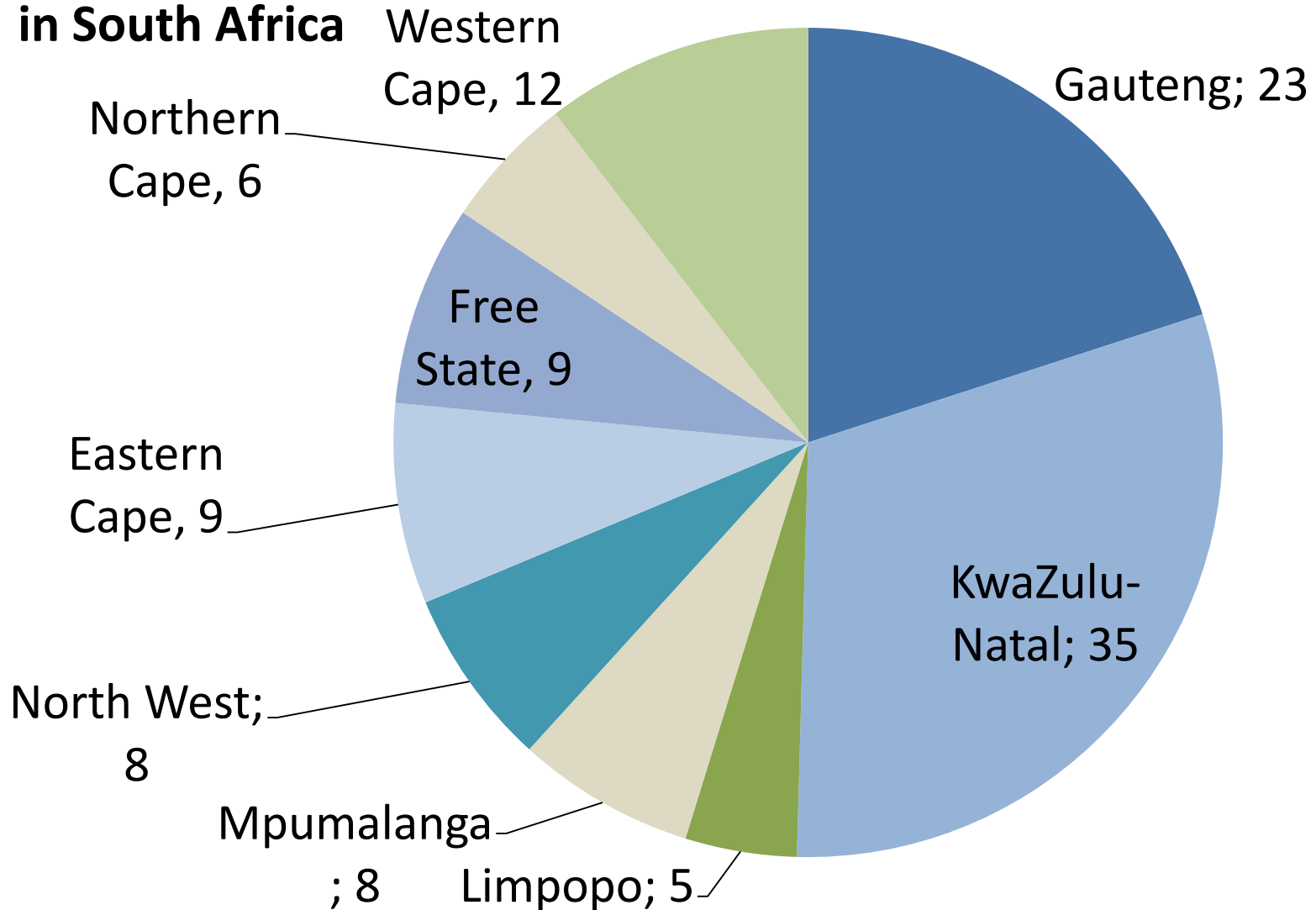
- Petroleum industry is dominated by refineries which are mostly located in the coastal cities
- The process starts with storage and handling of crude oil. Feed oil is pre-heated before it is fed into crude oil distillation column. Light products are recovered at the top of the column whilst heavy products are recovery at the bottom
- This product will go through various stages for further purification and production of different products like kerosene, diesel, gasoline etc.
- Sources of emissions in the oil refinery are fuel gas cleaning units where H_2S gas is produced, fluid catalytic cracking units, heaters/furnaces, boilers, flares, products loading and storage units
- Petroleum industry is the major source of VOCs

Petroleum Industry

- Sulphur is known to cause challenges in the refineries. The crude oil sulphur content ranges between 0.1% and 5% (De Klerk, 2008)
- The product purification units remove sulphur from the products to produce low sulphur kerosene, diesel, gasoline or fuel oil
- Most refinery use Claus process to produce pure elemental sulphur, however this is not sufficient to recover all sulphur from the feed oil. Fluid catalytic units, heaters, furnaces and flares emit a significant amount of sulphur
- Emissions from storage facilities are driven by the vapour pressure of the stored product

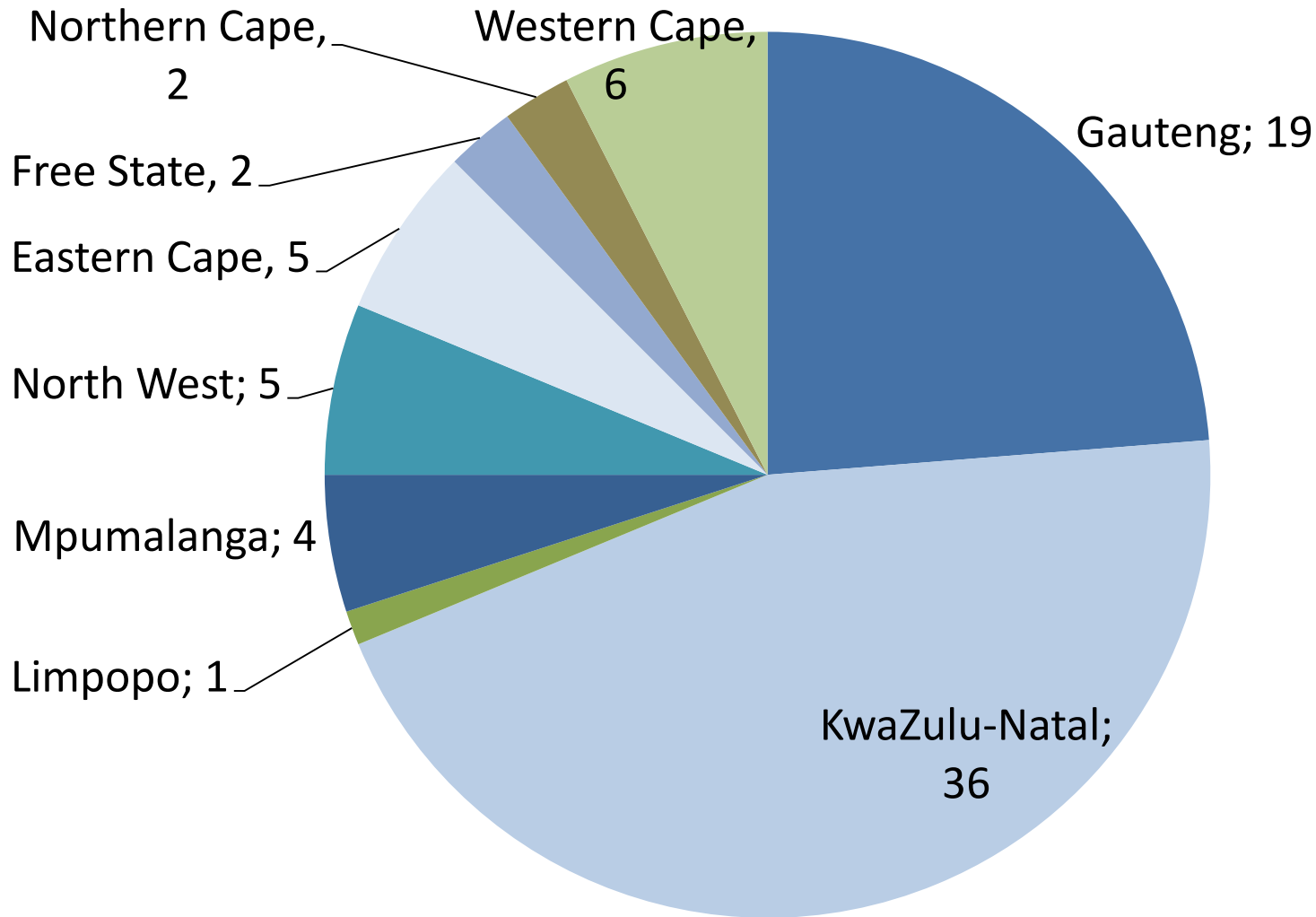
Petroleum Industry

- The distribution of petroleum production and storage facilities in South Africa



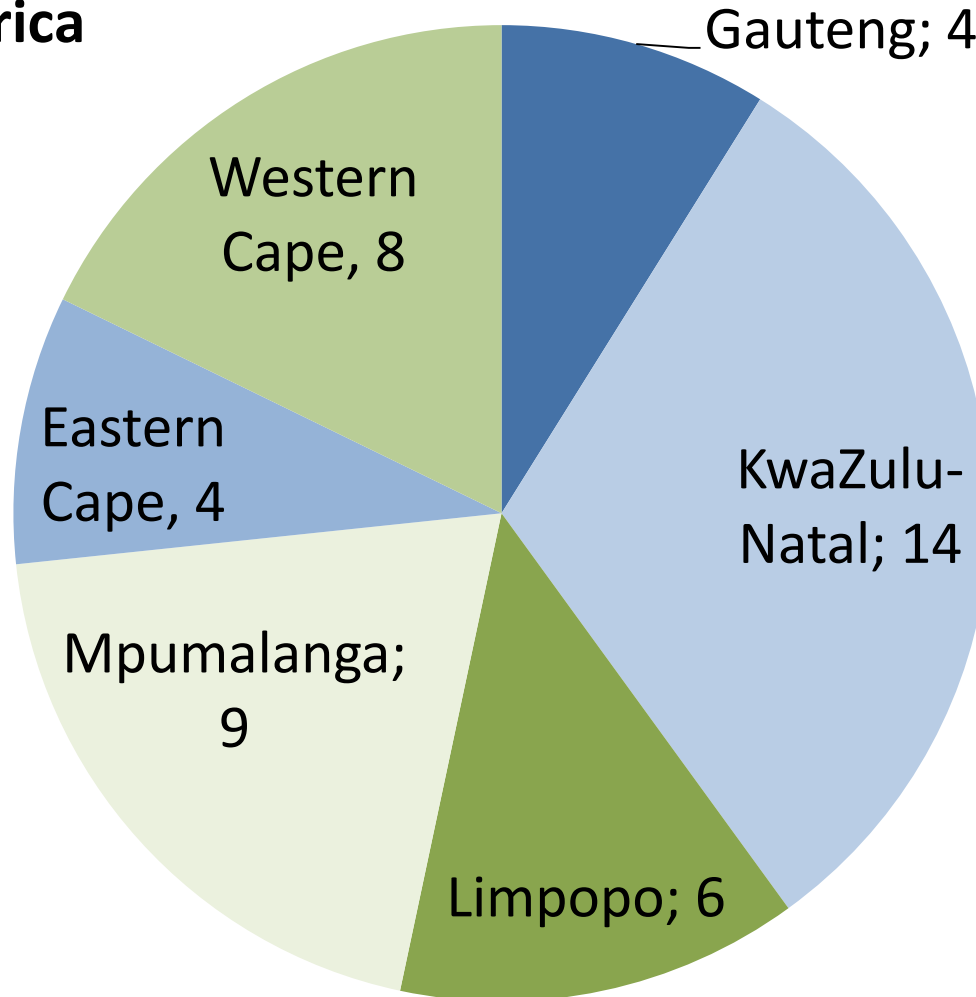
Chemical Industry

- **The distribution of chemical industry facilities in South Africa**

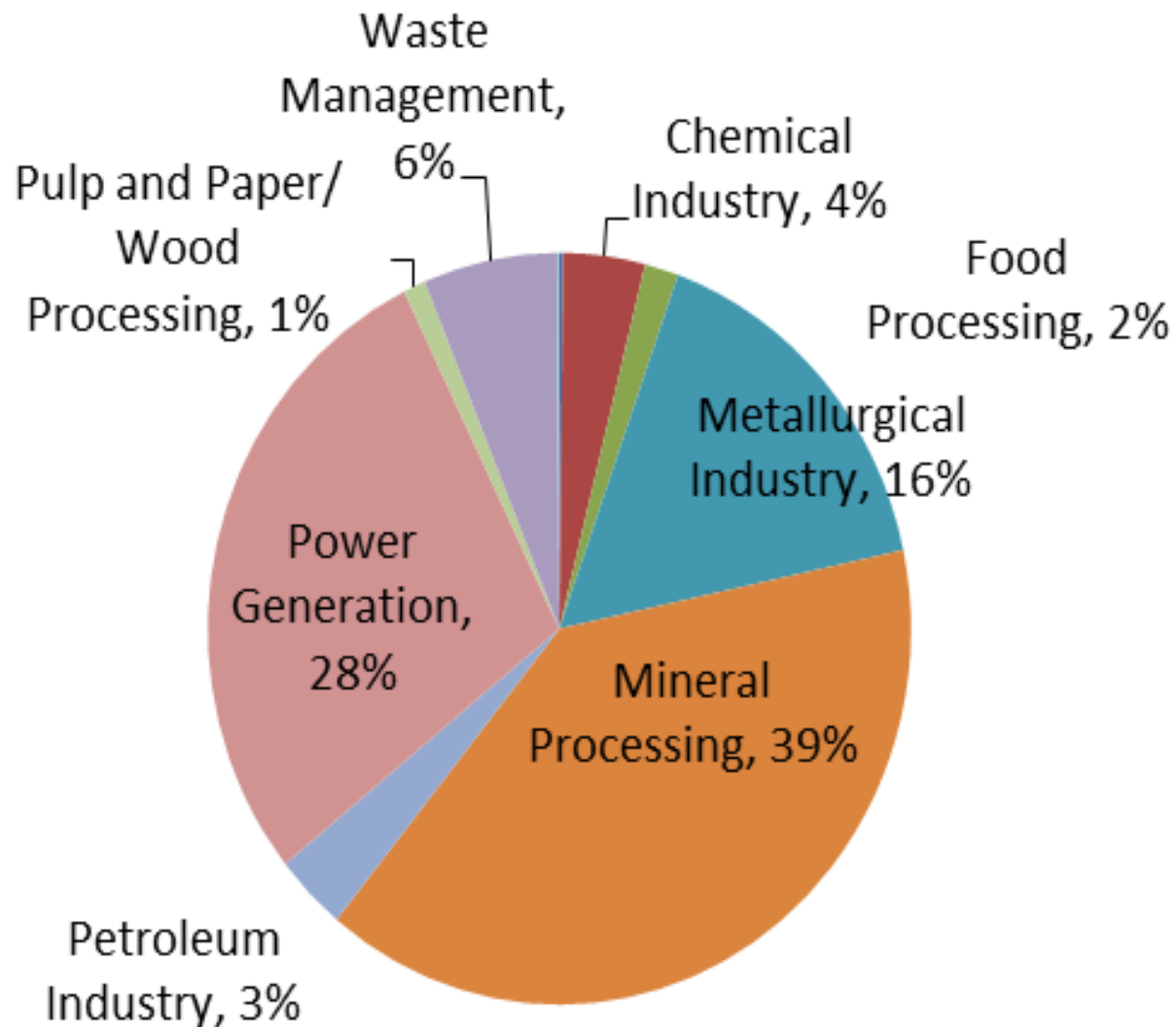


Paper and Pulp/Wood Processing

- The distribution of paper and pulp/wood processing facilities in South Africa



PM Emissions



PM10

PM Emissions

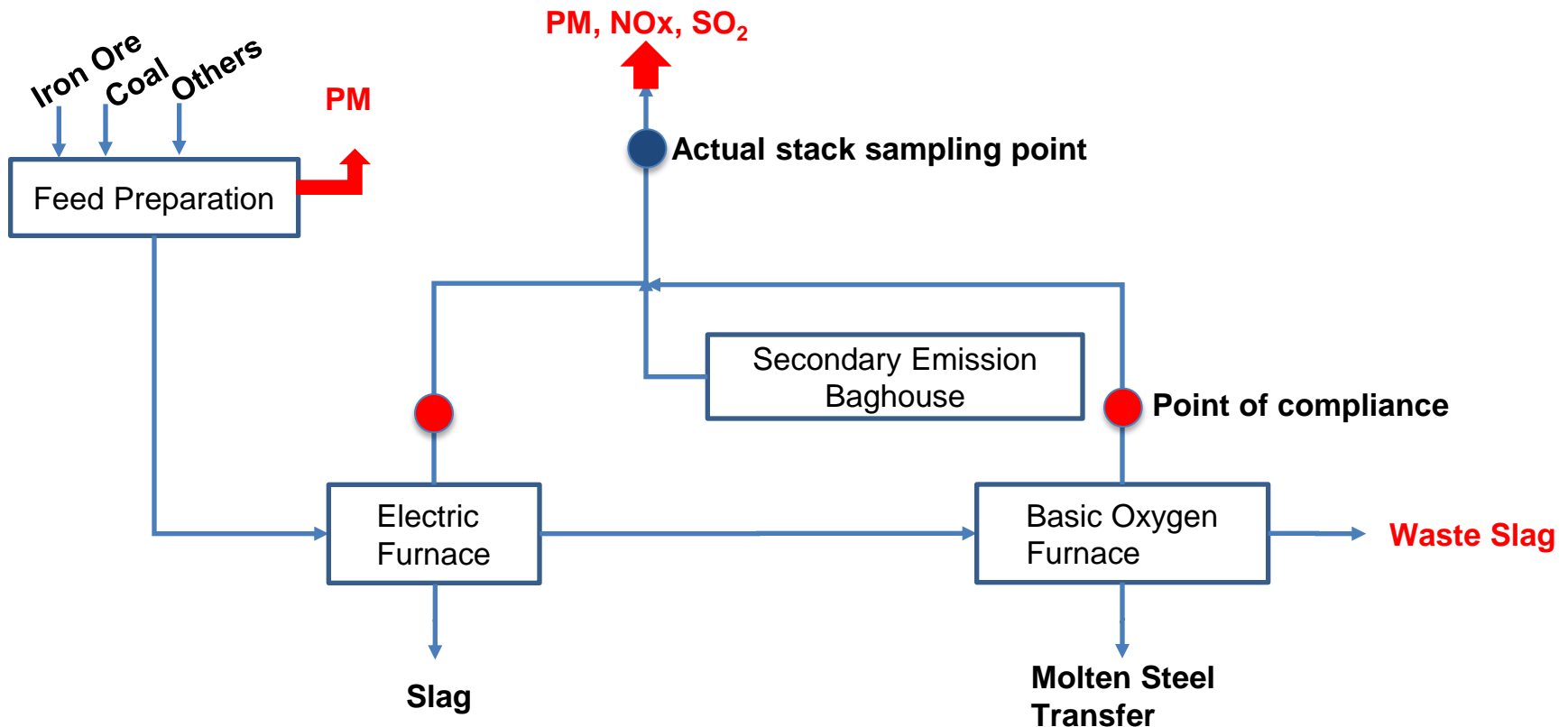
- The metallurgical and mineral processing industry contribute 55% of the PM emissions
- The main source of PM are cement kilns, ferrometals smelters and brick industry

The 2020 Standards

- The implementation of 2020 standard can achieve an average PM reduction of over 70% for iron ferrometal industry
- The cement kiln will achieve over 80% reduction in PM emissions. However fugitive emissions will remain a challenge
- Fugitive emissions are also a major source in brick industry

PM Emissions

- The secondary fume capture provision
- The emissions measurement could be improved



PM Emissions

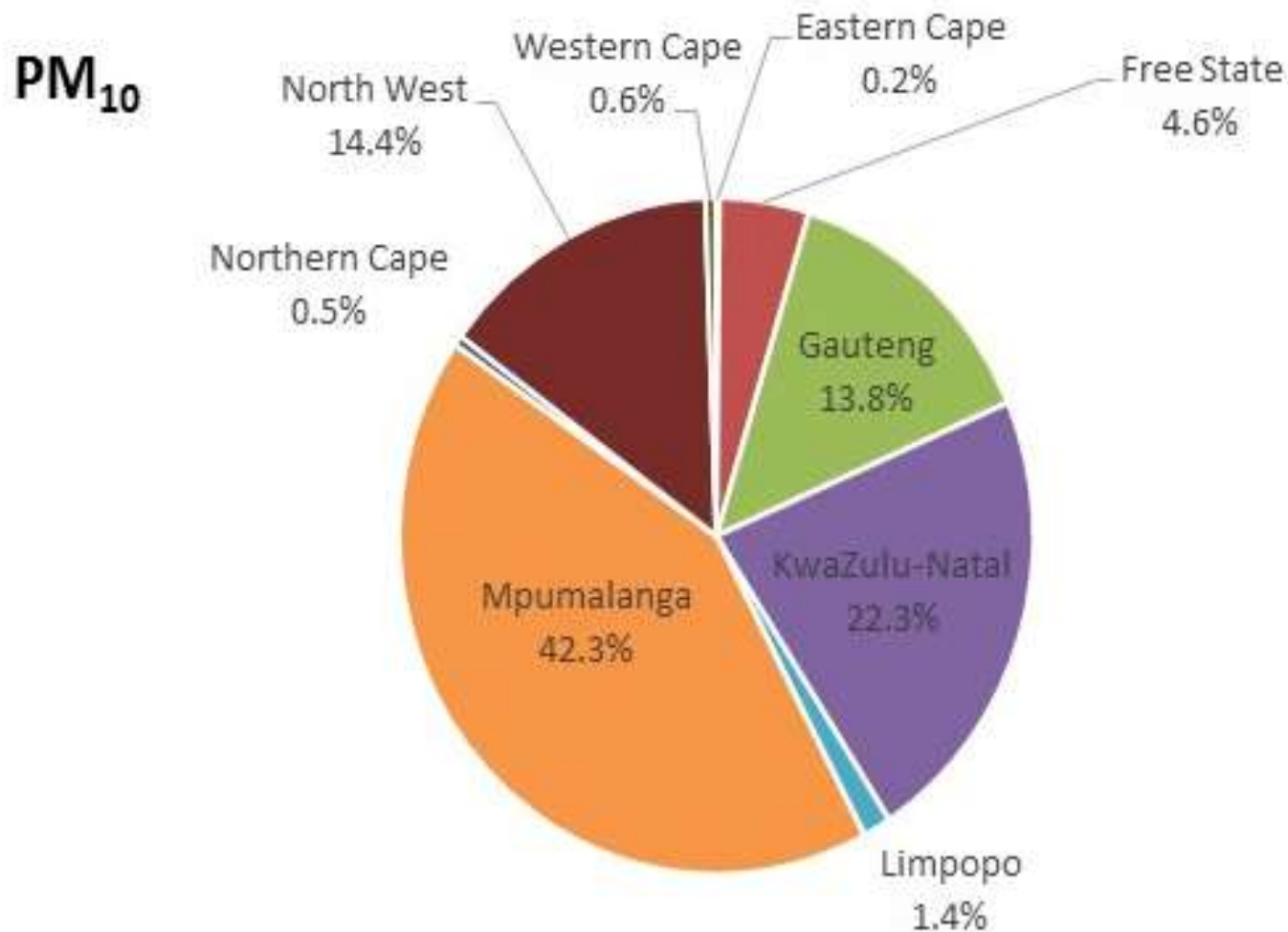
- The power generation contributes 28% of the total PM emissions.

The 2020 Standards

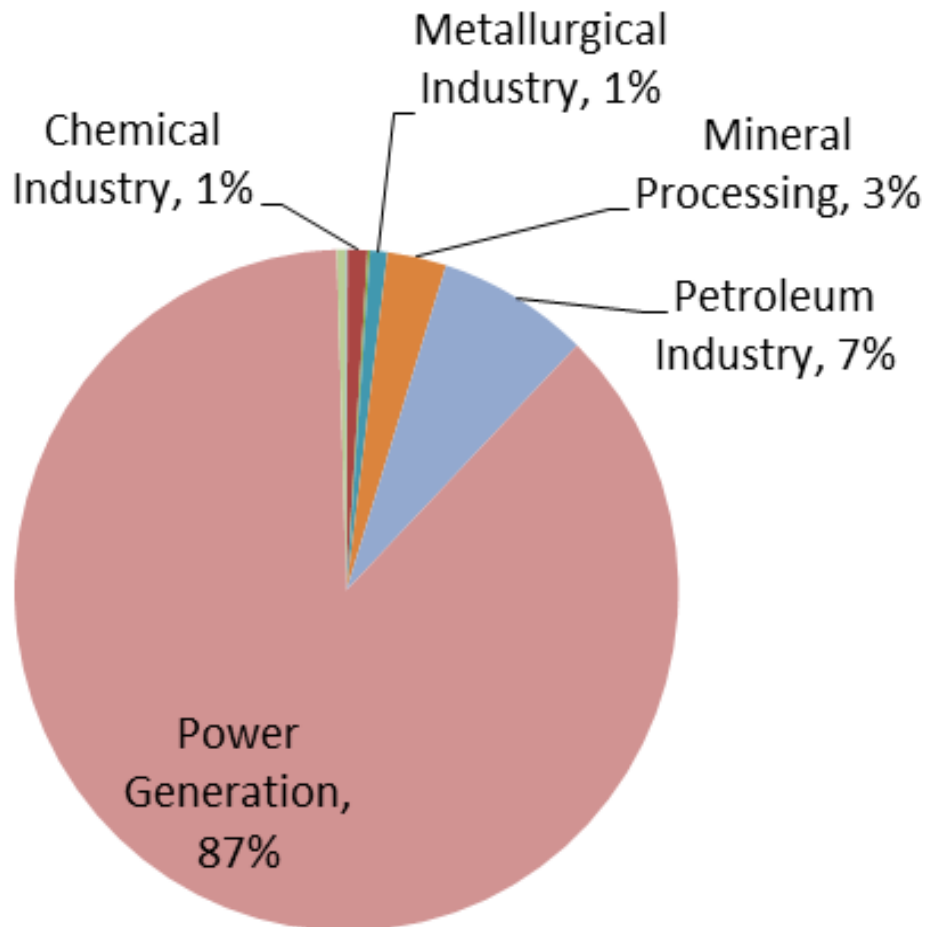
- The implementation of 2020 standard can achieve an average PM reduction of over 29%
- The existing power stations will have to upgrade their ESPs or install fabric bag filters

PM Emissions

- Interventions from Mpumalanga and Kwazulu-Natal should ensure the a significant reduction in PM emissions



NOx Emissions



NOX

NOx Emissions

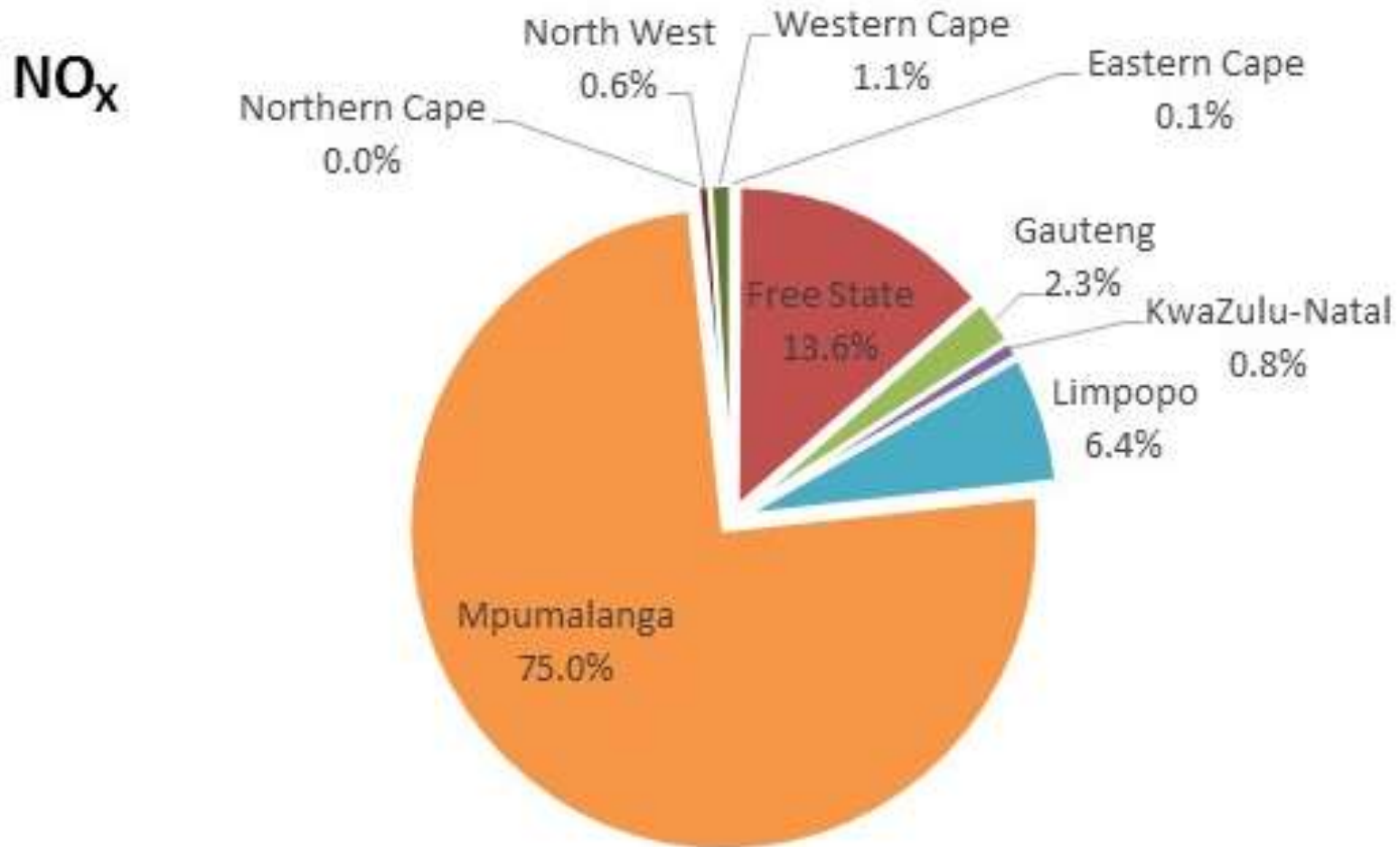
- The power generation contributes 87% of the total NOx emissions. This is attributed to high temperature oxidizing environment in the boiler

The 2020 Standards

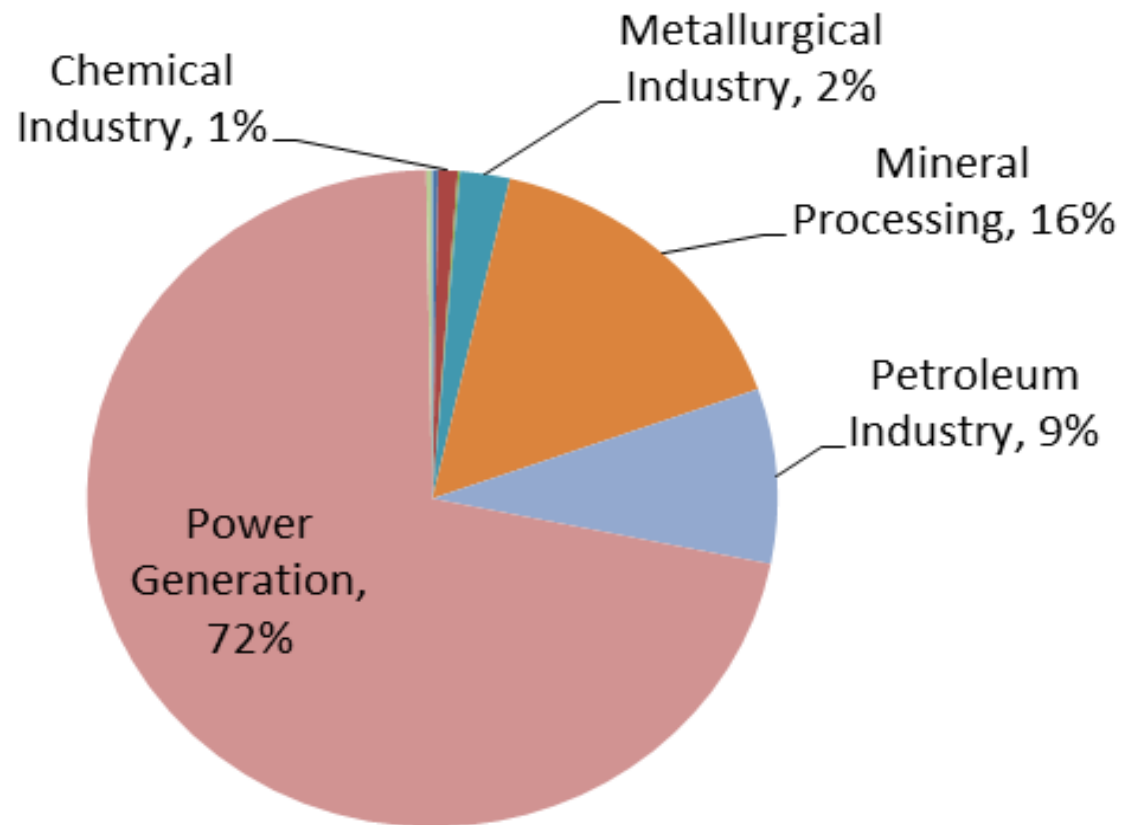
- The implementation of 2020 standard can achieve an average NOx emission reduction of over 24%. However some station can achieve 68% reduction
- The chemical industry only contribute 6% NOx emissions but they can achieve 46% NOx reduction
- The current feasible solution to achieve 2020 standard is installation of low Nox burner

NO_x Emissions

- Interventions from Mpumalanga and Free State will ensure a significant reduction in NO_x emissions



SO₂ Emissions



SO₂

SO₂ Emissions

- The power generation industry contribute 72% of the SO₂ emissions

The 2020 Standards

- The implementation of 2020 standard can achieve an average SO₂ reduction of over 70%
- Without FGD installation this cannot be achieved
- The petroleum refineries can achieve over 45% reduction in SO₂ emissions from the FCC units

SO₂ Emissions

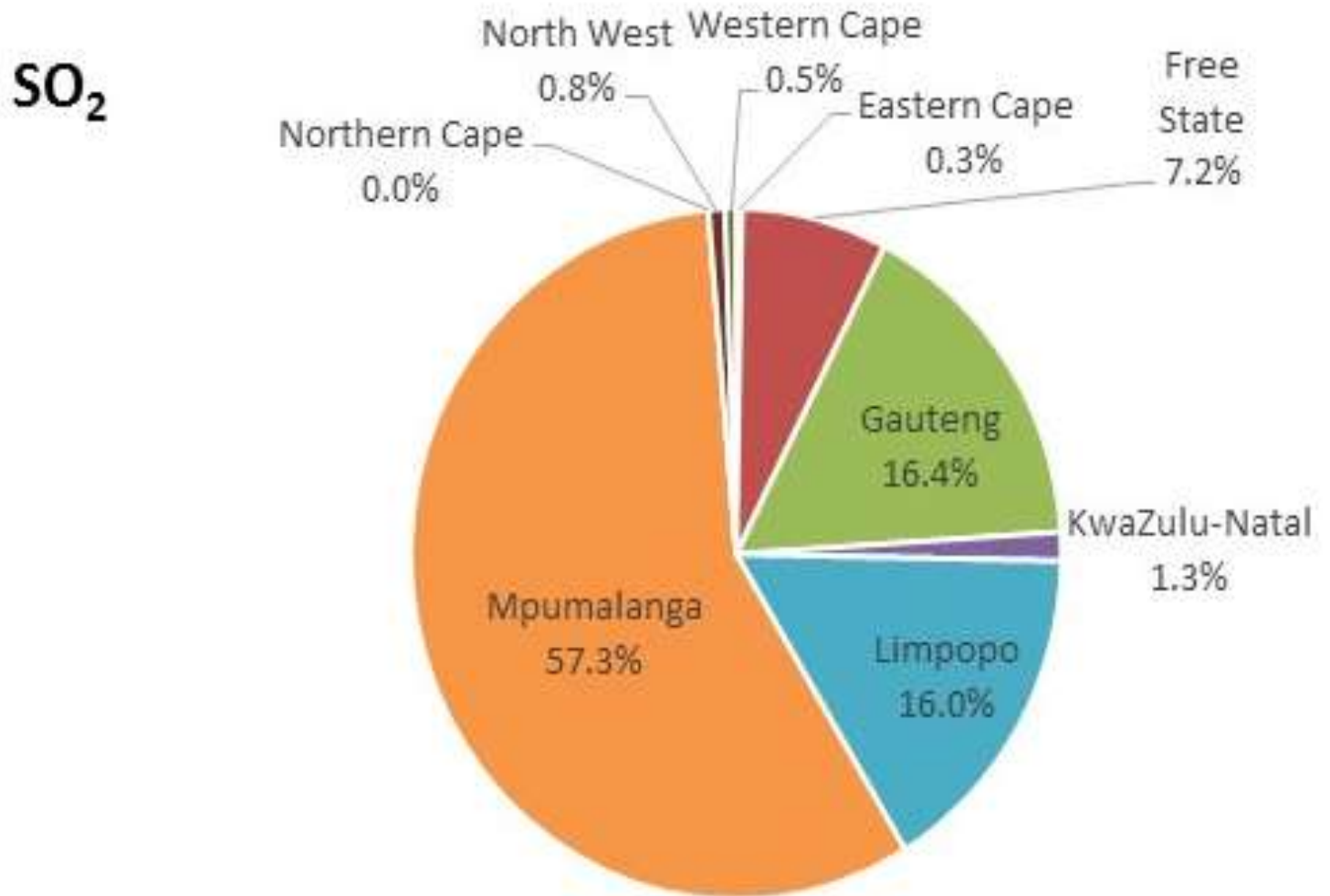
- The metallurgical and mineral processing industry contribute 18% of the SO₂ emissions
- The main source of SO₂ are ferrometals and PGM smelters

The 2020 Standards

- The implementation of 2020 standard can achieve an average SO₂ reduction of over 70% for ferrometal industry and over 80% in PGM smelters
- The PGM can achieve this by the installation of sulphuric acid plants
- Fugitive emissions are also a measure challenge that should be managed

SO₂ Emissions

- Interventions from Mpumalanga, Gauteng and Limpopo will ensure a significant reduction in SO₂ emissions



Conclusions and Recommendations

- Power generation industry is the major source of SO₂ and NO_x
- Metallurgical and mineral processing industry are the major sources of PM followed by power generation
- Mpumalanga power generation facilities are the major contributor of PM, SO₂ and NO_x in South Africa if not the whole of Africa
- Northern Free State power generation and chemical industry facility are also the major source of SO₂ and NO_x

Conclusions and Recommendations

- Gauteng and North West are contributing to PM
- Limpopo province power generation and PGM smelter also contribute to SO₂ and NO_x
- Localised SO₂ emissions from petroleum should be quantified and managed better

Conclusions and Recommendations

Industrial Emissions Inventory

- **Quality data collection** will assist in identifying processes that are major emissions source
- There is no one on planet who can produce better industrial emission inventory than us. We have the necessary data to verify and calculate inventory per facility

Conclusions and Recommendations

The 2020 MES

- The implementation of 2020 standard will reduce the PM and SO₂ emissions in South Africa
- The 2020 standard will not solve the NO_x emissions
- Targeted interventions are required
 - Lower NO_x limits in Priority Areas

Conclusions and Recommendations

Proposed Intervention

- Full implementation of 2020 MES in Mpumalanga, Limpopo and Northern Free State, North West and Kwazulu-Natal
- Enforcement activities in Mpumalanga should be prioritized
- Capacity building should be prioritised at a provincial level in Mpumalanga



Thank You

**“Legislation without an enforcement degenerates
into a wish list”**



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