Electricity Framework Review

PM Management System: Recommendations to the Electricity Framework Review Project Team for their consideration

Prepared by the PM Management System Task Group of the CASA Electricity Framework Review Project Team

April 16, 2015

Version 5

Contents

1 Introduction

Recommendation 29 of the 2003 Emissions Management Framework (the Framework) for Alberta recommends that Alberta Environment lead, in consultation with Alberta Energy and other regulatory authorities, the establishment of a formal process, to be undertaken every five years, to review certain elements of the Framework.

As part of the Five Year Review initiated in 2013, a multi-stakeholder Particulate Matter (PM) Management System Task Group was established to develop a PM Management System for existing units. This work originated from Recommendation 22 in the Framework, which stipulates:

> For existing and transitional coal-fired units, where mercury controls include fabric filters, the primary particulate matter target of 0.095 kg/MWh shall apply. If mercury control identified in the 2005 review does not provide this co-reduction of primary particulate matter, then the 2008 system review should develop a primary particulate matter management system for existing units.

2 Background

2.1. Management Approach for Primary PM

The 2003 Electricity Project Team (EPT) identified PM as a priority substance but recognized that reductions in primary PM are expected to happen as a result of the mercury management approach that was proposed. Clean coal technologies now under development were also expected to reduce primary PM emissions. As such, the EPT made the following 4 recommendations in the Framework:

Recommendation 19: Primary PM Standard

The EPT adopted the current federal guideline for primary PM as its recommended standard. This guideline came into effect in April 2003 and many coal units are close to that level now. Thus the EPT recommends that Effective January 1, 2006, the primary particulate matter standard for new coal-fired units be 0.095 kg/MWh.

Recommendation 20: Regulation of Primary PM

The team believes that the current system for regulating primary PM is adequate and recommends that Alberta Environment regulates primary particulate matter on a unit-by-unit basis through the Environmental Protection and Enhancement Act approval process.

Recommendation 21: Five-Year Review

As part of the Five-Year Review in recommendation 29, the EPT recommends that every five years, commencing in 2008, the technology be reviewed to determine BATEA level of the day for primary particulate matter, as part of the process described in recommendation 29.

Recommendation 22: Co-benefits of Mercury Control

By controlling mercury through the use of fabric filters, emissions of primary particulate matter are also expected to decrease. The EPT was of the view that the co-benefits of controlling mercury would be adequate to address primary particulate matter and thus recommends that for existing and transitional coal-fired units, where mercury controls include fabric filters, the primary particulate matter target of 0.095 kg/MWh shall apply. If mercury control identified in the 2005 review does not provide this co-reduction of primary particulate matter, then the 2008 system review should develop a primary particulate matter management system for existing units.

2.2. 2008 Five-Year Review

When the Framework was developed, the applied mercury control technology was expected to include activated carbon and compact bag houses (compact hybrid particulate collector, COHPAC); this technology was expected to have the co-benefit of significantly reducing primary PM emissions. The potential co-benefit of improved primary PM capture was not realized due to several factors. The initial challenges with the development of COHPAC technology were not overcome and it was found that advanced sorbent technology could achieve a good mercury capture rate with existing particulate control technology (electrostatic precipitators). Enhanced activated carbon sorbents in conjunction with existing electrostatic precipitators became the preferred technology for mercury removal, and thus the expected co-benefits of mercury control in terms of primary PM reductions to 0.095 kg/MWh (the BATEA PM emission level established in the 2003 Framework) were not realized.
As such, the 2008 Electricity Framework Review (EFR) Team needed to propose a specific plan to manage primary particulate matter. The team drafted terms of reference for a task group to develop a management plan for primary particulate matter.

To support the completion of this work, the task group hired Eastern Research Group (ERG) to assess PM controls on existing coal-fired electricity units in Alberta and determine the performance of the PM controls. They delivered their final report entitled "Electricity Framework Review – Evaluation of Existing Particulate Matter Management in Alberta" in September 2010. An attempt was made by the task team to develop a formal PM management plan. However, no agreement could be reached on the format and content of such a plan.

In roughly the same timeframe, the Federal Government introduced the Air Quality Management System (AQMS), which included the Base Level Industrial Emission Requirements (BLIERs) to reduce nitrogen oxides (NOx) and sulphur dioxide (SO_2). Additionally, the Federal Government started discussions about a new federal GHG regulation. In March 2011, the CASA Board of Directors agreed to put the 2008 EFR Team and task groups into abeyance until the proposed BLIERs concept and GHG Regulations were better understood and developed.

3 2013 PM Management Task Group

In their initial meetings, the 2013 PM Management Task group reviewed work-to-date, including the 2010 ERG report and discussed their mandate. They agreed to the following process:

1. Industry members will develop a detailed description of current PM management programs and activities and future plans for continuous improvement.
   - This should include a detailed review of current PM management optimization activities (since 2003).
   - This review should include an assessment of each of the options identified in the 2010 ERG report.
   - For each option, the assessment should state whether the facility/unit has implemented the option.
   - If the facility/unit has not implemented the option, a rationale should be provided, including as much detail as possible. Information on costs would be helpful. It is understood that detailed information may need to be presented on a sector basis to ensure anonymity.
   - The assessment could include a commitment to exploring any of the options further.
   - The assessment should be on a facility basis, due to the variable ash content of coal.

2. The task group will review each assessment collaboratively, allowing for comment from each member.

3. Based on the sum total of these assessments, the group will discuss whether current PM optimization is sufficient, or whether a PM Management System does, in fact, need to be developed.

4. The need for a PM Management System should be reevaluated at each Five-Year Review.

The group had considerable discussion on the general intent of the Framework in terms of PM management. The issue was whether or not, in the absence of specific PM Management Plan, PM was to be treated similar to SO_2 and NOx in terms of end of design life BATEA requirements. No consensus could be reached on this issue.

3.1. Industry Report

To complete Step 1 listed above, industry stakeholders provided a report entitled "Particulate Matter Emissions from Existing Alberta Coal-Fired Generating Stations, December 16, 2014." (Appendix A). The report states that

> Based on Alberta Environment and Sustainable Resource Department data, Primary PM emission from the coal-fired power plants have fallen from 9931 tonnes in 2002 to 5542 tonnes in 2013, a decrease of 44% over 12 years. The emission reductions were achieved through upgrades and improvement to control equipment (consistent with those listed in the 2008 ERG report) and the changing makeup of Alberta's electricity sector with a shift from coal-fired generation to (primarily) gas-fired generation. Three major impacts on future trends are expected to drive the sector's future performance in primary PM

emissions: the continued maintenance and improvement to the existing primary PM control equipment; the continued shift in generation from coal to gas; and the impact of the federal Reduction of Carbon Dioxide Emissions from Coal-fired Generation of Electricity Regulations which will result in the shutdown of coal-fired units starting in 2020.

The ENGOs have reviewed this report, and its underlying model, and disagree with a number of assertions and conclusions. It is their view that:

- Continuous improvement is a Framework commitment provided in exchange for industry exemption from regulated improvements to existing units *only* up to the unit's End of Design Life;
- The industry-proposed Business as Usual (BAU) will result in PM emissions significantly higher than Framework emission projections – clearly exceeding the Emissions Growth Trigger of 15% (Recommendation 34 in the Framework);
- The historical reduction in PM mass emissions (44% from 2002-2013) is a significant overstatement of industry-driven continuous improvement actions;
- Future industry capacity to achieve reductions through ongoing continuous improvement of currently installed technology is unlikely; and
- Annual decline in provincial coal-based generation is overstated – further exacerbating potential exceedances of PM emissions above that projected by the Framework.

Industry believes that the Emission Growth Trigger of 15% for PM has not been reached. Through the analysis of the assumptions, some mistakes and inappropriate assumptions were discovered in the 2003 and 2008 emission forecast reports. EDC's states in the final report[1]

> Past forecasts used a generic set of intensity assumptions that tended to be lower than actuals – 0.095 kg/MWh for existing coal and 0.066 kg/MWh for future coal (with the exceptions of the 3 Battle River units at 0.230 kg/MWh, Sheerness at 0.13 kg/MWh, Sundance #1/#2 at 0.11kg/MWh and HR Milner at 0.81 kg/MWh). In the 2009 forecast, 2016 sees a steep drop due to the assumed retirement of several high intensity units - Battle River #3 and #4, as well as HR Milner – without any replacement coal-fired capacity taking their place. This drop is not as steep in the 2003 forecast because the Battle River retirements were staggered and HR Milner was assumed to have retired in 2005. This is also the reason the 2003 forecast is noticeably below the 2009 forecast. Had HR Milner not been retired in 2005, the 2003 forecast would have started, and stayed, higher, albeit remaining below the 2009 forecast because of less forecast coal-fired generation.

4 Need for a PM Management System

Through Steps 2 and 3 listed above, the group discussed whether current PM optimization is sufficient, or whether a PM Management System does, in fact, need to be developed.

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[1] Electricity Framework 5 Year Review Generation & Emissions Forecasts, September 3, 2014

The Non-Government Organization (NGO) members of the PM Management Task Group have prepared a discussion paper (Appendix B) that provides a detailed assessment of the PM management issue and the reasons why development of such a system is a requirement, not an option, in terms of implementing the Framework. In summary, the NGOs believe that a PM Management System is clearly required as per Recommendation 22. NGOs proposed a number of possible options for such a PM management system. None of these options were pursued in detail as some industry members took the position that the "status quo" for PM management and requirements is adequate. Other industry members had the perspective that no action should be taken until the GoA makes a decision on the 2014 CASA EFR Interim Report. The NGOs do not accept either of these positions as one represents "business as usual" and the other links PM management to GHG management, which is inconsistent with the approach for SO_2 or NOx. In the absence of consensus on a PM management system, it is the NGO position that the Framework requires a unit, at the end of design life, to meet the BATEA of the day for PM control. NGOs recognize that, to be consistent with the SO_2 and NOx BATEA limit requirements at the end of design life, a mechanism should be established that would provide industry with some flexibility in how the BATEA PM limits could be met. E.g. credit generation and/or use. NGOs proposed some flexibility options. It was industry's position that BATEA limits for PM do not apply at the end of a unit's design life which the NGOs consider to be contrary to the spirit and intent of the Framework. From the NGO perspective, these two fundamental areas of disagreement i.e. that "status quo" fulfills recommendation 22 and that units at the end of design life do not have to meet BATEA PM limits, resulted in no meaningful progress on the fulfilling Recommendation 22. Since this is the second attempt to implement Recommendation 22, the NGOs question whether or not the Framework is being implemented as intended, and can, or should, still be considered to represent a consensus framework. These issues are elaborated on in detail in the NGO discussion paper.

Capital Power has provided a discussion paper (Appendix C) stating that existing coal-fired units are currently being regulated with respect to PM on a unit-by-unit basis through the EPEA approval process. The Minister of AESRD, in a letter to CASA dated August 13, 2014 advised that, pending the completion of the Government of Alberta's (GOA) consideration of the non-consensus report submitted by 2014 EFR, the existing Alberta Framework would remain in effect and be the basis for regulatory decisions. Once direction regarding the non-consensus report is provided by the GoA, Capital Power believes that a new PM Management System based on End of Design Life (EoDL) and flexibility should be developed to provide regulatory clarity for investors and provide compliance flexibility to bridge the compliance gap between EoDL and 50 years. Flexibility compliance options can be discussed at that stage. In addition, units that reach EoDL prior to a new Management System being developed should have special compliance provisions to accommodate their transition to the new Management System. Capital Power does not expect that such units will be grandfathered indefinitely but will comply with the new Management System at later stages.

Industry members feel that the current management activities for PM are sufficient (Appendix D). Areas where ambient PM has the potential to exceed provincial objectives should be dealt with on a unit-by-unit basis as described in *Alberta's Guide for Responding to Potential "Hot Spots" Resulting from Air Emissions from the Thermal Electric Power Generation Sector*. The electricity sector contributes less than 6% to Alberta's non-open source reported PM emissions and has control equipment in place to capture more than 99% of PM. Emissions have been reduced over the past 12 years and reductions are expected to continue in the future. The sector is responding to broad market forces in shifting away from coal, and to the federal GHG regulation that will drive significant capital stock turnover in the years ahead, and so the sector's PPM emissions will continue to decrease into the future, and potentially surpass the original CASA emission projections, without any additional regulatory action. The current management approach for PM is successful and further measures are not required.

The GoA has provided a discussion paper (Appendix E) assessing the historical PM management. Additionally, the GoA has stated in discussions at the PM Management subgroup that the end-of-design-life PM control requirements, while very important, are actually a subset of the broader discussion around the end-of-design-life requirements of existing coal units. Any decisions moving forward would have to consider this aspect and a decision would not be made in isolation. As such, the GoA has asked for stakeholders to provide their interests and thoughts.

Appendix A

Particulate Matter Emissions from Existing Alberta Coal-Fired Generating Stations (prepared by Barr Engineering and Environmental Science Canada Ltd and submitted by Industry representatives to the CASA 2013 EFR)

BARR

Particulate Matter Emissions from Existing Alberta Coal-Fired Generating Stations

Prepared for
CASA 2013 Electricity Framework Review, PM Sub-group

Prepared by
Barr Engineering and Environmental Science Canada Ltd.

December 16, 2014

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1 Introduction

In 2003, the Clean Air Strategic Alliance (CASA) *Emissions Management Framework for the Alberta Electricity Sector* (EMF) recommended a primary particulate matter (PPM) standard for new units and that PPM be regulated on a unit-by-unit basis through the Environmental Protection and Enhancement Act (EPEA) approval process (recommendations #19 and 20).

The CASA Particulate Matter Management Plan Task Group is tasked with developing a primary particulate matter management system for existing coal-fired units. This report, a component of the framework's second five-year review, provides an update on the coal-fired generating unit PPM emissions performance and projected future emissions.

The coal-fired generating unit PPM emissions data was obtained from Alberta Environmental and Sustainable Resource Development (ESRD) and additional emissions data was obtained from the federal government's National Pollutant Release Inventory (NPRI) website. The electricity generation data is from the Alberta Electric System Operator (AESO) website. Information on specific unit performance and control equipment maintenance and improvement initiatives is from three of the companies that operate coal-fired electricity generation units in the province.

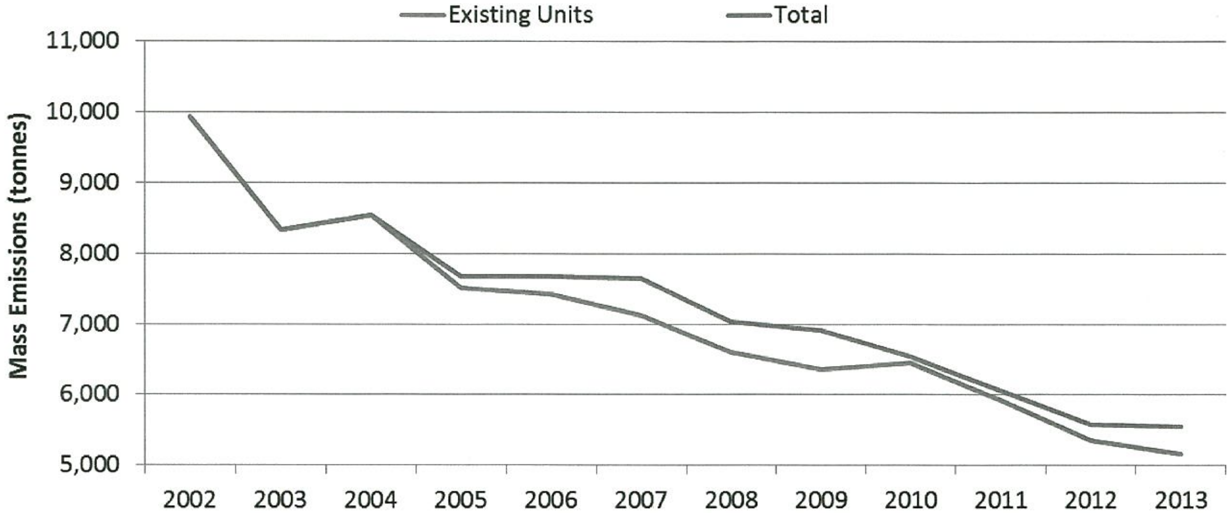
At the time the CASA EMF was developed in 2003, there were 19 existing coal-fired units in the province. All of these units have electrostatic precipitators (ESPs) for particulate matter control, except for H.R. Milner which has a fabric filter (FF). ESPs and FFs are designed to capture more than 99% of particulate matter. Since 2003, two new coal-fired generation units with FFs have been added (Genesee 3 and Keephills 3) and three units with ESPs have been retired (Wabamun 1, 2 and 4). The following sections describe the PPM emissions from the province's coal-fired generation units, and the actions taken by three companies that operate coal-fired generation units to reduce PPM emissions.

2 Emission Profiles

2.1 Coal PPM Emission Profile

As a starting point, we look at the most basic information: what have the emissions of PPM from existing coal-fired power plants been in Alberta, over the timeframe since the CASA process began? Figure 1 displays the total PPM emissions from existing (i.e. existing in 2003) and all coal-fired units from 2002 to 2013.

Figure 1 Coal-fired Power Plant PPM Emissions



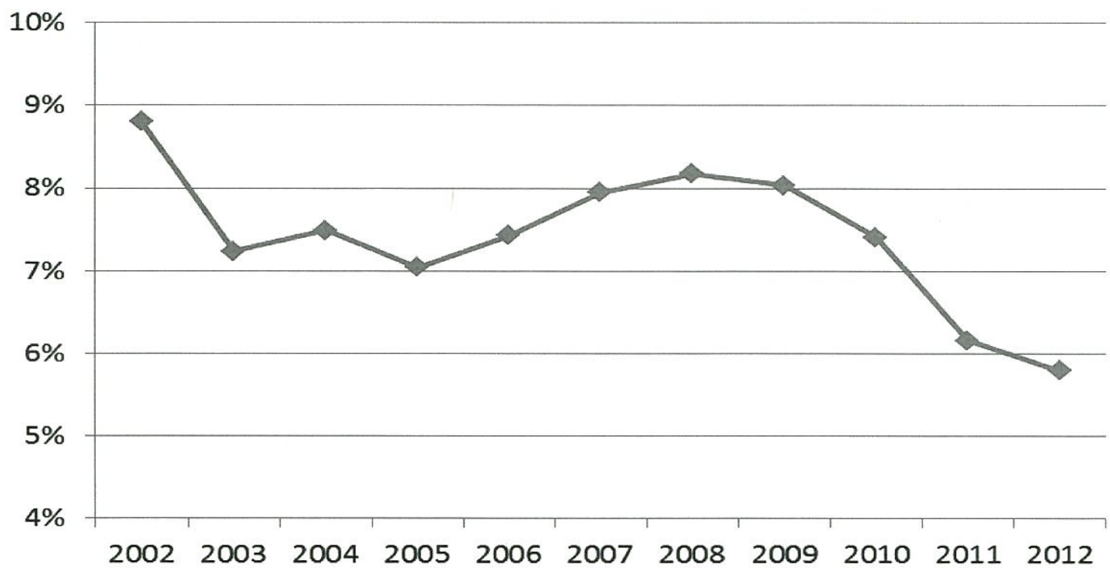
As can be seen, total PPM emissions from the sector have fallen from 9931 tonnes in 2002 to 5542 tonnes in 2013, a decrease of 44% over that time period. This represents a significant and steady improvement in the absolute contribution of the coal-fired electricity sector to Alberta's air quality. We examine the factors driving this performance later in this paper.

2.2 Comparison with Other Sectors

Before looking at the causes behind these improvements, we first want to put the contribution of the coal-fired generating fleet's emissions into context, compared to other sources of PM in the atmosphere. PM comes from a wide variety of sources. Open sources of PM are emitted over large geographical areas, primarily in a stationary but non-point-source manner. They are diffuse in nature and are generally dispersed over too great an area to allow control by conventional equipment. By contrast, non-open-source sectors represent traditional industrial, non-industrial and mobile sources of emissions. Note that NPRI data is reported as total particulate matter, however most of the emission factors used to generate this data are based on filterable (primary) PM.

Based on NPRI 2012 data, amongst non-open-source reported PM emissions, coal-fired electricity generation contributed 5.8% of non-open-source emissions (see Figure 2). If we also consider open sources of PM emissions, such as road dust and agriculture, coal-fired electricity contributed an insignificant 0.06% of total PM emissions in the province in 2012.

Figure 2 Coal-fired Power Plant PPM Emissions as Percentage of Alberta PM Emissions, excluding open sources



3 Drivers for Emission Reductions

3.1 Actions Taken by Industry

Having considered the relative contribution of the coal-fired generators' PPM emissions, let's examine why absolute emissions of PPM from coal-fired electricity generation have declined so significantly over the past 12 years.

There are two fundamental drivers behind this change:

- the improvements in performance at the province's coal-fired generating fleet as operators upgrade and improve their PPM controls in a wide variety of ways; and
- the changing makeup of Alberta's electricity generation sector with a shift from coal-fired generation to (primarily) gas-fired generation, including replacement of older higher emitting coal-fired generating units with newer lower emitting coal-fired generating units.

In 2010, the Eastern Research Group Inc. (ERG) prepared a report for CASA examining the potential for PPM control measures in the province's coal-fired electricity generation fleet. The report contained some very useful analysis and recommendations of measures that could be pursued, or at least considered, in Alberta. Very importantly, ERG clearly identified that there are no one-size-fits-all measures: the potential effectiveness and implementation cost of any given measure depends on a host of facility-specific considerations, and the report did not make explicit suggestions for PPM controls at individual facilities. The report did, however, identify a broad range of possible PPM control options that could be examined by the province's operators.

The ERG report looked separately at these approaches to PPM control, with an emphasis on ESP measures. For facilities that use ESPs, ERG suggested consideration of measures related to:

- Optimizing existing ESP performance
- Control systems upgrades
- Power supply changes
- Optimizing rapper performance
- Rebuilds with wider spacing
- Wire replacement
- Improving gas flow
- Adding fields or increasing field height
- Addition of flue gas conditioning
- Addition of other equipment options in addition to current ESPs
- Converting existing ESPs

For facilities that use FFs for PPM control, a smaller range of suggestions were given, relating to:

- Operating conditions
- Bag improvements
- Air-to-cloth ratios
- Flow distribution
- Flue gas conditioning

A brief survey of three of the province's coal-fired operators demonstrates that many of these suggestions have been implemented, or at least examined, in recent years as part of their commitment to continued improvement in their environmental performance – the results of which have been demonstrated in the sector's PPM emission intensity improvement. Some of the measures that facilities have adopted include:

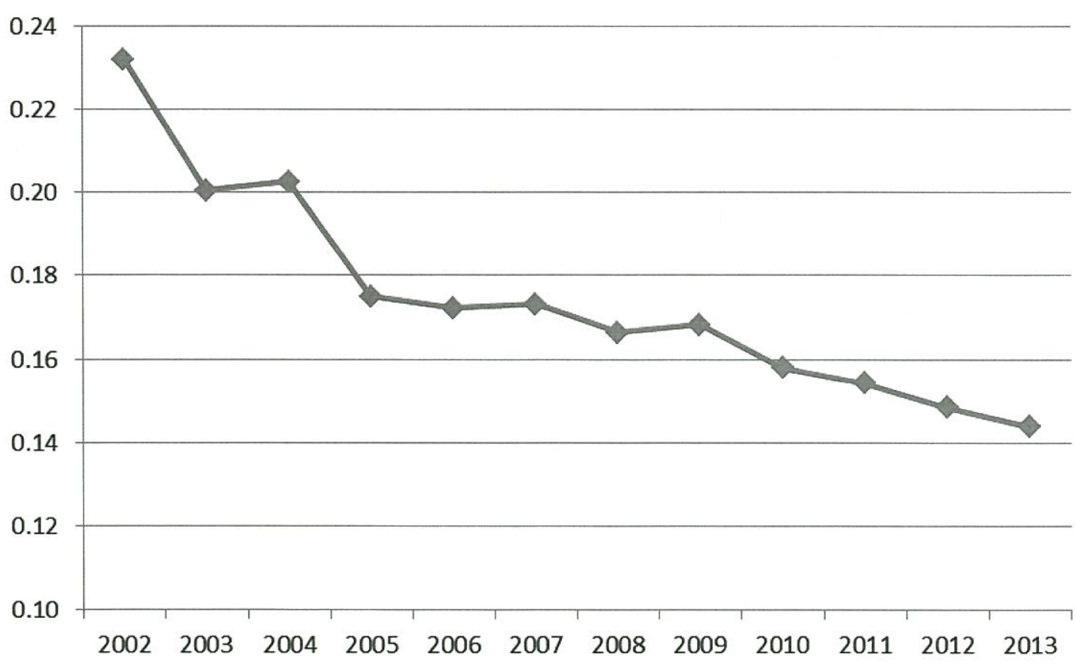
- Upgraded or replaced:
    - Analog control system
    - Emitter wires
    - Alignment kits
    - Transformer Rectifier
    - Rapper control system and mechanical components (as well as implemented measures to optimize rapper performance)
    - Nuclear ash hopper level detector system
- Implemented flow modification/transport optimization projects, such as addition of compressors, and/or improvements of the fluidizing system and instrumentation and

transport control system.

- Implemented operational adjustments to improve performance, such as cooling system monitoring during high ambient temperature days, monitoring ash resistivity, or monitoring and manipulating single fields in response to ash buildup.
- Explored ways to improve coal quality coming from the mines.
- Implemented flue gas conditioning projects.
- Adopted mechanical upgrades such as plate straightening or expansion joint replacements.
- Installed duct opacity monitoring instrumentation.
- Upgraded fabric filters bag type, and improved air-to-cloth ratios, as well as implemented operational improvements such as improved urea control.
- Improved staff training.
- The options of rebuilding ESP internals with wider spacing between electrodes, added fields or increased collector plate length, or addition of extra collecting equipment downstream of existing ESPs, were evaluated but determined to be cost prohibitive.
- Fuel switching from coal to natural gas, and/or derates based on in-stack opacity data.

The improvement in PM controls by facility operators is best illustrated by examining the trend in emissions intensity (kilograms of PPM per MWh of output). From 2002 to 2013, overall PM intensity for the sector has declined from 0.23 to 0.14 kg/MWh – an improvement of 39%. Figure 3 illustrates this trend. Notwithstanding the impact on this trend from the closure of the Wabamun facility, the data demonstrates that improvements in PM emission controls have been effective across the sector.

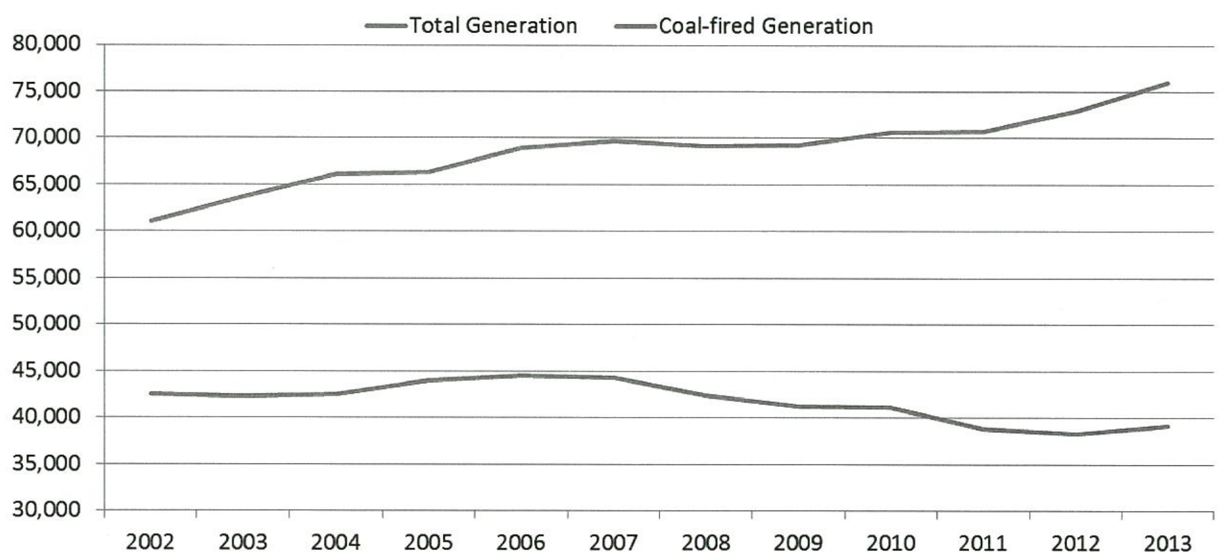
Figure 3 Coal-fired Power Plant PPM Emission Intensity (kg/MWh)



3.2 Greening the Grid

The shift in electricity generation over the past 12 years is clear: in 2002, 42,812 GWh of coal-fired electricity was generated in the province, but by 2013 this number had fallen to 38,520 GWh – a decline of 10%. Figure 4 depicts this trend. This decline reflects both the closure of one facility (Wabamun), but also a gradual displacement of coal-fired generation by gas-fired generation, and this has occurred despite the addition of two new (more efficient and lower emitting) coal-fired units during that time period (Genesee 3 and Keephills 3). Over this time period, the total electricity generation in the province has grown from 61,082 GWh to 76,004 GWh, so coal's contribution to total generation during that time has dropped from 70% to 51% in just over a decade (total generation statistics are from the Alberta Utilities Commission.)

Figure 4 Coal-fired Power Plant Generation vs. Alberta Total Generation (GWh)



4 Future Management of PPM Emissions

As described in section 3, operators have taken actions to control and reduce PPM emissions from their facilities. These actions are part of operational best practices, and it is reasonable to expect that they will continue. There are many drivers for these actions beyond strict regulatory controls on stack emissions, including (but not limited to) financial reasons, future project development, ambient quality targets, internal environmental targets, and stakeholder relations.

PPM management by the province's coal-fired operators includes the continuous improvement of preventative and corrective maintenance and operational practices. Derates or fuel switching to maintain opacity targets result in a financial penalty to operators and represent a significant incentive for investment in PPM reduction. PPM limits in facility approvals provide a last line of defense for PPM emissions, should other PPM management activities be ineffective. The downward trend in emission intensity (Figure 3) shows that these measures are effective.

5 Projected Emission Reductions to 2030

Having examined the fleet's performance over the last 12 years, we conclude by looking forward at likely future trends. Three major impacts on future trends are expected to drive the sector's future performance in PPM emissions: the impact of the federal Reduction of Carbon Dioxide Emissions from Coal-fired Generation of Electricity Regulations; the continued shift in generation from coal to gas; and the continued maintenance and improvement to the existing PM control equipment.

The federal greenhouse gas (GHG) regulation will have perhaps the biggest impact of these trends. It sets a performance standard for emissions intensity for operating coal units that is not economically attainable, without offering the use of flexibility mechanisms such as a technology fund or GHG offsets for compliance. As a result, a significant number of the province's coal-fired units will be retired at the end of their useful life (46 to 50 years) as set out in the regulation, including four units by the end of 2019. The anticipated retirements out to 2030 from this regulation are shown in Table 1. These retirements will represent a significant reduction in coal- fired capacity.

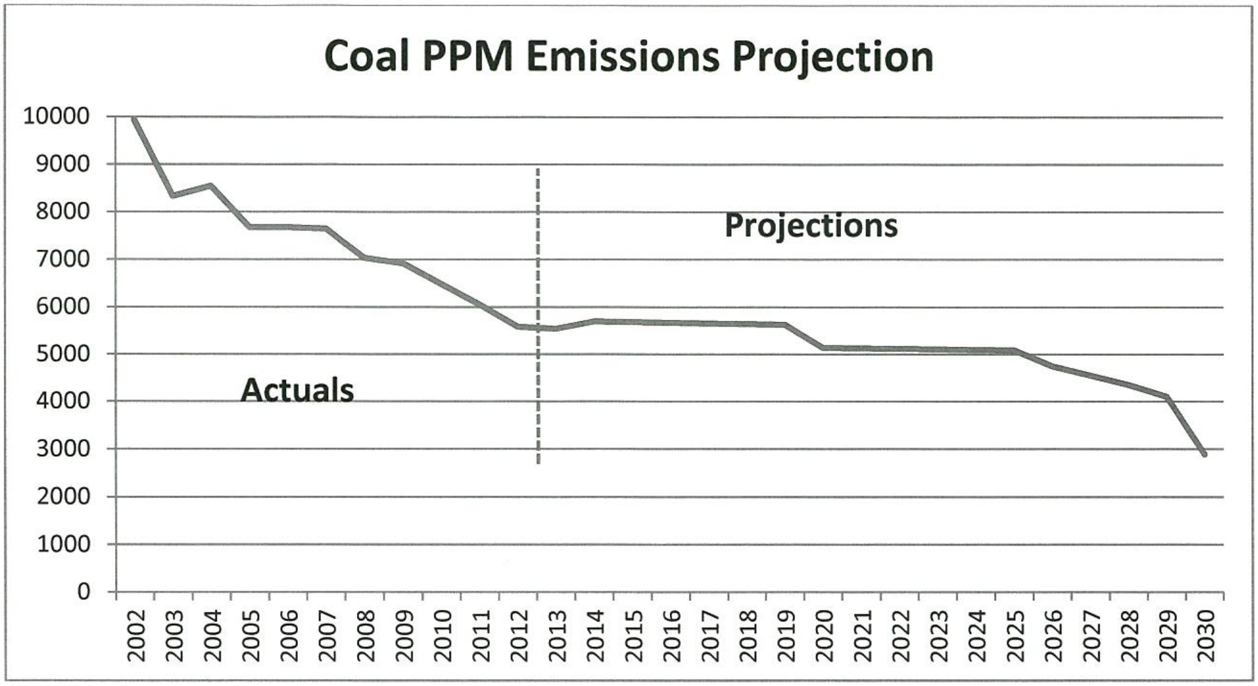
Table 1 Anticipated retirement dates for coal-fired units due to federal GHG regulation

Retirement Date	Unit	Capacity (MW)
2020	Milner 1	144
2020	ATCO Battle River 3	149
2020	TransAlta Sundance 1	288
2020	TransAlta Sundance 2	288
2026	ATCO Battle River 4	155
2027	TransAlta Sundance 3	362
2028	TransAlta Sundance 4	406
2029	TransAlta Sundance 5	406
2030	TransAlta Sundance 6	401
2030	ATCO Battle River 5	385

We have prepared projected PPM emissions from the coal-fired fleet out to 2030. It considers (1) the impact of retirements identified above, (2) the gradual and anticipated decline of total generation from all coal-fired units as demonstrated in Figure 1, and (3) the projected intensity trends for each generation unit based on recent performance in emissions intensity (as a proxy for the effectiveness of each operator's PPM controls). The results are shown in Figure 5 below.

This projection is a conservative scenario which probably underestimates the speed of the shift towards reduction in overall coal-fired generation, and also does not assume best-case performance in each unit's intensity trends. As Figure 5 illustrates, even under a conservative scenario, PPM emissions from coal-fired generation are projected to continue to decline. In 2020, the year after four generation units will be retired under the federal GHG regulation, projected PPM emissions will drop from 5542 tonnes in 2013 to 5137 tonnes – a projected decrease of over 7%; and by 2030, projected PPM emissions fall to 2885 tonnes – a decline of 48% from 2013 levels, and 71% from 2002 levels.

Figure 5 Coal-fired Power Plant PPM Emission Projection (tonnes)



It is particularly interesting to compare our projection to the original CASA projection in 2003, which informed Alberta's emissions management framework for the electricity sector. That 2003 projection set out an expectation that PPM emissions would be reduced by 3500 tonnes by 2025, compared to 2003. In our projection, the decline from 2003 (8330 tonnes) to 2025 (5090 tonnes) is 3240 tonnes – just shy of the stated expectation, which is achieved one year later in 2026 when projected emissions would be 4746 tonnes (a reduction from 2003 of 3584 tonnes). Considering the conservative assumptions built into our projection, it is reasonable to assume that actual performance for the sector will exceed this projection.

6 Conclusion

PPM emissions from the sector have fallen from 9931 tonnes in 2002 to 5542 tonnes in 2013, a decrease of 44% over 12 years. This represents a significant and steady improvement in the absolute contribution of the coal-fired electricity sector to Alberta's air quality. These emission reductions were achieved through upgrades and improvement to PPM control equipment (consistent with those listed in the ERG report) and the changing makeup of Alberta's electricity sector with a shift from coal-fired generation to (primarily) gas-fired generation. This demonstrates that the current PPM management process, with PPM regulated on a site-by-site basis through EPEA approvals, is effective.

The electricity sector PPM emission forecast prepared for this paper demonstrates that the sector is essentially on track to achieve the original 2003 CASA projected PPM reductions from the electricity sector of 3500 tonnes by 2025, compared to 2003 (slightly missing the target in 2025 but exceeding it in 2026). Three major impacts on future trends are expected to drive the sector's future performance in PPM emissions: the continued maintenance and improvement to the existing PPM control equipment; the continued shift in generation from coal to gas; and the impact of the federal Reduction of Carbon Dioxide Emissions from Coal-fired Generation of Electricity Regulations which will result in the shutdown of coal-fired units starting in 2020. The sector is responding to broad market forces in shifting away from coal, and to the federal GHG regulation that will drive significant capital stock turnover in the years ahead, and so the sector's PPM emissions will continue to decrease into the future, and surpass the original CASA emission projections, without any additional regulatory action.

Appendix B

Management Requirements and Options for Particulate Matter Emissions from Existing Alberta Coal-Fired Generating Stations (prepared by ENGO representatives to the CASA 2013 EFR)

Management Requirements and Options for Particulate Matter Emissions from Existing Alberta Coal-Fired Generating Stations

Prepared for:

CASA 2013 Electricity Framework Review, PM Sub-Group

Prepared by:

Thomas Marr-Laing, David Spink, Kristi Anderson
ENGO representatives to the CASA 2013 EFR

February 4, 2015

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1 Introduction

The Clean Air Strategic Alliance (CASA) Particulate Matter Management Plan Task Group is tasked with developing a primary particulate matter (PPM) system for existing coal-fired units. Particulate Matter (PM) reduces visibility and contains many substances with potential environmental and health impacts. Primary PM (PPM) emissions are associated mainly with coal-fired electricity generation and refer to the PM that comes directly out of the stack. These particles consist of various organic and inorganic substances, including metals, and can have environmental, health and aesthetic impacts. The CASA *Emissions Management Framework for the Alberta Electricity Sector* (EMF) identified PPM as one of the priority emission substances for management and provided guidance for developing a PPM system.

The Environmental Non-Governmental Organizations (ENGO) members of the PPM Task Group have prepared this report to provide their views on the context, as defined by the EMF, from which such a PPM system should be developed, with a focus on the obligation for existing units to meet the PM "BATEA of the day" when they reach their "End of Design Life". This document also responds to the report produced by some industry members of the PPM Task Group ("Particulate Matter Emissions from Existing Alberta Coal-Fired Generating Stations", December 16, 2014). Of particular concern is that PPM current and projected emissions by this sector are significantly higher than originally expected when the EMF was developed, necessitating concrete action be taken to effectively manage these emissions going forward. Ideas for potential "flexibility mechanisms" to facilitate industry's capacity to meet the PPM obligations under the EMF are proposed.

There is now a pressing need to develop a management plan for PM for existing units at the end of their design lives as envisioned by the 2003 Framework. Work began on a plan during the 2008 Framework Review and carried on after the completion of the Review but was shelved until the second five-year Review. To date, two coal-fired electricity units (Battle River 3 and H.R. Milner) have reached the end of their design lives and seven more will reach the end of their design lives over the next five years. Without a PM management plan that sets a standard that will achieve the emission reductions anticipated by the Framework, the de facto result is that the federal Greenhouse Gas Regulations will be the limiting regulation on PM emissions. This is counter to what was envisioned by Albertans who engaged in the multi-stakeholder process that created the Framework, and results in a substantially delayed timeline relative to the end of design life BATEA standard approach developed under the Framework.

Failure to uphold the tenets of the Framework around criteria air contaminant emissions means that not only is the future of the Framework at risk regarding these policy issues, but so too is the of the future of CASA as a meaningful and relevant forum for negotiating management frameworks.

2 PM BATEA applies at End of Design Life

A fundamental underpinning principle of the EMF was that existing units and new units would have a defined operating period after which the Best Available Technology Economically Achievable (BATEA) limits of the day would be applied. In this regard the Executive Summary of the EMF indicates that for existing units:

> *"There is a new requirement for units to reduce emissions to the latest BATEA performance standard at the end of their design life."*

This principle was generally applied to the priority management substances with the exception of mercury and in this regard the EMF indicates (Recommendation 12 Section) that:

> *"The EPT based its recommended emissions standards for NO_x, SO_2 and PM on BATEA levels, but a specific capture limit for mercury could not be set at this time because there is no established BATEA level for mercury."*

The EMF indicates (Recommendation 5 section) that:

> *"The design life of a unit generally refers to the time period that would allow a reasonable economic return on investment, after which the unit would be expected to meet the BATEA emission limits of the day or shut down."*

This section also defines BATEA as:

> *"BATEA limits of the day" means the BATEA limits that are in force as regulatory standards at that time and that will apply to new units as well as to existing units that have reached the end of their design life* [emphasis added]. *As noted in Recommendation 29, the BATEA levels will be reviewed every five years and revised in accordance with the results of such reviews."*

Furthermore, in the case of coal-fired units, Design Life *"is defined as the date of expiry of the [Power Purchase Agreement] term or 40 years from the date of commissioning, whichever is greater."*

Recommendation 21 in the EMF indicates that:

> *"Every five years, commencing in 2008, the technology be reviewed to determine BATEA level of the day for primary particulate matter, as part of the process described in recommendation 29."*

The principle of applying BATEA requirements for PM management at the end of design life was clearly evident by the analysis conducted in Section 6.5 of the EMF, including:

> *"Tables 4 and 5 illustrate the predicted impact of imposing on existing units, at the end of their Design Life, the 2006 BATEA standards for NO_x, SO_2, and primary PM, and of requiring 80% capture of mercury, based on the best estimates available to the team at the time."*

Recommendation 19 defined the PPM standard for coal-fired units to be 0.095 kg/MWh. This standard was revised after the first Five-Year Review to 6.4 ng/J of heat input (~0.066 kg/MWh).

Based on the above elements and excerpts from the EMF; and current ENGO members' direct involvement in, and recollections from, the 2002/2003 EMF work, it is the ENGOs' position that the EMF establishes the principle of BATEA limits for PPM at the end of design life. PPM is to be treated in the same way as SO_2 and NO_x i.e. BATEA limits are to be applied at the end of design life for all existing units.

3 Interpretation of specific EMF recommendations related to PPM

There are two EMF recommendations that appear to be the source of the different perspectives regarding PPM management in the context of existing units and end of design life. These are:

> **Recommendation 20: Regulation of Primary PM**
>
> *"The team believes that the current system for regulating primary PM is adequate and recommends that Alberta Environment regulate primary particulate matter on a unit-by-unit basis through the Environmental Protection and Enhancement process."*
>
> **Recommendation 22: Co-benefits of Mercury Control**
>
> *"By controlling mercury through the use of fabric filters, emissions of primary particulate matter are also expected to decrease. The EPT was of the view that the co-benefits of controlling mercury would be adequate to address primary particulate matter and thus recommends that:*
>
>> *For existing and transitional coal-fired units, where mercury controls include fabric filters, the primary particulate matter target of 0.095 kg/MWh shall apply. If mercury control identified in the 2005 review does not provide this co-reduction of primary particulate matter, then the 2008 system review should develop a primary particulate matter management system for existing units."*

With respect to Recommendation 20, it is the ENGO's understanding that this is specifically related to existing units that had not reached the end of design life. It therefore signaled that existing units that had not reached end of Design Life would not be required to undertake any new or additional PM controls beyond those currently being required. This was the same principle applied to SO_2 and NO_x emissions as stated in Recommendation 8.2: *"The emission rate for existing units prior to the end of their Design Life is the currently approved emission rate as specified in the regulatory approval"*.

Based on the "continuous improvement" reports provided by industry as part of the first and second Five-Year Reviews, it appears that the current regulatory system for PM and opacity emissions from coal-fired units is driving optimization of PPM control from existing control technologies. Therefore, for units that have not reached the end of Design Life current regulatory control and requirements are adequate - consistent with recommendation 20.

Regarding Recommendation 22, it was assumed that mercury control technology would address the issue of end of design life PM management in that the installation of COHPAC units for mercury control would result in all units meeting the PPM BATEA. The recommendation addressed the possibility of this co-benefit of mercury control technology not being realized and therefore the possible need for a PM management system for existing units. The context for such a system must, however, be the principles upon which the EMF was based: i.e. BATEA limits applying at the end of design life with some flexibility to allow operation at the end of design life without the need to physically meet the PPM BATEA limit – similar to the case forSO_2 and NO_x.

The possible use of a credit generation system for PPM was discussed during the development of the EMF and two challenges were identified: i) there was no continuous monitoring system for PPM so emission tracking and credit generation would be more difficult than it is for SO_2 and NO_x; and ii) some EMF Team members were concerned that PPM trading was not appropriate for a parameter for which no threshold has been identified below which no damage to health is observed. How to address these issues was not fully explored because mercury control using COHPAC seemed to suffice.

It is the ENGO position that recommendation 20 only applies to units *prior* to their end of design life; and that the management system development issue in Recommendation 22 relates to developing a system consistent with BATEA implementation at the end of design life in the same manner as with the current management systems for SO_2 and NO_x.

4 Regulations and Standards resulting from the Framework

The Alberta Air Emission Guidelines for Electricity Generation are clear about the origin of their standards. The standards are based on the emissions management Framework that was developed through the CASA process. Therefore, the absence of standards for PM at the end of design life is the consequence of the expectations outlined by the Emissions Management Framework which anticipated reductions in PM emissions as a result of technology deployed to reduce mercury emissions.

It is important to interpret the Framework as informing the standards in the Alberta Air Emissions Guidelines for Electricity Generation rather than to see the Framework as defined by the existence of a standard. An absence of a PM standard at the end of design life does not indicate lack of intent in the Framework to reduce PM emissions at the end of design life to a level at or below BATEA. Arguing that it does subverts the relationship between the Framework process and the Guideline standards that result from that process.

Similarly, the absence of PM from the Emissions Trading Regulation does not signal that there was no intent by the Framework to develop a mechanism to manage PM emissions that includes some level of flexibility. The reasons that PM was not included in the Emissions Trading Regulation are as follows. The Framework anticipated that the intensity level of PM emissions would be 4.5 kg/MWh lower than it is today. If these reductions had materialized, there would be no need for a BATEA standard and — in turn — no need for emissions trading for PM. In addition, the architects of the Framework felt it was inappropriate to develop a trading regime for a substance that has no minimum threshold to cause human health impacts.

The process through which the Framework was developed and agreed upon established a contract between the public and industry and with the government. The public has a reasonable right to expect that the conditions of the contract, as expressed in the Framework, will be fulfilled. In order to meet the obligations of the Framework, foresight, planning and investment is required on behalf of the industrial players. Failure to do so is a failure to uphold the Framework resulting in a breakdown of the social contract and a loss of industry's social license to operate.

The government and the electricity industry must not lose sight of the fact that communities situated near generating stations are impacted by facility operations. People living in these communities were made promises that with the implementation of the Framework, air emissions would be reduced to a level that would be significantly better than what could simply be achieved by continuing with the status quo. Implementation of the Framework had benefits for industry also, as the Framework was intended to result in a more stable business environment with less uncertainty for project developers and a level playing field within electricity sectors. A break from the Framework will lead to greater pressure for additional regulations and enhanced scrutiny of project renewals as well as newly proposed projects.

In the absence of a plan for managing PM at the end of design life, this made-in-Alberta Framework does not accomplish what it was expected to. This opens the Framework up to scrutiny by federal regulators who have indicated an interest in developing Base Level Industrial Emissions Requirements (BLIERS) that set a mid-design life standard. Members of the first five-year-review team argued against mid-life BLIERS, opting instead to keep the Framework intact, as that was anticipated to be the superior option for achieving a greater level of emission reductions.

The CASA roundtable process which developed the 71 consensus recommendations of the Framework created an obligation for the Government of Alberta to follow through with the recommendations once the Framework was accepted by the government. This led to the enactment of the Emissions Trading Regulation and the Alberta Air Emission Guidelines for Electricity Generation. Now that the Framework has undergone a five year review, and a ten year review is nearly complete with no sign of a management program for PM that would align with Recommendation 22, it is clear that advice to the government on how to develop a plan to manage PM is not forthcoming through a roundtable process. The Government of Alberta must fulfill its obligation to develop a standard to respond to Recommendation 22. The architects of the Framework set out what must be achieved in terms of emission reductions of PM; now it is up to the government to determine how to achieve these reductions.

5 Current BAU PM management will not achieve Framework Reductions

The CASA EFR PM Subgroup has been provided a report, *Particulate Matter Emissions from Existing Alberta Coal-Fired Generating Stations*, prepared by Barr Engineering and Environmental Science Canada Ltd. on behalf of some Industry members, which proposes reasons to support a "business-as-usual" (BAU) approach. This report suggests that there are three major trends driving reductions in PPM: continued maintenance and improvement to the existing PPM control equipment; continued shift in generation from coal to gas; and the impact of the federal GHG regulations. It is proposed that the reductions resulting from these trends are sufficient to "surpass the original CASA emission projections", thus require no regulatory action through the application of BATEA standards at the end of design life.

The ENGO members have reviewed this report, and its underlying model, and disagree with a number of its assertions and conclusions. In our view:

- Continuous Improvement is a Framework commitment provided in exchange for industry exemption from regulated improvements to existing units *only* up to a unit's End of Design Life;
- The industry-proposed BAU will result in PPM emissions significantly higher than Framework emission projections – clearly exceeding the Emissions Growth Review Trigger of 15% (EMF Recommendation 34);
- The historical reduction in PPM intensities (44% from 2002-2013) is a significant overstatement of industry-driven continuous improvement actions;
- Future industry capacity to achieve reductions through ongoing continuous improvement of currently installed technology is unlikely; and
- Annual decline in provincial coal-based generation is overstated – further exacerbating potential exceedances of PPM emissions above that projected by the Framework.

5.1 Continuous Improvement is an industry commitment provided in exchange for exemption from regulated improvements to existing units *only* up to a unit's End of Design Life.

ENGO members acknowledge that industry has achieved reductions in PPM emissions from coal-fired units during the last decade and that continuous improvement in optimization of currently installed control technologies has played a role. However, it is critical to recognize that continuous improvement was a key commitment made by industry and embedded within the Framework as part of the trade-off that allowed existing units to be "grandfathered" with no interim requests for performance improvements until they reached their End of Design Life (EMF Section 4.3.3 Continuous Improvement). Consistent with EUB decisions for Genesee 3 and Centennial, the concept of grandfathering in perpetuity (e.g. beyond End of Design Life) was not accepted by the Framework. Given that this compromise is already a part of the Framework, it is inappropriate to now argue that such continuous improvement justifies avoiding the requirement for existing units to comply with their End of Life PM BATEA requirements.

5.2 BAU has resulted, and will continue to result, in PPM emissions significantly higher than CASA emission projections – exceeding the 15% Emissions Growth Review Trigger

Figure 1 reproduces the BAU PPM emissions projection from the Industry paper, and overlays the 2003 CASA Framework projections for both the "Reference Case" (BAU at that time) and the anticipated reductions resulting from the Framework to 2025. Figure 2 calculates the annual percentage difference between these two forecasts.

Figure 1 Comparison of Industry Paper BAU Coal-fired PPM emissions to 2003 Framework

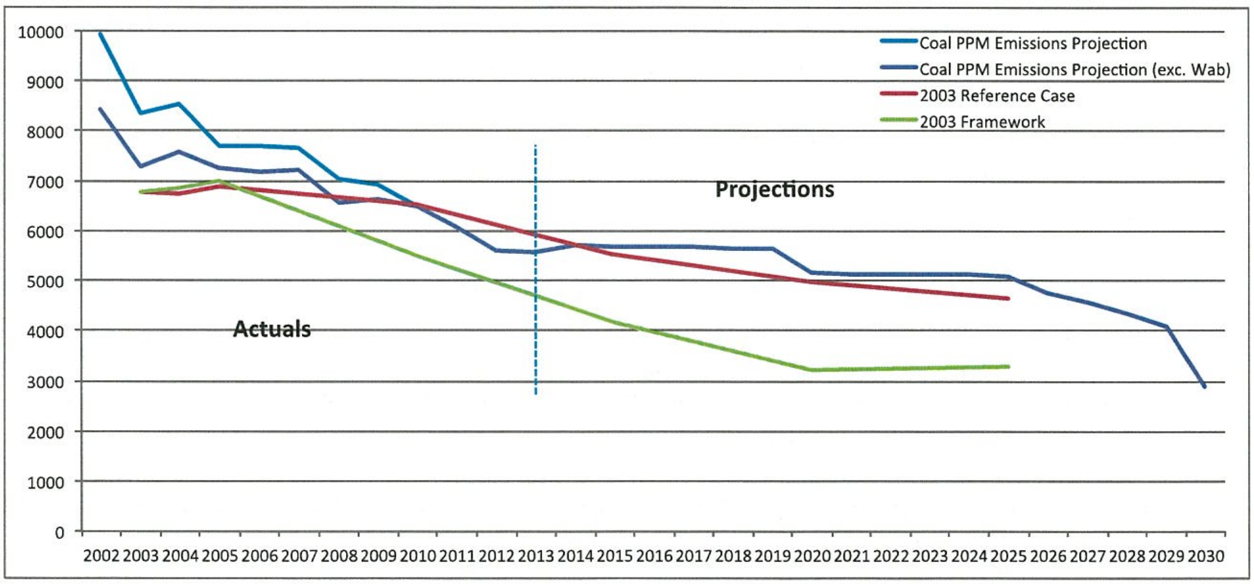
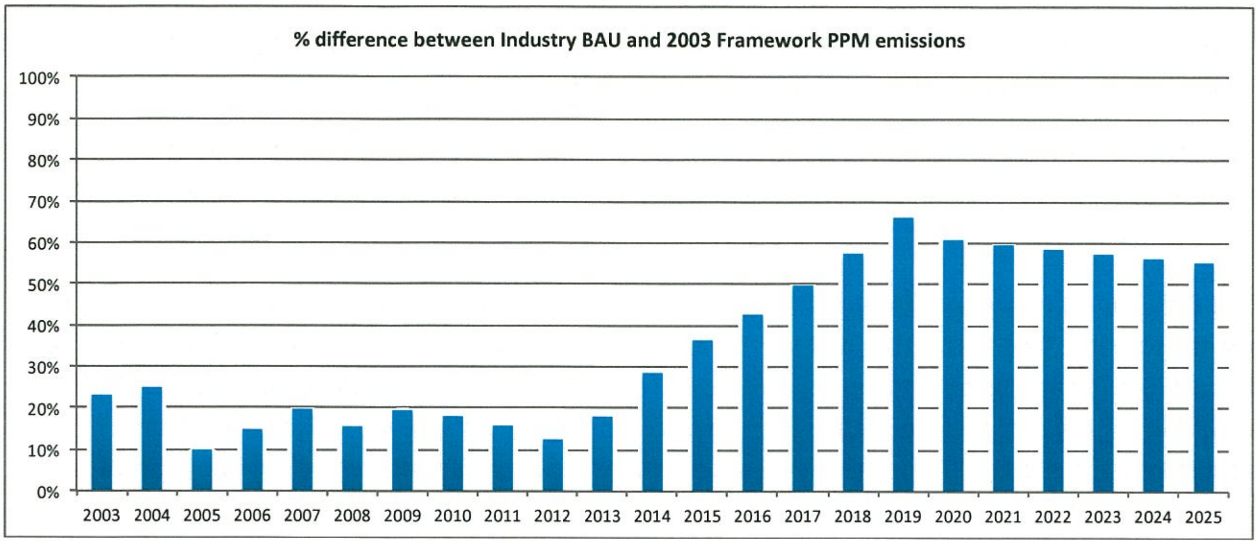


Figure 2 Percentage difference between Industry BAU and 2003 Framework PPM emissions



These figures demonstrates that the Industry paper BAU emissions are higher than the BAU Reference case projected in 2003, and significantly higher than those expected by the Framework. Actual emissions during the past decade have already been 16-19% higher than expected – primarily due to the fact that the PM reductions as a co-benefit of Mercury capture did not occur as planned and that the HR Milner unit was not retired in 2005 as anticipated.

For the coming period of 2014-2025, the gap between BAU and the 2003 Framework is projected to increase significantly - resulting in a total sum of 25,400 tonnes of PPM emissions more than expected with the Framework – approximately 2,100 tonnes per year more or 52% higher on average. A key driver for this increased gap is the ongoing operation of several coal-fired units which were expected to have retired at the end of their design life (i.e. Battle River 3 & 4, Sundance 1 & 2) or to have retrofitted to comply with the PM BATEA standard (i.e. Sundance 3, 4, 5 & 6; Battle River 5; Keephills 1 & 2) – but are projected in the BAU forecast to continue operations until retired under the Federal GHG regulations.

Furthermore, for the reasons discussed over the next few pages, the quantum of this difference is likely to be even larger.

Recommendation 34 of the EMF defines an "Emissions Growth Review Trigger" for the priority substances, including PM, which states that if the updated emissions forecast is 15% higher for a five-year period than projected in the previous Five-Year Review, the management framework elements addressing that substance should be reviewed. The above chart indicates that the average emissions during the past five-year period (2009-2013) were 17% above the 2003 Framework - exceeding the 15% threshold. Going forward, without, at a minimum, requiring existing coal-fired units to meet PM BATEA at their end of design life, PM emissions are set to exceed this threshold even more dramatically.

Indeed, it is not until 2030 that the Industry BAU projection reaches the lowest level anticipated by the Framework (3192 tonnes) in 2020 – a full decade later. Although the 2003 Framework only provided a projection to 2025, it can be demonstrated that, post-2025, PPM emissions under the Framework would continue to decline as coal-fired units, such as Sheerness 1 & 2 and Genesee 1,reached their End-of-Design-Life and either converted to the PM BATEA of the day or were replaced by other, lower emitting, forms of generation. As a result, the roughly 3,000 tonnes per annum achieved in 2030 by the Industry BAU would still be above what the Framework would otherwise achieve[1].

The 2003 Framework projection in this chart is based on the BATEA standard of 0.095 kg/MWh. The difference would be even more pronounced if the current (2011) BATEA standard of 0.066 kg/MWh were applied.

The BAU approach proposed by Industry will not result in PPM emissions that will come close to, let alone "surpass" those projected by the Framework. The Emissions Growth Review Trigger has already been exceeded and this exceedance is projected to grow dramatically. Application of the BATEA standard for PM at the end of design life – as envisioned by the Framework - is a fundamental requirement towards achieving the level of reductions in this pollutant committed to by the all-party consensus agreement underlying the Framework.

5.3 The historical reduction in PPM intensities (44% from 2002-2013) is a significant overstatement of industry-driven continuous improvement actions

The Industry paper places an emphasis on having achieved a 44% reduction in PPM emissions from 2002 (9931 tonnes) to 2013 (5542 tonnes) – an average of 3.7% per annum. It is indicated that these reductions have resulted from industry actions in the form of improvements in operating performance and the shifting from coal-fired generation to other forms of generation.

In assessing reductions during this period, it is critical to separate out the impact of the closure of the Wabamun plant. The closure of Wabamun was a result of a EUB requirement for that nearly 50-year old facility to either upgrade to the BATEA of the day, or shutdown, demonstrating the important role of regulation in influencing environmental performance. Removing all four Wabamun units (1500 tonnes) from the above calculation changes the emissions profile to that of 8429 tonnes in 2002 declining to 5542 tonnes in 2013 – a reduction of 34% (2.9% per year). Figure 1 (above) shows the Industry paper projections with the contribution of the Wabamun units removed.

Figure 1 also shows that coal units realized a particularly large and potentially one-time drop in PM emissions from 2002 to 2003 (1150 tonnes). Comparing instead the period of 2003-2013, the emissions profile changes to 7276 tonnes in 2003 declining to 5542 tonnes in 2013 – a reduction of 24% (2.2% per year).This more modest reduction rate could be viewed as the "natural" or industry-driven reductions due to continuous improvement of PM control technologies combined with fluctuations in annual coal-fired generation utilization by the Alberta electric system.

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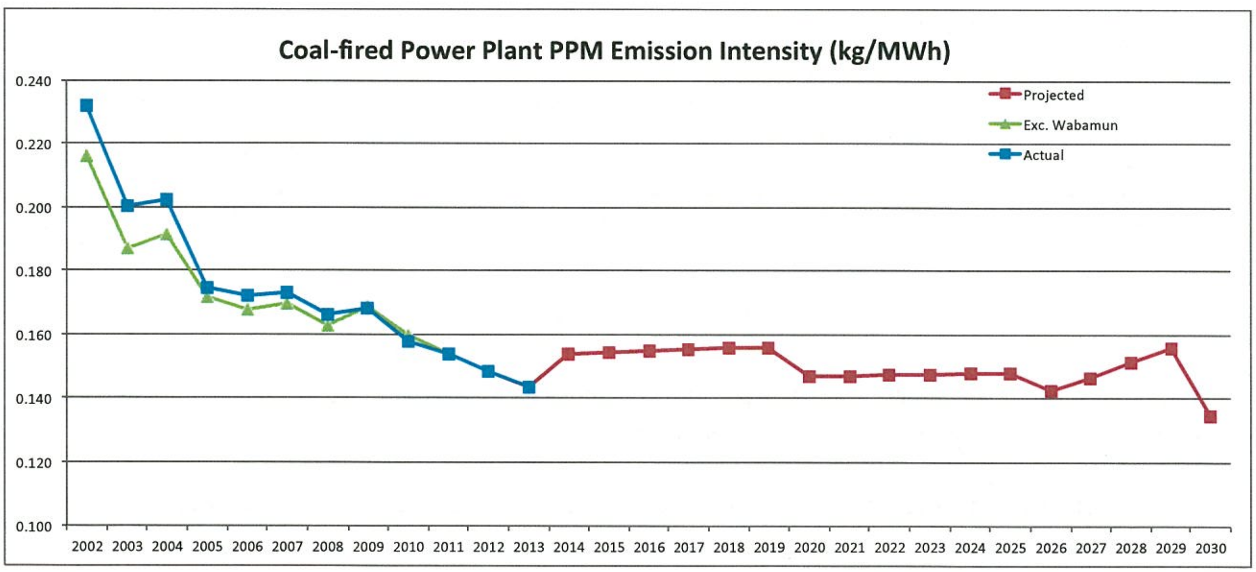
[1]Based on the Industry paper's modeling of generation and intensity projections for the 2030 period, BATEA-compliant emissions would be lowered by an additional 720 tonnes from 3200 tonnes to around 2480 tonnes.

5.4 Future industry capacity to achieve reductions through ongoing continuous improvement of currently-installed technology is unlikely.

As discussed in the Industry paper, there are several mutually-reinforcing incentives for industry to continue to strive for continuous improvement, including financial motivation. However, given what has already been achieved in optimizing currently-installed technology, it has not been demonstrated that industry has the capacity to continue to realize such gains out to 2030 at the rate achieved in the past. For example, the Industry paper indicates that many of the ERG suggestions for PPM controls have been "implemented, or at least examined, in recent years as part of their commitment to continued improvement". Reliance on continuous improvement is insufficient to achieve the results anticipated by the Framework.

Furthermore, in examining the historical changes in PM intensity rates for each of the 11 coal-fired stacks (excluding Wabamun) from 2003 to 2013, it is observed that the emission intensity has increased for 7 stacks (11 units) and decreased for only 4 (7 units). Indeed, the projected intensity and generation values used by the Industry paper show that average coal-fired PM intensity has, at best, flat-lined, and, more likely, will increase over the next 15 years – as shown in Figure 2.

Figure 3 Industry paper BAU PPM emission intensity: 2002-2030

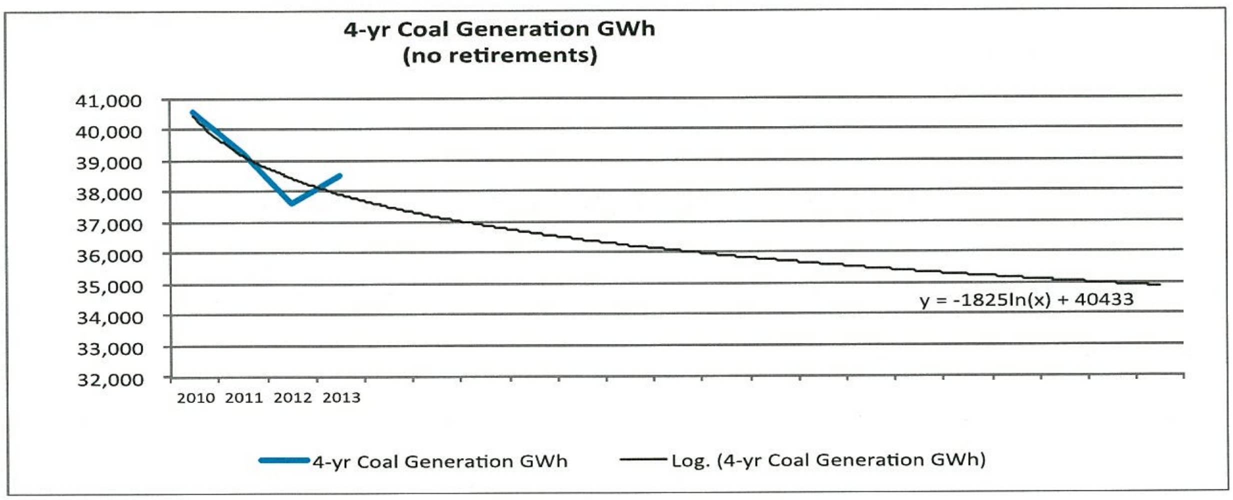


These results, based on the data used for the industry paper, lead to the conclusion that no further gains through continuous improvement are to be expected from existing installed pollution control technology.

5.5 Annual decline in provincial coal-based generation is overstated – further exacerbating potential exceedances of PPM emissions above that projected by the Framework.

The Industry paper examined historical coal-fired electricity generation (2002-2013) to project anticipated future coal-based generation out to 2030. The data points used in the model's regression analysis resulted in the following trendline: y= 1-1825ln(x) + 40433, as shown on the following graph provided by the model used for the Industry paper. This trendline is based upon the provincial coal GWh generated for the four years of 2010 to 2013 (excluding Wabamun 4) and projects total coal usage to decline by 9.5% from 2013 to 2030. It is understood that this analysis was used to represent the "continued shift in generation from coal to gas" and is separate from the impact of coal unit retirements due to the Federal GHG regulations.

Figure 4 Industry paper trendline for coal-fired generation utilization

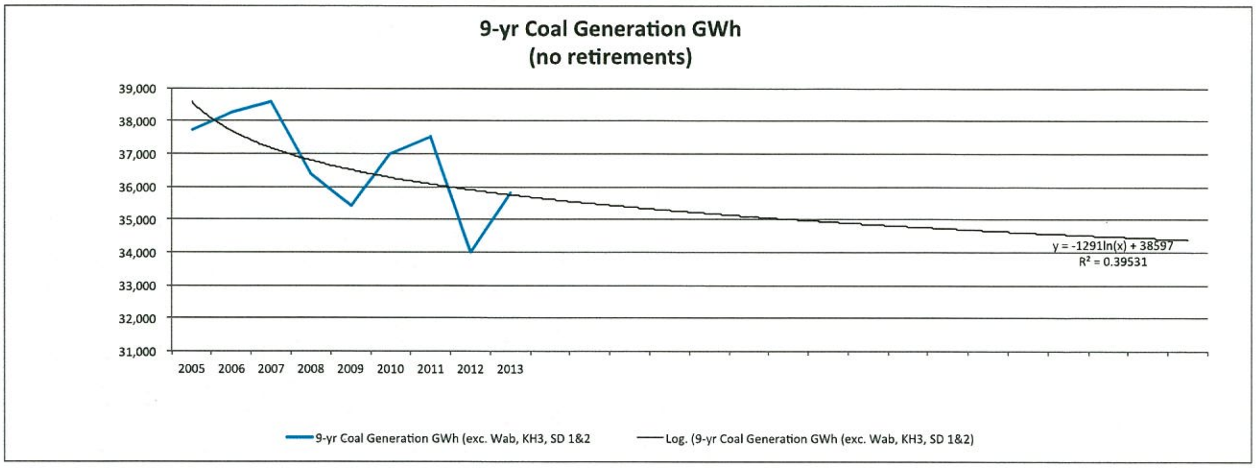


Close examination of the source data selected for this analysis raises the concern that a 9.5% decline is significantly skewed, because for those particular years:

- Sundance 1 & 2 were offline from January 2011 to late 2013 (contributing 0 GWh during this extended period);
- Keephills 1 was offline for 8.5 months during 2013;
- Keephills 3 only came online midway during 2011 (thus contributing 0 GWh in 2010 and roughly 50% in 2011).

If the data is normalized for these extreme events by excluding Keephills 3 and Sundance 1&2 and assuming Keephills 1 was fully operational during the period assessed, and by including more than just four years of data (e.g. nine years – beginning in 2005 when Genesee 3 is fully online), the resulting trendline (y= -1291ln(x) + 38597) indicates coal-based generation would decline by only 4.0% - as shown in Figure 4.

Figure 5 Revised trendline for coal-fired generation based on normalized data and 9-year history



Even if one assumes that Keephills 1&3 and Sundance 1&2 were fully operational for the entirety of this 9-year period, the decline is similar: 4.3%. Unless it is assumed that extreme (so-called *force majeure*) events are to be a normal and regularly occurring, it appears that the annual decline in coal usage is more likely in the range of 4%.

Further, due to the anomalous generation data for Sundance 1&2 and Keephills 1 during 2012 and 2013, the Industry model calculates a very low "go-forward" average capacity factor for these three units – resulting in a underrepresentation in PM emissions post-2013, particularly until 2019 when Sundance 1&2 are retired by the Federal GHG regulation.

Adjusting the rate of decline in coal-based generation and correcting for the Sundance 1&2 and Keephills 1 capacity factors revises the PPM emission projections of Figure 1 and 2 to that shown in Figure 6 and 7.

Figure 6 Revised comparison of Industry paper BAU PPM emissions with 2003 Framework

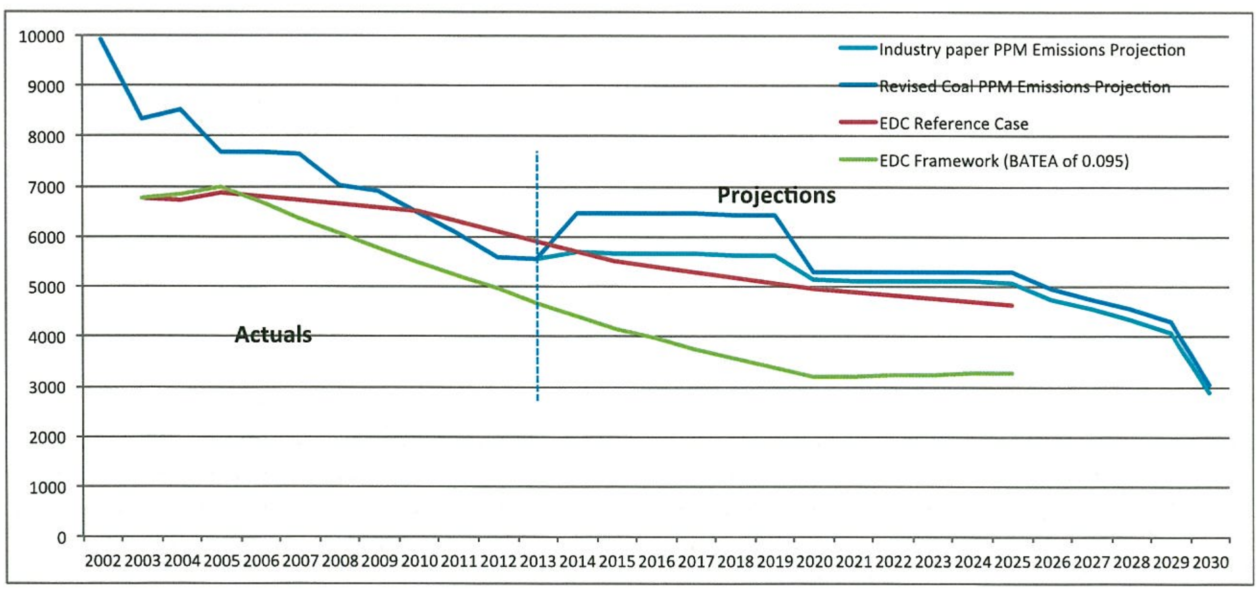
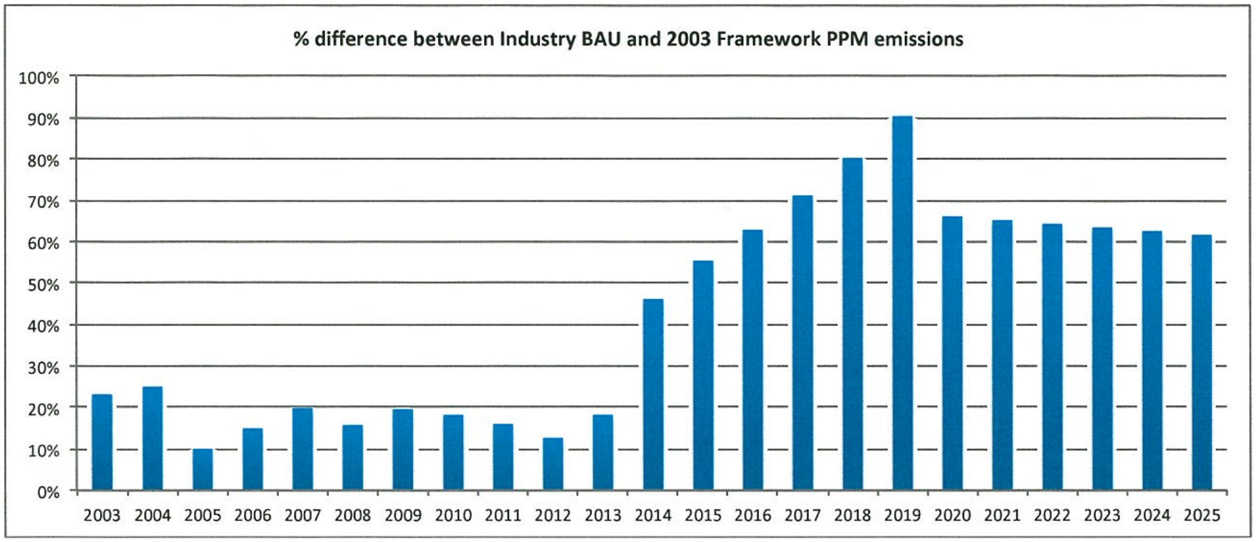


Figure 7 Percentage difference between revised Industry BAU and 2003 Framework PPM emissions



These revised figures demonstrates that the Industry BAU PPM emissions are likely to be even higher than that proposed by the Industry paper. For the period of 2014 – 2025, this would result in a total sum of 28,000 tonnes of PPM emissions more than expected under the Framework – approximately 2,300 tonnes per year more or an average of 66% higher than the 2003 Forecast[2].

[2]This revised result is similar to the EDC 2014 PM Emissions Forecast prepared for CASA that assumes no PM BATEA at end of Design Life and all unit retirements occur due to the Federal GHG regulations - *Electricity Framework Five Year Review Generation & Emissions Forecasts*, October 29, 2014, Figure 14(attached as appendix, p. 20). Note: a comparison of this forecast with the 2009 Forecast (where Mercury co-benefits are not realized and some coal unit retirements are delayed) demonstrates that PM emissions still continue to significantly exceed the Emissions Growth Review Trigger (see Figure 20, p. 22).

6 Conclusions

Based on the above analysis, it is the ENGO position that:

a) The EMF obligates all coal-fired units (new and existing) to comply with the PM BATEA standard at the end of their design life (defined as *the date of expiry of the PPA term or 40 years from the date of commissioning, whichever is greater*). This standard is currently 6.4 ng/J of heat input (~0.066 kg/MWh);

b) Historical and projected PM emissions significantly exceed the 15% Emissions Trigger threshold. This underscores the urgency for existing units to comply with the PM BATEA and further signals that additional action might be required to bring emissions back under this threshold;

c) Continuous Improvement, while important, is a commitment made by industry under the Framework that was provided in exchange for industry exemption from regulated improvements to existing units *only* up to a unit's end of Design Life. Continuous improvement cannot be viewed as a substitute for complying with BATEA at the end of design life; and

d) The consensus underlying the EMF is based upon acceptance of its package of recommendation in their entirety. Adherence to implementation of PPM BATEA by existing units at their end of Design Life is a key component of this package.

The ENGOs are also mindful that PPM from electricity generators in the Edmonton area has been identified as one of the sources contributing to exceedances of the ambient air quality objectives in the Capital Region, further underscoring the necessity for such coal-fired units to, at a minimum, comply with the PM BATEA standard requirements.

7 PM Management System Flexibility

ENGOs recognize that in order to for coal-fired units to meet the BATEA intensity standard at the end of their design life, capital costs may be incurred. In keeping with the principles of the EMF, some degree of flexibility could be introduced into the management system for PM to allow such units greater efficiency in complying with their regulatory obligations.

ENGOs would offer the following possible PM management system options that introduce flexibility around the timing of capital cost expenditures to achieve the standard set by the EMF:

1. Establish a PM credit system similar to what is already in place for SO_2 and NO_x. In order for such a program to be put in place, issues around monitoring will have to be resolved.

2. Allow SO_2 and/or NO_x credits to be used to meet the end of design life BATEA PM limit on the basis that SO_2 and NO_x emissions contribute to secondary particulate formation and further reducing SO_2 and NO_x emissions would in essence achieve reductions in ambient PM levels. An appropriate ratio would have to be developed and applied to reflect the proportion of secondary PM that is likely to be formed by emissions of SO_2 and NO_x. The use of credits would be applied to either NO_x/ SO_2 or PM, not both.

Appendix A: Coal-fired unit compliance deadlines

Table 1 Coal-fired unit compliance deadlines

Unit	ISD Year	End of Design Life or PPA expiry	50th year or GHG EOL
Milner	1972	2012	2019
Battle River 3	1969	2013	2019
Battle River 4	1975	2015	2025
Sundance 1	1970	2017	2019
Sundance 2	1973	2017	2019
Sundance 3	1976	2020	2026
Sundance 4	1977	2020	2027
Sundance 5	1978	2020	2028
Sundance 6	1980	2020	2029
Battle River 5	1981	2021	2029
Keephills 1	1983	2023	2029
Keephills 2	1984	2024	2029
Sheerness 1	1986	2026	2036
Genesee 1	1989	2029	2039
Sheerness 2	1990	2030	2040
Genesee 2	1994	2034	2044
Genesee 3	2004	2044	2054
Keephills 3	2011	2051	2061

Appendix B: Excerpts from Emissions Forecast reports

Excerpts: Selections from Electricity Price, Energy Production and Emissions Impact Optimized Scenario & Sensitivity Results prepared for CASA, EDC Associates, September, 2003

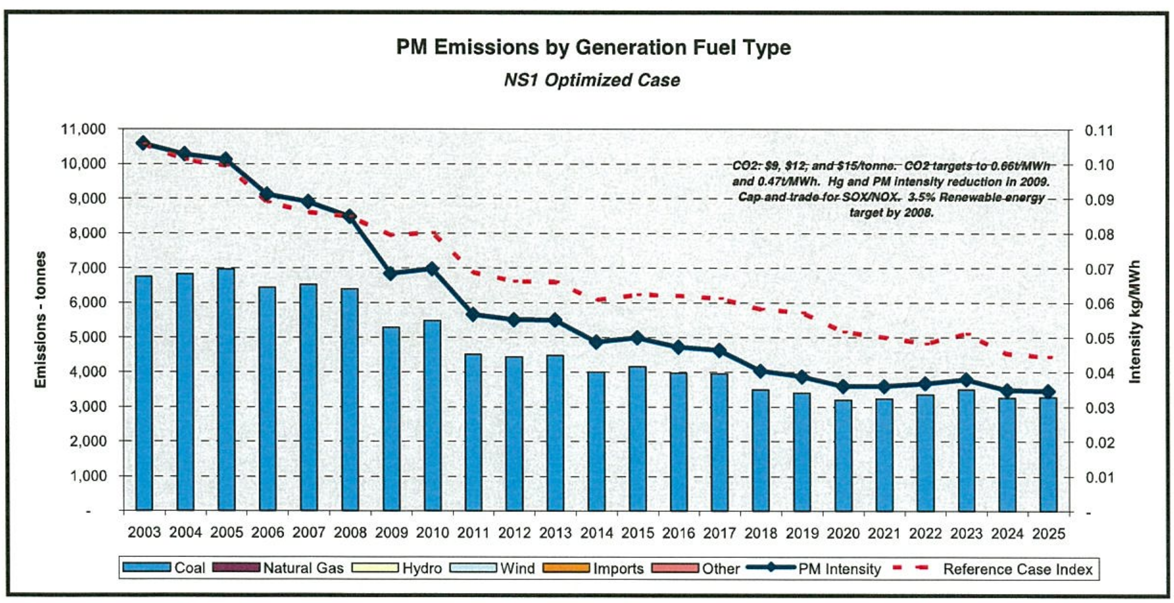
Reference case: Particulate Matter Emissions (p. 40)

Particulate Matter (PM) emissions fall slightly more than Mercury emissions, although the difference is quite small on a percentage basis. The average intensity falls by roughly 60%, with a substantial drop in 2011 when Wabamun 4 retires. Overall emissions fall by roughly 30%, falling from just under 7000 tonnes in 2005 to around 4600 tonnes in 2025.

NS1 Optimized case: Particulate Matter Emissions (p. 46)

Figure 20 illustrates the results for particulate matter emissions. PM matter emissions fall as a co- benefit of the installation of mercury reduction capital, and it is no surprise that the figure shows very similar results as those observed for mercury. PM emissions fall dramatically in 2009 when the policy is enacted, just as mercury emissions did. There is a further reduction evident in 2011 as a result of the retirement of Wabamun 4 which was not quite as obvious in the mercury graph. Note that Wabamun 4 retires in both NS1 and the Reference Case.

Figure 20 - Particulate Matter Emission Volumes and Intensity Index (NS1 Optimized Case)



Retirements (p. 34)

The underlying assumption in this analysis is that coal plants have an economic life of 50 years and natural gas fired units have an economic life of 30 years. However, several retirements are assumed to take place during the forecast period that are contrary to this basic assumption. The following units have been retired at the noted time in all the Cases and Scenarios presented in this document:

1. *H.R. Milner, January 1st 2006*
2. *Clover Bar 1-4, January 1st 2006*
3. *Rossdale 8-10, January 1st 2006*
4. *Sturgeon 1-2, January 1st 2006*

Other assumed retirements due to Mercury control obligations (p.43)

Mercury emission controls are the second main policy item constant across all three Optimized Cases. In each Case, the policy calls for mercury emission abatement technology to be installed at existing coal facilities by December 31st, 2009 at the latest, with one exception. Any plant that commits, by December 31st, 2008, to retire before December 31st, 2017, is exempt from the mercury control requirements. This exception is expected to apply to four coal facilities, Battle River 3 and 4 and Sundance 1 and 2. Finally, as a co-benefit of mercury controls, particulate matter is also expected to be reduced, which represents the third common policy across the three Cases.

Excerpts: Selections from Electricity Framework 5Year Review, Generation & Emissions Forecasts, EDC Associates, September, 2008

Particulate Matter (p.4)

Absolute particulate matter emissions follow a similar trend as in the 2003 forecast but are considerably higher throughout the 2008 forecast. This is principally the result of the switch in technology from bag houses to activated carbon for the capture of mercury. Activated carbon and the electrostatic precipitators alone do not provide the associated benefit of particulate matter capture. As well, increased coal-fired generation levels over those in the 2003 report add to the absolute emission level of the current forecast. Particulate matter intensity levels across the forecast have remained relatively flat when compared to the 2003 forecast as higher absolute levels are offset by an overall reduction in generation market share of coal-fired generation shifting to renewable energy technology.

Retirements – 2003 Forecast (p. 10)

The underlying assumption in the analysis was that coal plants have an economic life of 50 years and natural gas-fired units have an economic life of 30 years. However, contrary to this basic assumption, several retirements were assumed to take place during the forecast period as a result of contractual obligations and physical operating characteristics. Table 1 shows the units and retirement schedule utilized in the 2003 NS1 scenario referenced in this document.

Table 1 – 2003 NS1 Case Generation Unit Retirement Schedule

EDC - 2003 NS1 Case Retirments					
Generator Unit	Company Name	Fuel Type	Gross MCR	Net to Grid MCR	Retirement Date
Clover Bar 1-4	EPCOR	Natural Gas	628	628	Jan-06
Rossdale 8-10	EPCOR	Natural Gas	209	209	Jan-06
Sturgeon 1-2	ATCO	Natural Gas	18	18	Jan-06
Rainbow 1-3	ATCO	Natural Gas	87	87	Jan-06
HR Milner	ATCO	Coal	143	143	Jan-09
Wabamun 4	TransAlta	Coal	279	279	Jan-11
Battle River 3 and 4	ATCO	Coal	296	296	Jan-16
Sundance 1 and 2	TransAlta	Coal	560	560	Jan-18

The decision to retire HR Milner was based on its operating costs and fuel supply options. The 2002 sales agreement for the plant highlighted that the new owners procured coal supply for the facility for 2004 through 2008 although alternative options were being pursued. Since the facility was only marginally economic over the course of the next several years, it was assumed that it will not be extended beyond this coal supply agreement. The Battle River and Sundance retirements occur as a result of the mercury emission policy requirements coinciding with the expiration of their PPA.

Generation Retirement Assumptions - 2009 Forecast (p. 20)

Generation unit retirements are an important element of the resource adequacy picture, as there are several older coal and natural gas facilities that could retire in the near future at the end of their physical and useful life. In aggregate the model has 626 MW of gross capacity and 591 MW of net-to-grid capacity retiring between 2008 and 2013. Of the later amount, approximately 313 MW is natural gas-fired and 279 MW is coal-fired. Plant retirement assumptions over the next 5 years are outlined in Table 2.

The majority of the plants listed in Table 2 are being retired because they are reaching the end of their reasonable operating life, although some plants like Sundance 1 and 2 and Battle River 3 and 4 are assumed to retire specifically as the result of environmental policy (CASA recommendations for mercury standards). With federal legislation potentially coming into effect by 2012 it is possible some older plants may retire around this time rather than upgrade. However, with the potential to trade emission credits for NO_X and SO_X, new environmental standards may not trigger any retirements not already contemplated.

TransAlta has announced that it may consider extending the life of Wabamun 4 as regulatory uncertainty, uncertainty around transmission development and environmental rules may potentially delay decisions to build new power plants. Within the forecast, Wabamun 4 is assumed to retire in March 2010, but there is some degree of risk around this assumption. Some might argue that Wabamun 4 may not retire until Keephills 3 gets built, particularly if a supply crunch has a significant likelihood to occur around 2011 which represents a risk in the forecast.

Table 2 – 2008 Base Case Generation Retirement Schedule

Retirement Assumptions _ EDC 2008 Base Case Forecast - 2008 - 2013					
Generator Unit	Company Name	Fuel Type	Gross MCR	Net to Grid MCR	Retirement Date
Rossdale #10	EPCOR	Gas	71	71	Jul-09
Rossdale #8	EPCOR	Gas	67	67	Jul-09
Rossdale #9	EPCOR	Gas	71	71	Jul-09
Sturgeon #1	ATCO	Gas	10	10	Jan-10
Sturgeon #2	ATCO	Gas	8	8	Jan-10
Wabamun #4	TransAlta	Coal	279	279	Mar-10
Rainbow #1	ATCO	Gas	26	26	Jan-11
Rainbow #2	ATCO	Gas	40	40	Jan-11
Rainbow #3	ATCO	Gas	21	21	Jan-11
Weyerhaeuser	Weyerhaeuser	Biomass	35	0	Jan-13

The current retirement assumptions have varied from the assumptions made in the 2003 report in both the specific units and the timing. The Clover Bar facility has been retired by EPCOR and the Rainbow and Rossdale units are being kept online for TMR services, at the request of the

AESO. It is assumed that these units will retire when the upgrade to the transmission system in northwest Alberta is complete, and at this time January 2010 has been assumed as the retirement date. The HR Milner facility is currently forecast to remain online until 2015 as per the fuel supply agreement and the Wabamun 4 unit is retiring during 2010 due to mercury emission requirements.

Retirements cont'd. (P. 23)

...The retirement assumptions for Battle River and Sundance units have not changed between the forecasts but the type and cost of replacement capacity is substantially higher. Coal-fired capacity replaces much of the retired energy and it is priced at a higher cost as a result of emissions control technology. In the 2003 NS1 case the majority of the replacement capacity was cogeneration units which, with the low natural gas prices of the day, yielded low cost energy production.

Mercury (Hg) Emissions (p. 24)

Absolute mercury emissions exhibit much the same trend in the 2008 forecast as they did in the 2003 forecast. The most significant change between the two forecasts occurs in the 2009 to 2011 period as a result of adjusted input assumptions. In the previous analysis it was expected that mercury emissions legislation would be in place for 2009. The 2008 update adjusts this assumption to the 2011 period to match current expected policy implementation dates. Higher absolute emission levels between 2003 and 2008 forecasts are the result of increased coal-fired generation relative to the 2003 assumptions. As discussed earlier, there has been less cogeneration capacity installed in the province as a result of higher natural gas price expectations along with capital cost constraints at oil sands facilities with the result being an increase in coal-fired output over the forecast period.

Looking forward, the retirement of Wabamun 4 in 2010 contributes to a reduction in absolute Hg emission levels as this unit's replacement with cleaner burning generation reduces the mercury intensity below the 2003 forecast. ***The existing HR Milner unit retirement date has been extended to 2015 in this forecast*** *but has no effect on mercury emission levels as the unit has a bag house and fully captures mercury emissions.* ***As per the 2003 forecast the removal of Sundance 1 and 2 in 2018 produces a second step change in both absolute emission and intensity levels of mercury.*** *In the latter years of the forecast, mercury emissions continue to decline as legacy coal plants are phased out of the electricity generation portfolio.*

Particulate Matter (PM) Emissions (p. 25)

The target emission level for PM is 0.095 Kg/MWh. The technology to be employed for mercury reduction is activated carbon and is no longer a bag house technology due to lower capital and operational costs as well as a higher capture rate on the activated carbon process. This change has a direct effect on PM emissions which no longer decline in step with mercury reduction. Absolute particulate matter emission reduction occurs solely as a result of the retirement of the legacy coal plants.

The notable difference between the 2003 and 2008 forecasts is that the actual aggregate coal-fired generation is higher in the 2008 forecast relative to the 2003 forecast which relates to the lower-than-expected actual natural gas generation development over the forecast period. Across the forecast period absolute PM emissions are higher than in the 2003 forecast due to the use of *activated carbon and electrostatic precipitators to control mercury reductions in place of bag houses. Activated carbon provides no residual benefit to the capture of PM emissions. As well, the higher aggregate coal-fired generation resulting from less gas-fired generation being installed in the 2008 forecast also contributes to this outcome. Higher PM emissions in the post 2020 time frame are related to a higher level of coal-fired generation levels relative to the 2003 analysis. Again, absolute particulate matter emissions posts 2022 are higher than in the 2003 forecast levels as a result of the technology shift away from bag houses. While PM intensity levels are higher in the first half of the 2008 forecast relative to the 2003 forecast, the PM intensity levels post 2009 are well below the target level of 0.095 KG/MWh. This result is a product of the fact that coal-fired energy production holds a smaller percentage share of the total market production*

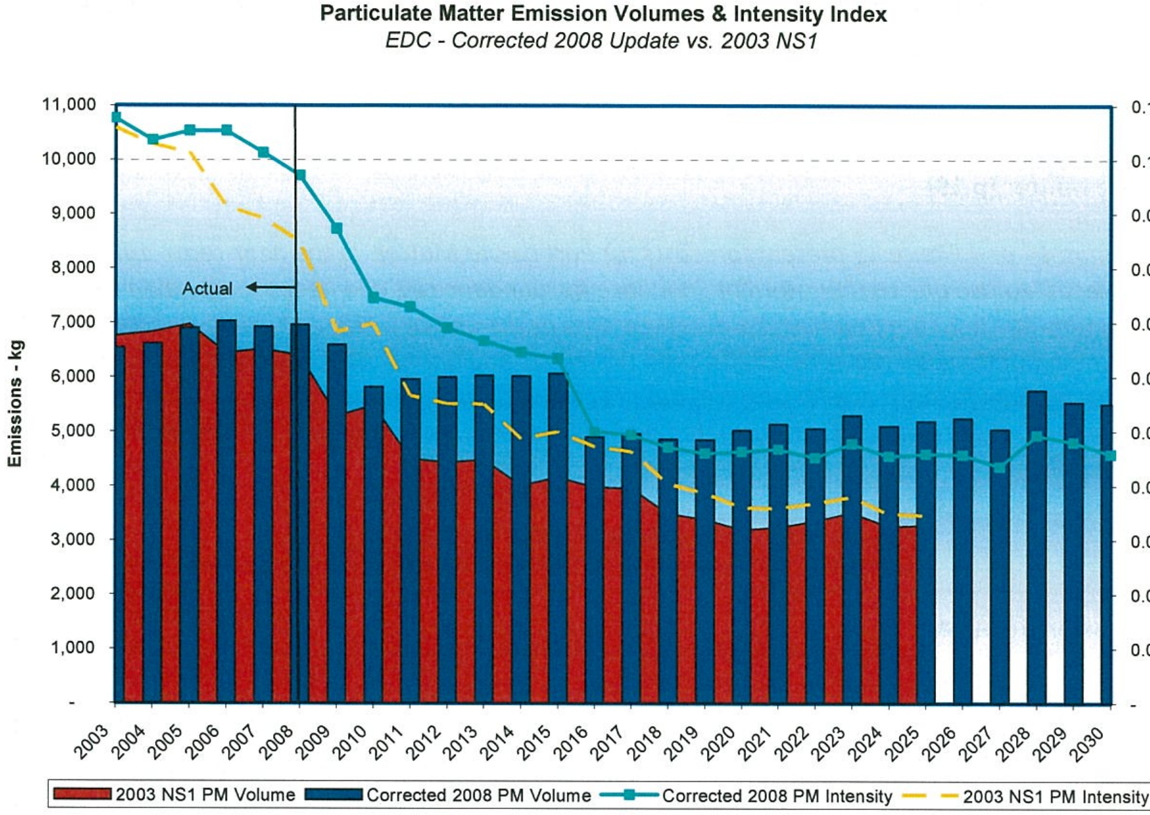
The overall PM emission intensity is on par with than those reported in the 2003 report in the post 2016 period as a result of the lower relative percentage of energy produced from coal-fired units due to the expectation of higher energy production from competing technologies despite the Mercury reduction technology change.

Particulate Matter (PM) Emissions (Appendix 4 – Corrected 2008 Forecast Results)

...The third revision related to the omission of formulas of several coal-fired generation additions scheduled to come on-line over the forecast period. These units had been inadvertently omitted from the emission forecast totals. Starting with Keephills 3, scheduled to come on-line in 2011, these coal-fired generators represent a noticeable portion of future supply as some older coal generation retires and Alberta's electricity demand continues to grow. For the most part, the inclusion of the emissions associated with these facilities resulted in higher absolute forecast emissions and a higher expected emission intensities in the corrected 2008 forecast results.

...A similar formulaic error to that which omitted the emissions of future coal-fired generation also omitted the emissions from three existing coal-fired units over the last 5 years of the forecast period. As a result of including PM emissions from those previously omitted coal-fired generators, corrected PM emissions accumulated to 3,019 kg by 2030. On a base of 5,506 kg in 2030, this represents a 121% increase in PM emissions. This understated the PM emission intensity in 2030 by 0.025 kg/MWh. On a base of 0.046 kg/MWh, this also represents an increase of 121%. The corrected 2008 PM emissions forecast is shown in Figure 15 along with the PM emissions level and emission intensity forecast from the 2003 NS1 case.

Figure 15 – Particulate Matter Emissions Volumes & Intensity Index (Corrected 2008 vs. 2003 NS1 Case)



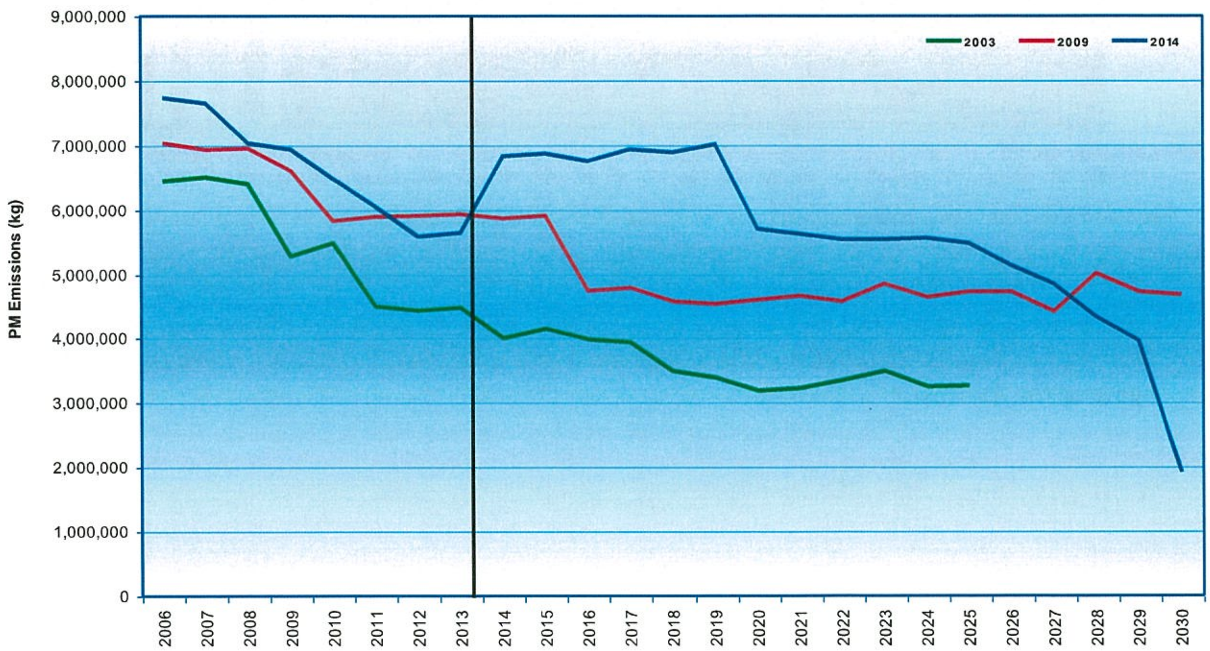
Total corrected PM emissions are expected to reach 5,506 kg by 2030, representing an average decrease of 50 kg (or 1%) in each year from 2009 to 2030. By 2030, the PM emission intensity is forecast to amount to 0.046 kg/MWh, from an average decline of 0.002 kg/MWh (or 2%) each year of the forecast.

Excerpts: Selections from Electricity Framework 5 Year Review, Generation & Emissions Forecasts, EDC Associates, October 29, 2014

Particulate Matter (p.19)

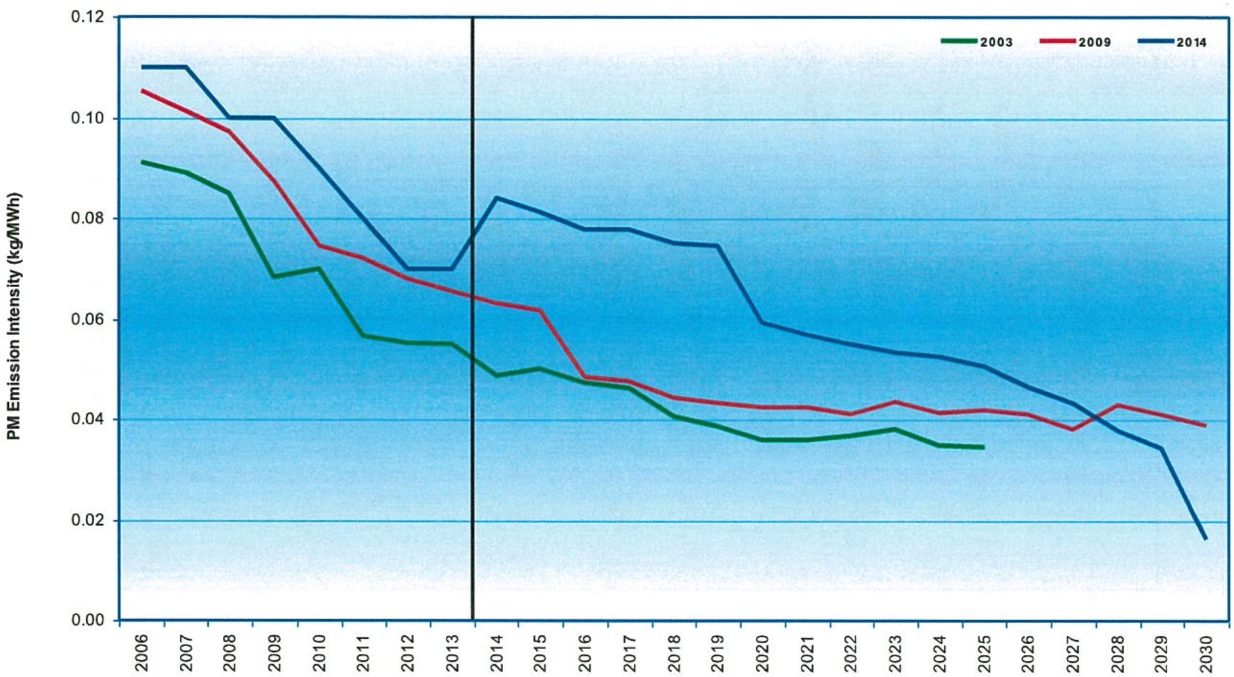
Figure 14 and Figure 15 present forecasts for Particulate Matter. In the near-term, emissions are forecast to rise due to the return of Sundance #1, Sundance #2 and Keephills #1, then remain roughly flat until the first tranche of retirements at the end of 2019. Particulate matter should remain flat through the early 2020s, then decline as additional coal-fired units retire. Intensity assumptions follow a similar pattern, but in years without retirements, exhibit downwards momentum since intensity is calculated by dividing total emissions (flat) by total fleet generation (growing).

Figure 14 - Particulate Matter Emissions (kg)



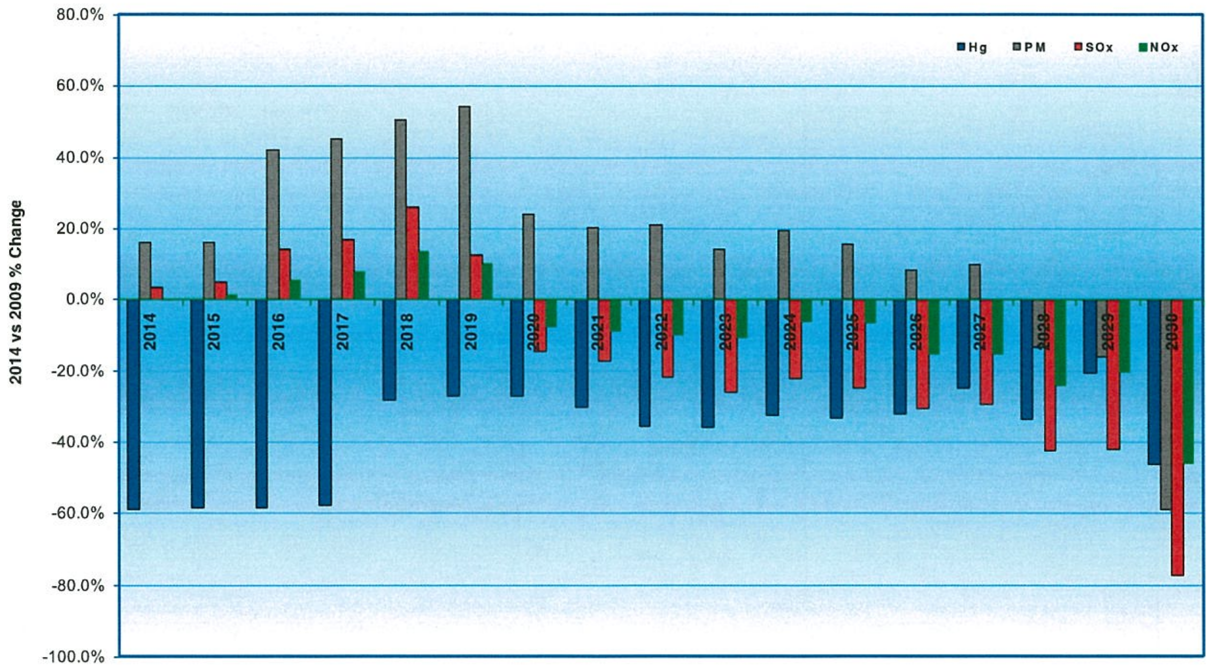
Past forecasts used a generic set of intensity assumptions that tended to be lower than actuals – 0.095 kg/MWh for existing coal and 0.066 kg/MWh for future coal (with the exceptions of the 3 Battle River units at 0.230 kg/MWh, Sheerness at 0.13 kg/MWh, Sundance #1/#2 at 0.11kg/MWh and HR Milner at 0.81 kg/MWh). In the 2009 forecast, 2016 sees a steep drop due to the assumed retirement of several high intensity units - Battle River #3 and #4, as well as HR Milner – without any replacement coal-fired capacity taking their place. This drop is not as steep in the 2003 forecast because the Battle River retirements were staggered and HR Milner was assumed to have retired in 2005. This is also the reason the 2003 forecast is noticeably below the 2009 forecast. Had HR Milner not been retired in 2005, the 2003 forecast would have started, and stayed, higher, albeit remaining below the 2009 forecast because of less forecast coal-fired *generation.*

Figure 15 - Particulate Matter Emission Intensity (kg/MWh)



Current (2014) vs Prior (2009) Emission Forecast Differences (p.25)

Figure 20 - % Change Between the 2014 and 2009 Emissions Forecasts



Excerpt: Electricity Framework 5 Year Review 2013 Phase I Report, EDC Associates, April, 2014.

Appendix 4 – Used ('03, 09) Particulate Matter Intensities by Unit and Year

		2003 Particulate Matter (kg/MWh)					2008 Particulate Matter (kg/MWh)					2014 Particulate Matter (kg/MWh)		
ID	Name	PM Installed	Pre-Installation CASA	Post-Installation CASA	Pre-Installation Hard-Overwrite	Post-Installation Hard Overwrite	PM Installed	Pre-Installation CASA	Post-Installation CASA	Pre-Installation Hard-Overwrite	Post-Installation Hard Overwrite	PM Installed	Pre-Installation	Post-Installation
BR3	Battle River #3	2009	0.23	0.095	0.23	0.23	2009	0.23	0.095	0.23	0.23			
BR4	Battle River #4	2009	0.23	0.095	0.23	0.23	2009	0.23	0.095	0.23	0.23			
BR5	Battle River #5	2009	0.23	0.095			2009	0.23	0.095	0.23	0.23			
HRM	H.R. Milner	2009	0.81	0.095			2009	0.81	0.095	0.81	0.81			
SH1	Sheerness #1	2009	0.13	0.095			2009	0.13	0.095	0.13	0.13			
SH2	Sheerness #2	2009	0.13	0.095			2009	0.13	0.095	0.13	0.13			
GN1	Genesee #1	2009	0.14	0.095			2009	0.14	0.095					
GN2	Genesee #2	2009	0.14	0.095			2009	0.14	0.095					
KH1	Keephills #1	2009	0.11	0.095			2009	0.11	0.095					
KH2	Keephills #2	2009	0.11	0.095			2009	0.11	0.095					
SD1	Sundance #1	2009	0.11	0.095	0.11	0.11	2009	0.11	0.095					
SD2	Sundance #2	2009	0.11	0.095	0.11	0.11	2009	0.11	0.095	0.11	0.11			
SD3	Sundance #3	2009	0.11	0.095			2009	0.11	0.095	0.11	0.11			
SD4	Sundance #4	2009	0.11	0.095			2009	0.11	0.095					
SD5	Sundance #5	2009	0.11	0.095			2009	0.11	0.095					
SD6	Sundance #6	2009	0.11	0.095			2009	0.11	0.095					
WB1	Wabamun #1	2009	0.45				2009	0.45						
WB2	Wabamun #2	2009	0.45				2009	0.45						
WB3	Wabamun #3	2009	0.45				2009	0.45						
WB4	Wabamun #4	2010	0.45				2010	0.45						
GN3	Genesee #3	2009	0.095	0.095			2009	0.095	0.095					
KH3	Keephills #3	2009	0.095	0.095			2009	0.066	0.066					
SD4/5/6U	SD4/5/6 Uprates	2009	(various)	(various)	0	0	2009	(various)	(various)	0	0			
Other Future Coal		All other future coal has 0kg/MWh PM emissions					All other future coal has 0.066kg/MWh PM emissions							

Appendix C

Capital Power Views: Primary Particulate Matter Management System for Existing Coal-Fired Units

Capital Power Views

Primary Particulate Matter Management System for Existing Coal-Fired Units

Purpose

The purpose of this document is to present Capital Power views and rationales on the Primary Particulate Matter (PM) Management System for Existing Coal-Fired Units (Management System) for the Clean Air Strategic Alliance (CASA) 2013 Electricity Framework Review (EFR).

Capital Power Views

In 2003, *An Emissions Management Framework for the Alberta Electricity Sector* (Alberta Framework) recommended regulating PM on a unit-by-unit basis through the Environmental Protection and Enhancement Act (EPEA) approval process (Recommendation 20) until the mercury co-reductions are evaluated as per Recommendation 22 in Alberta Framework. The Alberta Framework also provided that, in case the co-benefits of mercury control are not realized, the EFR review should develop a primary particulate matter management system for existing units.

It appears that the mercury co-reductions have not been realized and that – with the exception of the Sheerness units – none of the existing [1] coal-fired units have met the PM emission intensity of 0.095 kg/MWh described in Recommendation 22. In accordance with Recommendation 22, the EFR should proceed with developing a Management System.

Existing coal-fired units are currently regulated with respect to PM on a unit-by-unit basis through the EPEA approval process. The Minister of AESRD, in a letter to CASA dated August 13, 2014 advised that, pending the completion of the Government of Alberta's (GOA) consideration of the non-consensus report submitted by 2013 EFR, the existing Alberta Framework would remain in effect and be the basis for regulatory decisions. Capital Power submits the current approach for regulation of PM on a unit-by-unit basis should remain in effect at least until such time as the GOA provides its direction regarding the non-consensus report.

Once such direction is provided by the GOA, Capital Power would support CASA proceeding with the development of a new Management System that is based on End of Design Life (EoDL) and flexibility mechanisms.

1. Unit-by-Units basis

Capital Power believes that installing PM control technologies before EoDL to reduce PM (Mid-Life PM Control) is not justified or warranted because PM does not impose immediate health or environmental risks. Alberta's Guide for Responding to Potential "Hot Spots" Resulting from Air Emissions from the Thermal Electric Power Generation Sector outlines a clear and transparent process for identifying and managing potential hot spots caused or potentially caused by air emissions of thermal electric generation facilities. In addition, existing coal-fired units have reduced the PM emissions from 9931 tonnes in 2002 to approximately 5000 tonnes in 2013.

The need for significant, unplanned capital investment life at existing units poses greater challenges for units subject to Power Purchase Arrangements (PPAs). Under the terms of a PPA, the PPA Buyer would be responsible to cover the expense under the Change in Law provisions. It would be very difficult for the limited number of PPA Owners to bear the initial up front capital expenditures. In addition, PPA Owners may have similar challenges to fully recover the required capital investment because these units have limited remaining life under the PPA to recover costs. It should also be noted that the Mid-Life PM Control retrofit costs may create PPA conflicts and may result in extended arbitrations.

2. Management System with Flexibility Options

Once direction regarding the non-consensus report is provided by the GOA, Capital Power believes that a new Management System that based on EoDL and flexibility should be developed to provide regulatory clarity for investors and provide compliance flexibilities to bridge the compliance gap between EoDL and 50 years. Flexibility compliance options can be discussed at that stage. In addition, Units that reach EoDL prior to developing a new Management System should have special compliance provisions to accommodate their transition to the new Management System. Capital Power does not expect that such units will be grandfathered indefinitely but will comply with the new Management System at later stages.

Appendix D
Industry Views: Primary Particulate Matter Management System for Existing Coal-Fired Units

1. **Based on the information received from industry, what is your view on current PM Management activities?**
   - The current PM Management process is working.
   - Significant and steady reductions have occurred in sector actual mass emissions (down 44% in 12 years since 2003).
   - The sector is essentially on track to achieve the original 2003 CASA projected PM reductions from the electricity sector of 3500 tonnes by 2025, compared to 2003 (slightly missing the target in 2025 but exceeding it in 2026).
   - Reductions in sector emissions are expected to continue in the future with the replacement of coal generation with lower and non-emitting generation technology.
   - Additional regulatory action is not required.

2. **What is your view on the requirement for a PM Management Plan for existing units? Do you think that current PM management activities are sufficient? Is status quo acceptable?**
   - The current management activities are sufficient. For areas where ambient PM is close to or exceeding provincial objectives, then these situations should be dealt with on a unit by unit basis as described in *Alberta's Guide for Responding to Potential "Hot Spots" Resulting from Air Emissions from the Thermal Electric Power Generation Sector.*
   - The electricity sector contributes less than 6% to Alberta's non open source reported PM emissions and has control equipment in place to capture more than 99% of particulate matter. Emissions have been reduced over the past 12 years are reductions are expected to continue in the future. The current PM Management Plan is successful and further measures are not required.

3. **What is your view on the requirements for a PM Management Plan for units reaching end of design life?**
   - A PM Management Plan is already in place for end of life units and consists of PM testing, in-stack opacity monitoring and reporting, continual improvement operational and maintenance measures, and monthly assessments by ESRD.
   - The CASA framework recommendations were adopted by the GOA and there is no requirement to change the existing unit PM standards at End of Design Life:
     - Emissions Trading Regulation does not specify an End of Design Life requirement for PM. The Regulation refers to the Alberta Air Emissions Standards for Electricity Generation document for Emissions Standards.
     - Alberta Air Emission Standards for Electricity Generation and Alberta Air Emissions Guidelines for Electricity Generation set new coal unit standards for NOx, SO_2 and PM and set End of Design Life coal unit standards for SO_2 and NOx.
     - Coal facility approvals set PM concentration limits, PM mass limits, and opacity standards. The facility approvals include a post design life annual mass emission limit for SO_2 and NOx. There is no requirement specified for post design life PM emissions.
     - These documents are clear that the PM requirements for existing coal units do not change at End of Design Life. This is supported by two coal units that have reached End of Design Life and have been directed to continue with existing requirements for PM and opacity.

4. **If you have options to address any issues, please include a brief description of the options.**
   - Not required, see above.

Appendix E
Discussion Paper – Using In-Stack Opacity Measurements for Minimizing Emissions of Primary Particulate Matter from Coal-Fired Power Plants (prepared by Alberta Environment and Sustainable Resource Development representatives to the CASA 2013 EFR)

Discussion Paper – Using In-Stack Opacity Measurements for Minimizing Emissions of Primary Particulate Matter from Coal-Fired Power Plants

Particulate Emission Control at Existing Coal-Fired Units in Alberta

Primary particulate matter emissions from the utility sector are mostly controlled by the use of electrostatic precipitators (ESPs), although there are both vintage and state-of-the-art fabric filter baghouses operating within the province of Alberta. ESPs control particulate matter emissions by attaching a negative charge to a particle and then attracting it to a positively charged plate, which are then "rapped" to remove the particles from the plate. ESPs are devices that, if properly maintained, run well but only at close to steady state conditions. Overall removal efficiency (on a mass basis) of an ESP in Alberta can range from 99.5% to 99.9%. Removal efficiency is also size dependent and smaller diameter particles are not removed to the same extent for various reasons. New fabric filter baghouses can remove particulate matter at the high end of the range, and are more efficient at removing small diameter particles.

Background

Coal-fired power plants in Alberta are major sources of air contaminant emissions, including primary particulate matter, and have significant continuous emission monitoring (CEM) requirements, as laid out in the facility's operating approval. Unlike the direct measurements made for SO_2 and NO_x, particulate emissions were correlated to the measurement of in-stack opacity. While there is a compliance component to all continuous emission monitoring, these measurement can also be utilized by an operator to take proactive actions to minimize emissions.

The magnitude of the potential number of opacity exceedance incidents (and possible excessive particulate matter emissions) was originally discovered when CEM reporting was changed from a longer term averaging period to reporting on a six-minute average. When the measurement records were moved to an environmental computer as opposed to a circular chart recorder, the issue of opacity exceedance became obvious to all parties.

Two problems that have been addressed in the past to better deal with particulate matter emissions include improvements in the operation of pollution control equipment at steady state conditions, and setting of performance requirements during transient conditions (that is during periods of start-up and shutdown). This work has been ongoing for more than twenty years. Performance improvements of particulate control equipment during steady state operation included upgraded maintenance (replacement of wires and their connectors, removal of particulate matter (PM) build-up on plates) and major capital projects (replacement of T/R controllers, air flow modifications, and chemical conditioning of particulate to change resistivity of the flyash).

Improvements in performance during transient conditions came from the results of work done by the Opacity Task Force Working Group, which consisted of ESRD, industry and suppliers and was formed in late 1991. This working group identified limitations based on particulate control equipment design and Fire Code requirements, and the group's findings led to operational changes but no equipment modifications. Additionally, a new requirement for longer averaging times for opacity limits during start-up and shutdown was implemented.

Present Situation

Within Alberta, there has been a long standing requirement to measure and report in-stack opacity levels. While it is fully recognized that in-stack opacity is not a direct measurement of the emissions of primary particulate (ASSC Method 5 is the compliance method and consists of doing isokinetic sampling to obtain a gravimetric sample), it is certainly a surrogate for particulate mass emissions. The reporting is done on a frequency distribution basis so that ESRD can see how the facility generally performs. The intent of the program is to identify operational conditions under which the particulate control equipment is underperforming. This allows the operator to correct the operational issues long before the issues are confirmed through a compliance manual stack survey (which is typically done twice per year as covered by three one-hour tests).

Future Direction

Even with the advent of new CEMS technologies which purport to be able to continuously monitor particulate mass emissions, it appears that the measurement are not gravimetric but rather are surrogates for mass emissions. It is important to ask whether more can be done to measure and report these emissions. Short of replacement of the ESP, PM control depends on the capabilities of the installed equipment. Performance is tracked by the use of in-stack opacity monitors and the data reported to ESRD is based on a frequency distribution report. Additionally chemical conditioning, while effective in certain cases, does lead to collateral emissions of ammonia or SO_2 and SO_3 depending on what compound is used. Chemical conditioning may also affect mercury removal.

Implications of the Existing PM Emission Management Optimization Program

There is a regulatory expectation that operators will continue their proactive actions to maintain and enhance PM control device operations. This requirement will not change as existing coal units move closer to their CASA end-of-design-life. Performance is also assessed monthly by the ESRD Operations staff through the review of monthly reports and/or immediate reporting on emission control equipment outages.