Development of Current and Future-year Point Source Air Emissions Inventories for Alberta Province of Canada
FOR THE 15th ANNUAL CMAS CONFERENCE

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1. INTRODUCTION

This paper introduce the method of building a comprehensive database for point source air emissions inventory and model inputs for regions of Alberta province. The current and future year point source emissions are also summarized.

2. CURRENT YEAR NEW POINT SOURCE EMISSIONS

The following different existing emission inventories and data sources are used to develop the new point source inventory.

2.1 DATA SOURCES

Capital Region and SAOS (South Athabasca Oil Sands)/CEMA (Environmental Management Association) Inventories.

This is a province-wide emission inventory up to the year of 2010) and it is regarded as to be of high quality and accuracy in oil sands area.

EC (Environment Canada) 2010 Inventories. This is the latest comprehensive emissions inventory developed by Environment Canada for 2010 and it is the most accurate data source for smaller upstream oil and gas emission sources which may not be included in other inventories.

JOSM (Joint Oil Sands Monitoring) 2013 Inventories. The Joint Oil Sands Monitoring (JOSM) emissions data were based on the joint effort of Environment Canada and Alberta Environment and Parks focusing on oil sands emissions and were partially taken from continuous emissions monitoring system (CEMS) on selected sources.

EIAs (Environmental Impact Assessment) Inventories. All environmental impact assessments (EIAs) inventories are considered to have more accurate stack parameter information but not for actual emission rates.

NPRI (National Pollutant Release Inventory) Inventories. Total emissions from the National Pollutant Release Inventory (NPRI) are considered very accurate at the facility level. However, this inventory is lack of detail information of stack location and individual emission inventory.

Three Creek inventory. Three Creeks Inventory for 2012 were included in the inventory covering Cold Heavy Oil Production with Sand (CHOPS) emissions with a pseudo stack for each of the source types.

2.2 HARMONIZATION METHOD

In order to harmonize the various data sources and create a new single emissions inventory for the province, the data was classified into three groups: 1) top 100 facilities (by total emissions) province-wide, 2) emitters greater than 50 tonnes/year (55 tons/year) for any CAC pollutant, and 3) emitters below 50 tonnes/year. These classifications were based on the Capital Region/SAOS database.

For the top 100 largest emissions, Alberta Air Emission Inventory (AAEI) data from the Capital Region/SAOS Projects were found to be the most accurate and used when available. EC 2010 data were used as the next best information source. JOSM data were used only for the stacks that had hourly monitoring data. EIA information was used only to update stack locations and parameters.

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For all facilities with total emissions less than 50 tonnes/year, the EC 2010 emissions data were included in the inventory.

2.3 EMISSION SUMMARY

Figure1 is a comparison of province-wide emissions of criteria air contaminants between the various existing inventories and the new inventory. The removal of some duplicate emissions leads to lower emissions in the new inventory for some pollutants, compared to the original inventories (Capital Region/SAOS). The total emissions of NOx, SO2, CO PM2.5 and PM10 are lower than that in EC2010 inventory. Only VOC emissions is little higher than that in the EC2010 inventory.

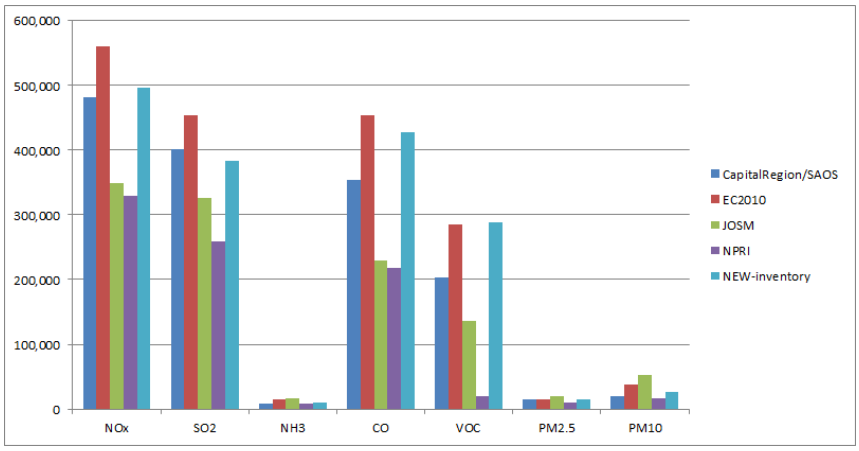

Figure 1, Comparison of emissions between the new harmonized emissions and other existing Inventories.

3. FUTURE-YEAR POINT SOURCE EMISSIONS

The future-year scenarios were developed for two separate periods: 2030 and 2045. The year 2030 was selected to be a major milestone of Alberta's climate plan that will phase out of emissions from coal generated electricity by 2030. The selected year 2045 is to take into account available activity data for the shale-gas industry as well as the limitation of mobile emission projection tools.

3.1 DATA SOURCE

NSRP future-year emissions. The first set of emission is North Saskatchewan Regional Plan (NSRP) future-year inventories.

The NSRP future year emissions were developed by Ramboll Environ (2015) at the provincial level based on the NEB-2009 forecasts that provided projections for oil, gas and bitumen production to the year 2020. The trends in the 2010 to 2020 forecasts were extrapolated to 2050 at every 10-year interval (i.e., 2010, 2020, 2030, 2040, and 2050). These forecasts illustrated a decline in the production of conventional crude oil and natural gas and an increase production of bitumen and synthetic oil (made from bitumen).

CEMA future year database. The second set of emission is CEMA future-year database in the oil sands area including oil sands mining and in-situ production. This database estimated emissions for the following two future year scenarios:

- Future Case 1, based on a nominal development scenario that is 15 years in the future (i.e., the 2025/2030 period).
- Future Case 2, based on a nominal development scenario that is 30 years in the future (i.e., the 2040/2045 period).

SAOS future year scenarios. The future-year inventory in the SAOS region were developed based on Alberta energy projection from 2010 to 2045 and focused on in-situ oil and gas production. The inventory included two separate periods; 2020 and 2050. Forecasts covered low, medium, and high production scenarios for 2020 and a high production scenario for 2050 defined by AEP.

3.2 METHODOLOGY

3.2.1 OUTSIDE CEMA OIL SAND AREA

Removal of conventional UOG (upstream oil and gas) emission.

According to AER-30 year forecast provided by Alberta Environment and Parks, conventional oil and gas will be phased out before 2030. Thus all emission sources associated with the conventional upstream oil and gas sector, were removed from the inventory for future years outside of the CEMA oil sands area. All oil and gas activity outside the oil sands area is related to hydraulically fractured wells in 2030 and 2045.

Applying growth coefficient factors to other industrial sources.

Regarding the other industrial stacks for the future emission scenarios, growth coefficient factors were applied. The growth factors are based on the Industrial projection factors developed by Ramboll Environ for the years 2030 and 2045.

Figure 2 is the growth coefficient factors for different industrial source (Food preparation, Grain industries, Bakeries, Ferrous Foundries, etc).

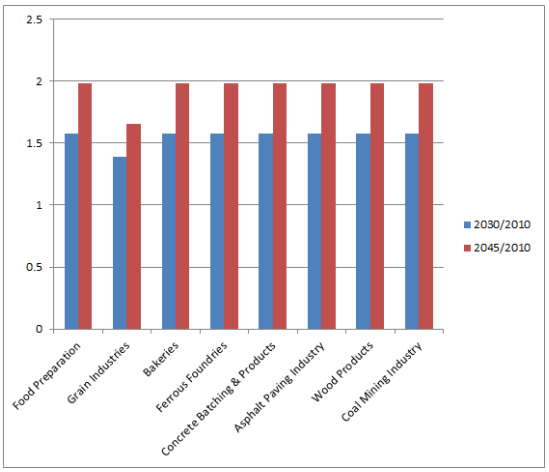

Figure 2, Growth coefficient factors for different industrial source.

Removal of coal-fired power plants.

Based on the Alberta government's new plan to Phase-out Coal Fired Emissions in Alberta, released in March 2016 as shown in Figure 3, emissions associated with these plants were removed from the future year 2030 and 2045 inventories.

Figure 3, Planned Phase-Out of Coal-Fired Emissions in Alberta

Adding natural gas and green energy facilities

After coal plant facilities were removed, a natural gas power production facility was added to the inventory to replace the 1/3 of capacity and the remaining 2/3 power generation capacity will be replaced by green energy with zero emissions. Natural gas facilities were located in the same location as the coal plants removed, with the same exhaust parameters. Emissions for the natural gas facilities were determined by averaging the emissions of existing facilities of similar size, released by the Commission for Environmental Cooperation's North American Power Plant Air Emissions

3.2.2 INSIDE CEMA OIL SAND AREA

The CEMA future production forecast covers the oil sands area and the Lower Athabasca region of the province. Specifically, many of the large in-situ facilities are located within the SAOS region (CEMA includes SAOS area). However, different emissions projections allows us to split SAOS emissions from CEMA emissions projections.

Inside SAOS.

Within the SAOS area, future year point source emissions for the major stack inventory were estimated based on forecasted oil production figures that were provided by AEP. Forecasts covered low, medium, and high production scenarios for 2020 and a high production scenario for 2050 defined by AEP. These production

forecasts were then used to generate emission estimates in the area.

Future year emissions from gas plants and other sources in the CEMA boundary were taken directly from the CEMA inventory in the CEMA Future Case 1 and Future Case 2 scenarios

Outside SAOS.

Forecast for outside SAOS included future gas plant projections and future stack emissions from CEMA major facilities. The forecasts included the addition of 1044 stacks in the 2030 scenarios and 1131 stacks in the 2045 Scenario.

3.4. EMISSION SUMMARY

A summary of the total emissions for the base year 2010, 2013 update, 2030 and 2045 forecast scenarios are shown in Figure 4. VOC emissions in future years (2030, 2045) reduced approximately 90%. Furthermore, NOx reduced 40-50%, SO2 and CO emission reduced about 20-30%. The reduction of the total number of stacks in the future caused this emission reduction. Specifically, total emissions of SO2 are reduced due to the decommissioning of coal-fired power plants

On the other hand, NH3 and particulates (PM10 and PM2.5) increased, which resulted from the growth of chemical industrial and downstream oil and gas sectors.

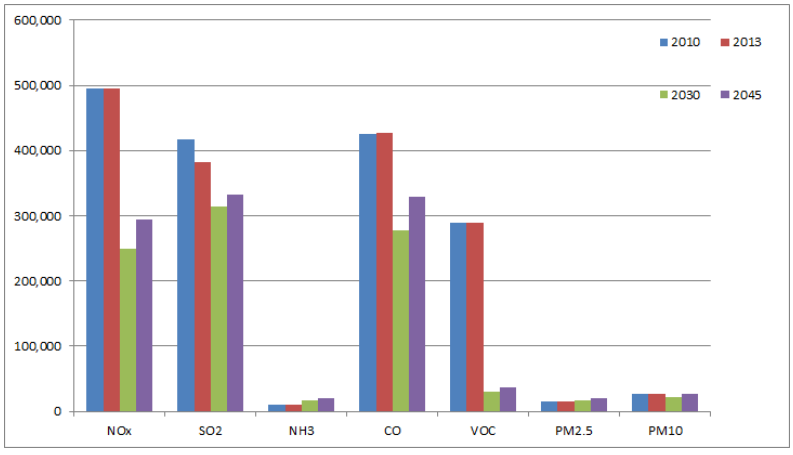

Figure 4, Comparison of current year and future year emissions.

4. Discussions

Due to the large amount of data from various sources and with different quality, QA is a necessary and cumbersome task when harmonizing them together.

For different datasets, we use different tools, such as GPS, character identifier and delimiter scanning techniques to ensure data source correctness. Manual QA checks for duplicates against the raw data files were also performed at each stage where new files were created.

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