Quantifying the Carbon Footprint of the Alouette Aluminum Smelter

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Abstract

The Alouette primary aluminum smelter is the largest in the Americas with an annual production close to 630 000 tonnes of aluminum. The smelter uses hydroelectric power, operates with benchmark performance levels, and meets all the criteria for a smelter producing low carbon aluminum. In this collaborative study, a detailed product carbon footprint analysis of the Alouette smelter was undertaken by Rain Carbon using a large body of primary emissions data. Life cycle assessment modeling following the ISO 14067 standard provided a complete cradle-to-gate analysis of the smelter's scope 1 (direct emissions), scope 2 (indirect emissions from generation of purchased energy), and scope 3 (all other) emissions. The total carbon footprint of the smelter in 2019 was 3914 kg CO_2e per tonne of aluminum for scope 1, 2 and 3 emissions and 1835 kg CO_2e per tonne of aluminum for scope 1 and 2 emissions.

When the results were compared to those generated with reference datasets developed by the International Aluminium Institute (IAI) and Sphera (GaBi Professional database), the total carbon footprint of the Alouette smelter is 75 % lower than a world average smelter and 25% lower than a Canadian average smelter. The use of hydroelectric power is the primary driver of the significantly lower CO_2 footprint versus a global average smelter. Compared to a Canadian reference smelter, the lower CO_2 footprint at Alouette is driven by lower emissions from the production of alumina and CPC used at the smelter. The study presents the first detailed breakdown of CO_2 emissions associated with the anode supply chain at a smelter. Previous publications have relied on the use of secondary data and reference datasets in this area. The work covered in this presentation will be published in more detail in the Journal of Metals (JOM) in 2022.

During the modeling work, an error was uncovered in the reference dataset for net and gross anode consumption, which resulted in an under-estimation of the net carbon consumption by 24 %. This was corrected to allow the above comparisons and has been communicated to the IAI and Sphera. New reference datasets for aluminum production are expected to be published by the IAI/Sphera in 2023. When the modeling results for Alouette are examined in more detail, direct process emissions from electrolysis (which includes CO_2 from anode consumption and fluoride emissions) account for approximately 42 % of the total emissions. The next largest contribution comes from alumina production and bauxite mining at 35 %, and anode production and related upstream production of CPC and CTP accounts for 20 %. The electricity supply accounts for only 0.2 %, and all other raw material inputs plus their transport to the smelter accounts for approximately 3 % of the total smelter emissions.

Over the longer term, Alouette's carbon footprint is set to decrease further. In 2022, the fuel source for the anode baking furnaces will be switched from fuel oil to natural gas. The smelter will also start to rebuild its Phase I anode baking furnaces in 2023, which is expected to further reduce fuel consumption related to anode baking. In 2023, the refinery supplying alumina to Alouette will switch from the use of heavy fuel oil to LNG (liquid natural gas). The smelter will also complete a multi-year transition to the AP40 cathode lining design in 2023 which will help operational stability over the longer term.

Keywords: Carbon footprint, Scope 1, 2, 3 emissions, Alouette aluminum smelter, Sustainability.