

GLENCORE



Study on the economic importance of sulphuric acid

Final report

September 20th, 2024



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Sulphuric acid, a little-known but essential product to several economic sectors



Glencore, a key player in the sulphuric acid sector in Quebec and Canada

Through the Horne Smelter, CEZinc and INO Sudbury, Glencore produces hundreds of tons of sulphuric acid annually. NorFalco is the Glencore-owned company that markets and distributes this sulphuric acid. Through these three facilities, Glencore supplies sulphuric acid to customers in Eastern Canada and the United States.

A significant economic contribution to Quebec and Canada

Glencore's sulphuric acid production and distribution activities contributed \$89.3 million to real GDP in Quebec, compared with \$138.9 million in Canada. Overall, all economic agents benefit from these activities, while their revenues are all on the rise (governments, households and businesses)

- Glencore's activities also increase investment in the economy, a vector for long-term economic growth.

It is also estimated that the use of sulphuric acid by user companies is beneficial to the economy, as it is beneficial for these companies' productivity and thus avoid economic losses

- Sulphuric acid stands out not only for its versatility, but also for its low price. A number of products can be used as substitutes for sulphuric acid, but they are often more expensive, impacting the productivity of companies that have to pay more
- In this way, the use of sulphuric acid avoids economic losses.

Summary of economic and tax benefits¹

Canada and Quebec, in \$ millions

	Scenario 1: Glencore activities related to sulphuric acid		Scenario 2: Economic losses avoided
	Quebec	Canada	Quebec
Real GDP	89.3	138.9	9.7
Government Rev.	74.5 ²	106.2 ³	9.3 ²
Household disposable income	91.4	141.9	12.0
Corporate income	49.5	117.9	5.7
Total investments	120.2	215.5	14.6



Future demand will grow

Market studies estimate that both the volume (CAGR +2.4%) and value (CAGR +13.5%) of the sulphuric acid market will increase by 2032. The more pronounced rise in market value suggests that the price of sulphuric acid is set to rise.



The product is essential to the energy transition

Governments' ambitions are clear: reducing economic dependence on fossil fuels is a priority. Gasoline-powered cars should slowly give way to 100% electric cars. As an integral part of the battery industry, sulphuric acid plays a central role in achieving government objectives in terms of meeting environmental targets and decarbonizing the economy.



Its use is at the heart of various economic sectors

It is used in both traditional and emerging sectors, demonstrating the versatility of sulphuric acid's use. Nevertheless, more than 50% of production is destined for the agricultural sector for the manufacture of fertilizer. In addition to this sector, sulphuric acid is also used in a number of other industries, such as batteries, water treatment, metal treatment, pulp and paper, pharmaceuticals, etc.

Analysis of structuring effects

The importance of sulphuric acid in the economy goes far beyond its contribution to GDP and income for economic agents. Less quantifiable, but just as important, effects flow from its use. Five structuring effects have been identified.

Security and environmental impact

- 1 | Glencore's sulphuric acid production is based on metal roasting which produce sulfur dioxide. Sulfur dioxide is a gas which, if not captured, causes acid rain.

Circular economy

- 2 | Recovering sulfur dioxide into sulphuric acid is in line with the principles of the circular economy and follows one of the nine circular economy strategies: valuation.

Integration into the electric vehicle battery chain

- 3 | Governments are betting on the development of the EV battery industry, from the extraction of metals for manufacturing to battery recycling. Sulphuric acid comes into play at different points in an EV battery's life cycle.

Essential product

- 4 | Sulphuric acid is essential to human life, as it is used in key sectors such as water treatment.

Security of supply

- 5 | Canada is the world's leading exporter of sulphuric acid, which means that local companies can count on a local supply. Demand for sulphuric acid is expected to grow in the short to medium term. Canadian companies will be able to count on a local supply.

(1) More information on the methodology and assumptions used for the modeling is presented in the section "Methodological approach and main assumptions. (2) Aggregation of Quebec and Canadian government revenues. (3) Aggregation of provincial and Canadian government revenues. Sources: NorFalco, Aviseo Consulting analysis based on simulations of Quebec's computable general equilibrium model, 2024

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Background and study objectives

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A report to highlight the importance of sulphuric acid

Sulphuric acid is an essential input in the manufacturing process of many key industries of the future. It is best known for its use in the agricultural sector, as an input in the manufacture of fertilizers. However, it plays a central role in the energy transition, notably as a key chemical compound in the manufacture and recovery of batteries

- In Canada, NorFalco, a company owned by the multinational Glencore, is one of the largest sulphuric acid traders in North America. The company distributes over 1.5 million tonnes of sulphuric acid annually
- Sulphuric acid is often known for its hazardous nature; however, it is at the heart of the production of essential goods and needs to be better known by the public and government authorities
- It is against this backdrop that Glencore has decided to commission a study to shed light on the importance of sulphuric acid to the economy of Quebec and Canada. Accordingly, this report aims to meet the following objectives:

- 1 Raising awareness of sulphuric acid and its market
- 2 Documenting the economic and structuring importance of sulphuric acid

The analyses produced by Aviseo Consulting are based on information and data available between May and August 2024. The data used comes mainly from internal and public data from Glencore's facilities, including NorFalco, while secondary data comes from recognized statistical agencies

- Although every effort has been made to ensure the accuracy of the information contained in this report, there can be no guarantee that it will be accurate at the date it is received by the reader, or that it will continue to be so in the future.



The report is structured around four main complementary sections

To achieve the objectives of the study, the approach used by Aviseo requires documentation and a methodology in line with good business practice.

Each section is self-supporting, with its own findings, but they feed into each other in the development of the study that describes the importance of sulphuric acid for Quebec and Canada. To this end, the document is divided into four sections:

<p>1. Product and sector presentation</p>	<ul style="list-style-type: none"> – This first section of the report takes the form of a portrait to better understand the dynamics of the sulphuric acid market. – More concretely, the section looks at sulphuric acid production, its uses and growth prospects.
<p>2. Methodological approach</p>	<ul style="list-style-type: none"> – A second section presents the methodology used to estimate the economic impact of sulphuric acid in Quebec and Canada. – Aviseo has developed two scenarios. The first models the economic impact of Glencore's sulphuric acid activities, while the second models the impact on companies of using a substitute product that is more expensive than sulphuric acid.
<p>3. Economic contribution</p>	<ul style="list-style-type: none"> – This section presents the results of the two scenarios. – Aviseo uses a computable general equilibrium model to estimate impacts based on a variety of variables, including GDP, investment, revenues for households, businesses, governments, and so on.
<p>4. Structuring effects</p>	<ul style="list-style-type: none"> – Finally, to capture the full importance of sulphuric acid, this section presents the structuring effects associated with the product. These include its contribution to the energy transition, its role in the EV battery industry, its designation as an essential product, etc.

Nomenclature in the document

Sulphuric acid H_2SO_4

Sulfur dioxide SO_2

Sulfur trioxide SO_3

NorFalco is one of North America's largest marketers of sulphuric acid

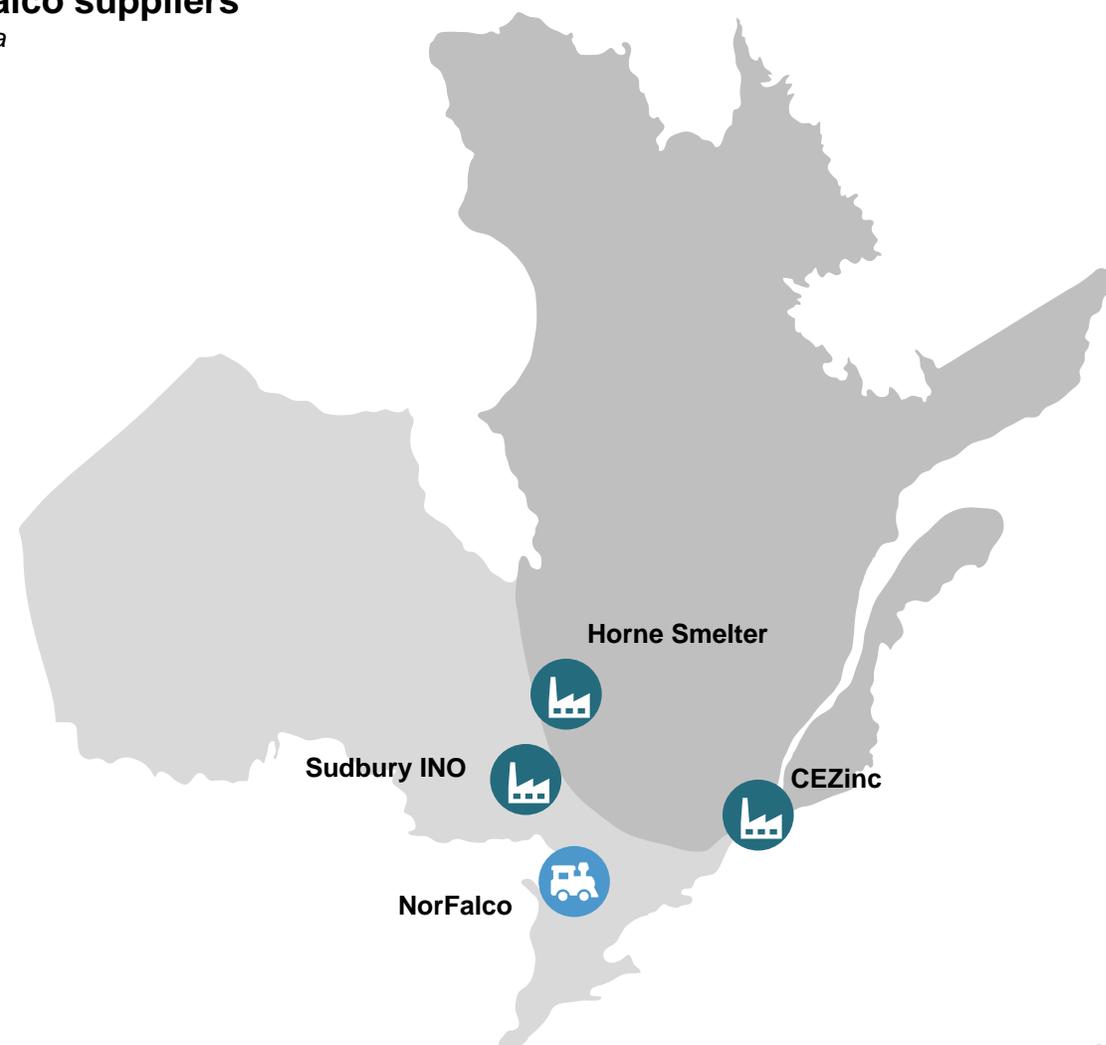
The company is responsible for the marketing and distribution of over 1.5 million tonnes of sulphuric acid per year in Eastern Canada and the United States

- Through its parent company, NorFalco has exclusive access to sulphuric acid production from the Horne smelter, Sudbury INO and CEZinc operations
- This privileged access provides NorFalco with a stable and predictable supply of sulphuric acid for the benefit of its many customers
- Nevertheless, NorFalco's supply is highly correlated with mining activities, which are influenced by market conditions such as metal prices.

Glencore's Quebec operations are among the few facilities producing sulphuric acid in Quebec.

Norfalco suppliers

Canada





Product and sector presentation

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The oxidation of sulfur dioxide is the main principles underlying the production of sulphuric acid

Manufacturing activities in the mining sector produce large quantities of sulphur dioxide during the smelting and roasting of metals

- When released into the air, SO_2 is harmful to the environment and contributes to the creation of acid rain
- In order to reduce the impact of this gas on ecosystems, technologies have been developed to capture it and convert it back into sulphuric acid¹

In addition to production via the direct capture of SO_2 , sulphuric acid is also produced by the combustion of elemental sulfur, which is then transformed into SO_2 .

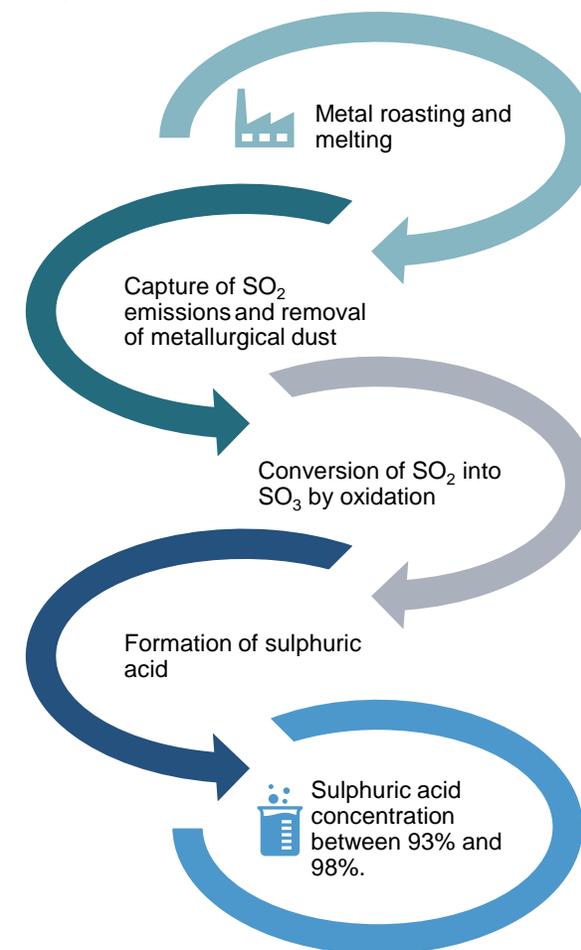
Two processes are used to produce sulphuric acid. In the 20th^e century, over 50% of production was carried out using the lead chamber process. Today, the majority of production is carried out using the "contact" process, the one used by Glencore's facilities

- This involves capturing the SO_2 emitted during the roasting and melting of metals
- Once cleaned, the SO_2 is transformed into SO_3 by oxidation
- The final step involves dissolving the SO_3 in a low-grade sulphuric acid solution to obtain concentrated sulphuric acid of between 93% and 98%.



Photo credit: Mathieu Dupuis

Sulphuric acid production using Glencore's contact process



(1) A more detailed discussion of environmental impact is presented in the structuring effects section.

Sources: Horne Smelter, Sudbury INO, Merchant Reseach & Consulting, l'élémentarium, Analysis Aviseo Consulting, 2024

6% of Canadian GDP is generated by sectors capable of producing the input needed to manufacture sulphuric acid

The production of sulphuric acid requires a high sulfide input and comes essentially from certain primary and secondary sectors

- Most elemental sulphur comes from oil refining and natural gas processing activities
 - In 2020, the Canadian reserve of elemental sulphur from the sector's activities amounted to 21.4 million tonnes.
- The production of sulfur dioxide results from the roasting of ores, pyrites and elemental sulfur.

In Canada, the oil refining and mineral extraction and processing sectors will account for over \$135 billion in value added in 2023, or 6.2% of Canadian GDP

- Over the past ten years, the share of GDP generated by these sectors has remained relatively stable, fluctuating between 6.2% and 6.6% of Canadian GDP
- The western provinces are characterized by a strong presence of oil refining activities, while in Quebec and Ontario, we find more mineral roasting activities.

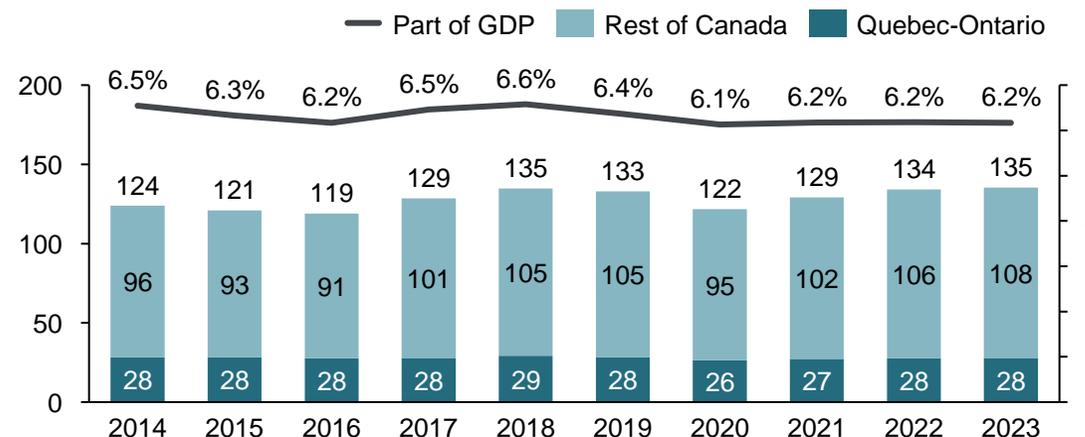
Sulphuric acid production by raw materials

World, 2020

Provenance	Products	Share (%)
Oil refining and natural gas processing	Elemental sulfur	≈ 60%
Roasting of copper, zinc and nickel ores	Sulfur dioxide	≈ 30%
Pyrite and other roasting	Sulfur dioxide	≈ 10%

GDP trends for the main sulphuric acid-producing industries¹

Canada, 2014 to 2023; in chained \$B from 2017 (left) and in % (right)



(1) It is included in the main sulphuric acid-producing industries: Mining, Quarrying and Petroleum Extraction (21), Petroleum Refining (311) and Primary Metal Manufacturing (32411).

Sources: Statistics Canada, Statista, Natural Resources Canada (2008), Analysis Aviseo Consulting, 2024

Canada is the world's leading exporter of sulphuric acid

In 2023, Canada exported \$375 million worth of sulphuric acid worldwide, representing 28% of the total value of exports of this product

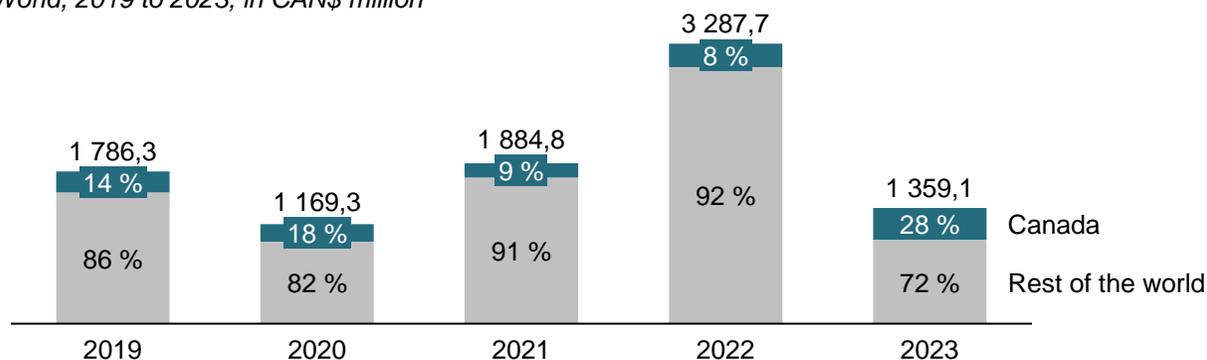
- Of this amount, \$373 million was sold to the United States, representing 99.5% of Canadian sulphuric acid exports
- Being a product that requires a higher level of safety during transport, it is not surprising that the United States is Canada's main trading partner for this product, due to their geographical proximity.

Exports have several beneficial effects on the economy

- In addition to injecting new money into the country, access to the foreign market enables companies to increase their income, which is positively reflected in national savings. Higher savings lead to increased investment, which in turn has a positive impact on productivity.

Worldwide sulphuric acid exports

World, 2019 to 2023; in CAN\$ million



Sources: United Nations (Trade Data), Statistics Canada, Aviseo Consulting analysis, 2024

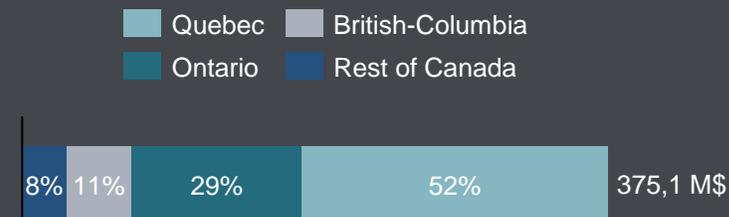
Quebec is Canada's leading exporter of sulphuric acid

In 2023, the value of Quebec exports accounted for 52% of Canadian sulphuric acid exports, for a total of over \$195 million.

As Quebec is a major producer of sulphuric acid, this is reflected in Norfalco's sources of supply, with the majority of the sulphuric acid the company distributes coming from Horne smelter and CEZinc.

Value of sulphuric acid exports

Canada, 2023; in millions of Canadian dollars



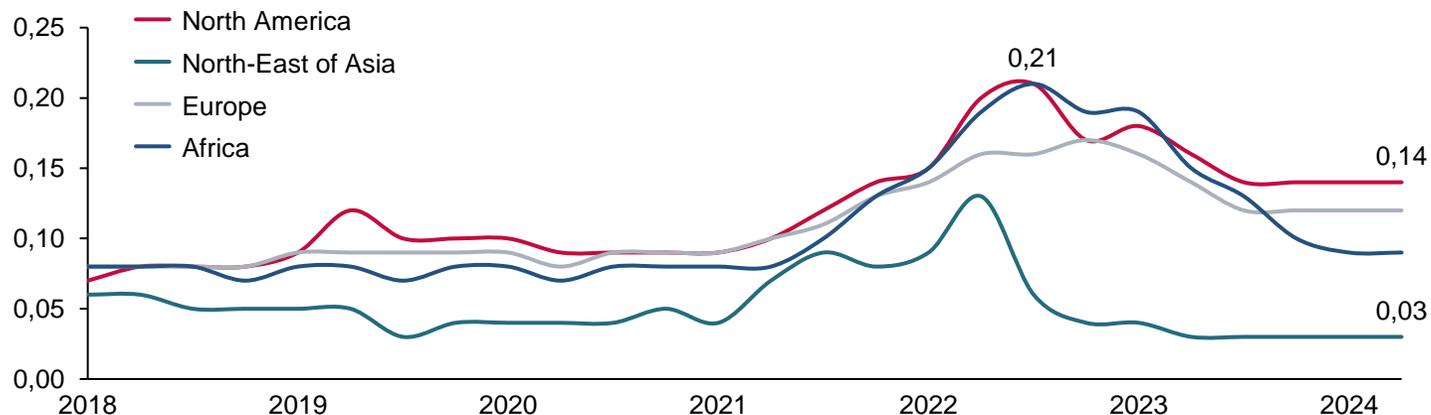
Sulphuric acid's selling price gives it a comparative advantage over its substitutes

Sulphuric acid prices vary from region to region

- In North America, the price of sulphuric acid doubled between January 2018 and April 2024, rising from US\$0.07 per kilogram to US\$0.14 per kilogram
- Despite a price that has doubled in more than five years, sulphuric acid is still an advantage over some of its comparable
 - By way of example, phosphoric acid can be used as an alternative in certain industrial applications, notably in the manufacture of fertilizers and certain chemical products
 - It sold for US\$1.00 per kilogram in April 2024, more than seven times the price of sulphuric acid in North America.

Sulphuric acid market prices - by region

January 2018 to April 2024, in US\$ per kilogram



"Some acids, in certain applications, may be substituted for sulphuric acid, but usually at a higher cost."

- U.S Mineral Commodity, 2024

The sulphuric acid market is expected to continue in the coming years

There are numerous market studies on the subject, all pointing in the same direction, i.e. towards worldwide growth in the sulphuric acid market

- In terms of volume, the sulphuric acid market was growing steadily before the health crisis of 2020. It grew by an average of 2.2% per year between 2015 and 2020, before declining by 4.8% in 2021
- Nevertheless, forecasts for 2030 are positive. Market volume should rise from 265 million to over 321 million metric tons (CAGR¹ +2.4%).

Sulphuric acid is the most widely produced chemical in the world. Its versatility gives it a role in a multitude of economic sectors, increasing demand for the product.

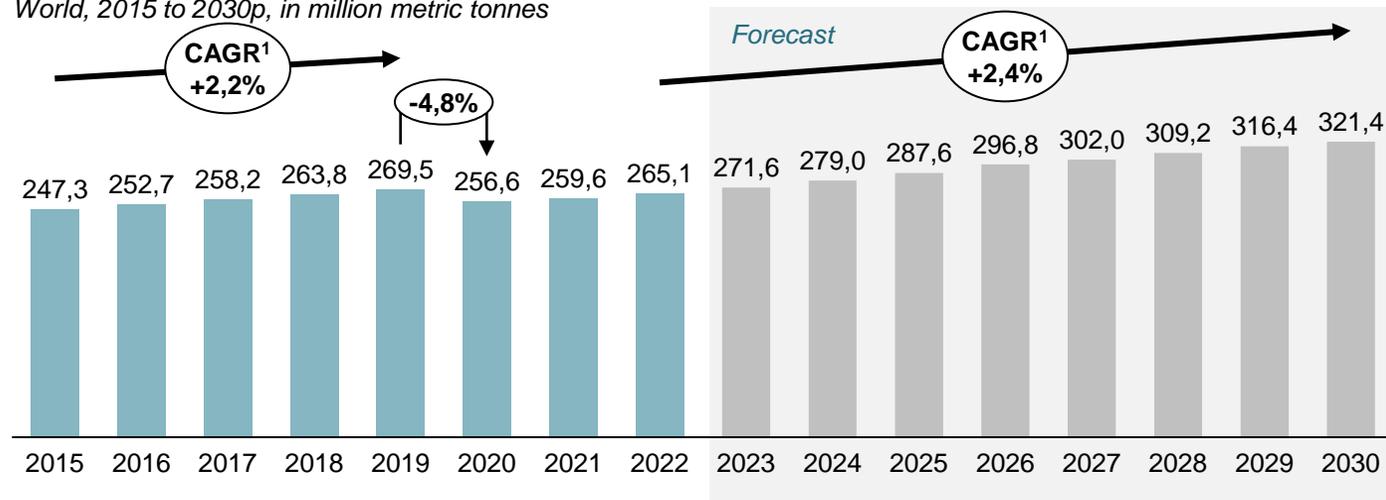
According to various market studies, the global sulphuric acid market will be worth around \$17 billion by 2023

- The latter is expected to grow steadily, reaching more than \$50 billion in 2032
- The fact that market value has risen more sharply than volume suggests that sulphuric acid prices will continue to rise over the next few years.

Forecasts point to an increase in the volume and price of H₂SO₄ over the next few years.

Sulphuric acid market volume worldwide

World, 2015 to 2030p, in million metric tonnes



(1) Compound annual growth rate (CAGR)

Sources: Statista (2023), Global Market Insights (2024), Market Research Future (2024), Zion Market Research (2024), Analysis Aviseo Consulting, 2024

Sulphuric acid market forecast

2023 and 2032p, in US\$ billion

Sources	Market value		CAGR ¹ (2023-2032)
	2023	2032	
Global Market Insights	\$23 B	\$56 B	+11.2%
Market research future	\$16 B	\$50 B	+13.6%
Zion Market Research	\$13 B	\$56 B	+17.5%
Average	\$17 B	\$54 B	+13.5%

Sulphuric acid is a chemical compound used in several sectors of activity

Most sulphuric acid is used to manufacture fertilizers for the agricultural industry, but its uses extend far beyond this sector

- Sulphuric acid is used in water treatment processes, in the manufacture of medicines and chemicals, in petroleum refining and in the pulp and paper industry
- Its use is essential to a number of economic sectors, but also to human life through, for example, its use in the wastewater treatment process and the production of drinking water
- Sulphuric acid is used in a wide range of industries, and in a variety of forms such as solvents, dehydrating agents, catalysts and reagents.



During the health crisis of 2020, NorFalco's activities were declared essential due to the use of sulphuric acid in various crucial sectors, such as water treatment. The company was able to continue operations when the economy was on pause. Horne smelter, CEZinc and INO Sudbury were also allowed to continue operating.

As an integral part of the production process in many industries, sulphuric acid makes a significant contribution to the economy, facilitating the efficient production of various products and supporting essential industrial processes

- In other words, its varied use demonstrates the versatility of the product and its importance to the economy.

Industries	Example of use of H ₂ SO ₄
 Agricultural	<ul style="list-style-type: none"> – Fertilizer manufacturing <i>Around 50% of the world's sulphuric acid supply is used to produce phosphate fertilizer.</i>
 Battery	<ul style="list-style-type: none"> – Lead acid battery and EV battery manufacturing and recovery,
 Chemical and pharmaceutical products	<ul style="list-style-type: none"> – Production of various chemical products such as dyes and pharmaceuticals.
 Oil refining	<ul style="list-style-type: none"> – Production of high-octane petroleum (purification or alkylation process).
 Pulp and paper	<ul style="list-style-type: none"> – Manufacture of bleaching agents for the pulp and paper industry.
 Metals	<ul style="list-style-type: none"> – Used in the leaching process for metals such as copper, nickel, zinc and cobalt.
 Water treatment	<ul style="list-style-type: none"> – Wastewater treatment and drinking water production.

Demand for sulphuric acid is set to grow, driven mainly by the electric vehicle and agricultural sectors



Electric vehicle sector

The car fleet is changing fast, and gasoline-powered cars are increasingly being replaced by electric cars.

Public policies are accelerating this trend.

- For example, several countries are banning the sale of all new gasoline-powered vehicles after 2035. These include Canada, the European Union and some US states. In Canada, governments are offering financial assistance for the purchase of electric vehicles to help citizens make the switch.
- It is estimated that 147 million electric vehicles will be on the road by 2050.
- What's more, according to IBIS World, Canadian battery manufacturers should see their revenues grow by an average of 3.9% per year between 2023 and 2028, mainly driven by the automotive sector.

Sulphuric acid is a necessary input for the manufacture and recovery of electric vehicle batteries. An increase in demand for electric cars automatically generates an increase in demand for sulphuric acid.



Agricultural sector

Demographic forecasts point to an increase in the world's population, which will translate into a growing need for food.

What's more, intensive farming - which requires a greater input of fertilizers than conventional agriculture - is developing more and more to meet the need for food.

More than half the sulphuric acid sold worldwide is used to produce fertilizer, an essential product for plant growth and crop yields. Growth in this sector should be reflected in demand for sulphuric acid.

It is estimated that rapid growth in the green economy and intensive agriculture could increase global demand for sulphuric acid to over 400 million tons by 2040.



Domestic market

In the medium to long term, demand for sulphuric acid in the domestic market is set to grow, thanks in part to the development of the battery industry.

In Quebec, the government is deploying efforts and initiatives to support the development of this sector.

- In 2023, for example, he announced the creation of an innovation zone in Bécancour focusing, among other things, on the battery industry. Since then, investment announcements have multiplied, and major players in the automotive and battery sectors have set up shop in Quebec. GM, for example, is planning to open a plant in Bécancour to produce 40% of its batteries for the North American market.
- Projects announced for the battery sector in Quebec total nearly \$11 billion.

NorFalco is already benefiting from the emergence of this new sector, having signed a sulphuric acid supply agreement with First Phosphate in 2023 to open a phosphoric acid production plant in the Saguenay.



Although the economy is changing, sulphuric acid remains a highly used product, in both emerging and more traditional sectors

Decarbonization of the economy should influence sulphuric acid production

Just over 60% of sulphuric acid is produced from sulfur, which comes from refining oil and natural gas

- Climate change risks are prompting the world's economies to reduce their dependence on fossil fuels, which could lead to a decline in oil and gas refining activities
- However, a decline in the sector's activities will consequently mean a reduction in the production of sulphuric acid, a necessary input for the manufacture of lithium-ion batteries to ensure a green shift and pursue efforts to decarbonize the economy
- A study carried out by the University of Leuven has estimated that the annual sulphuric acid supply deficit could amount to between 100 and 320 million tons by 2040, depending on the speed at which the economy decarbonizes, while demand for sulphuric acid should amount to between 350 and 400 million tons by 2040
- **In this context, sulphuric acid production from metallurgical and mining activities will play a greater role in global supply.**



A section enabling readers to find out more about sulphuric acid

Key findings from the presentation of the sector and its outlook

Future demand will grow

- Demand for sulphuric acid is expected to grow over the next few years. The growing agricultural sector is likely to require just as much sulphuric acid via fertilizers. The emergence of the battery sector should also boost demand for the product.
- Market studies estimate that both the volume (CAGR +2.4%) and value (CAGR 13.5%) of the sulphuric acid market are set to grow between now and 2032. The more pronounced rise in market value suggests that the price of the product should increase.

The product is essential to the energy transition

- Governments' ambitions are clear: reducing economic dependence on fossil fuels is a priority. Gasoline-powered cars should slowly give way to 100% electric vehicles.
- Sulphuric acid plays a central role in the energy transition through its integration in the EV battery industry.
- Nevertheless, the decarbonization of the economy means a drop in the production of natural gas or oil, a sector that supports the production of sulphuric acid. Metallurgical activities will then have to adjust to meet demand.

Its use is at the heart of several sectors

- Sulphuric acid is the world's most widely produced chemical. Its versatility gives it a role in many sectors, both traditional and emerging.
- Nevertheless, over 50% of sulphuric acid is used in the agricultural sector for the manufacture of fertilizer. In addition to the agricultural sector, sulphuric acid is also used in other sectors such as batteries, water treatment and metal processing.
- Quebec and Canadian companies can benefit from local sourcing, since Canada is the world's leading exporter of sulphuric acid.

Illustration of the main sectors using sulphuric acid





Methodological approaches and main assumptions

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A methodology that capitalizes on the advantages of a computable general equilibrium model

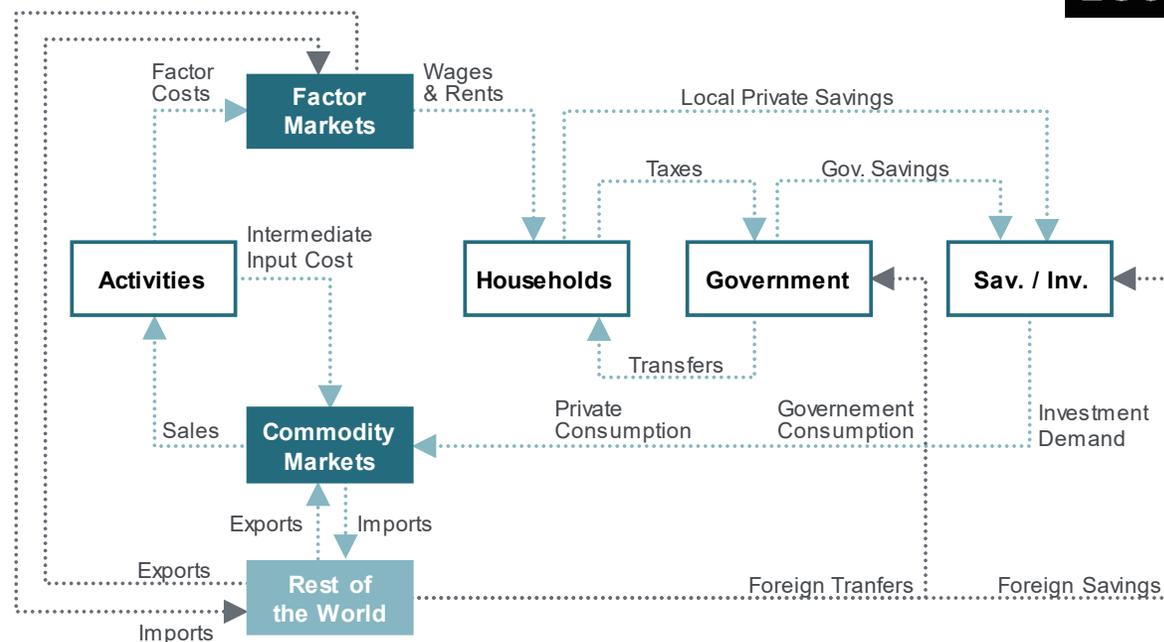
The Computable General Equilibrium (CGE) model is distinguished by the inclusion of market equilibrium conditions, the presence of prices, the behaviors and interactions between agents, and above all by a high degree of modeling flexibility. It is a mathematical representation of the economy that approximates its actual functioning.

Main components of a CGE model

- The model is calibrated to a Quebec and Canadian social accounting matrix for 2019
 - Although 2020 data is the most recent, Aviseo has chosen to use 2019 data as it is more representative of the economy. 2020 was a pandemic year.
- Quebec and Canada are modeled as small open economies with government
- The sectors use two factors of production, labour and capital, which are internationally immobile, and they produce according to a Cobb-Douglas production function.
- The labor supply function is endogenous, which means that workers can work more or less. Modeling the labor market reflects the constraints present in the economy.
- The results are comprehensive, representing the sum of direct, indirect and induced effects.

Flow structure of an EGC model

For illustration



To estimate the economic impact, a number of assumptions need to be made

Aviseo made a series of assumptions in order to estimate the economic impact of sulphuric acid production in Quebec and Canada. The following are the main assumptions used by the authors:

- The simulations were carried out on the basis of operating expenses provided by NorFalco for winter 2023. As a company that distributes and markets sulphuric acid, NorFalco devotes the vast majority of its expenses to purchasing the entire production of sulphuric acid from Horne smelter, CEZinc and INO Sudbury.
 - Thus, an increase or decrease in sulphuric acid production by these three entities would have a positive or negative impact on economic spin-offs
 - In addition, the economic impact could vary if spending were to be revised at a later date
 - Finally, Aviseo has segmented spending by place of origin, based on data shared by NorFalco
- The effects on government revenues are based on the 2022 tax structure. Impacts could vary if the tax system were to change
- Complementary Analysis were carried out using secondary public data available in June and July 2024. Public data may be subject to revision
- Since the methodological framework consists of CGE modelling, economic benefits must be considered as all-encompassing and net, i.e. as the sum of direct, indirect and induced effects, and as the sum of effects on all economic sectors
 - The use of a CGE model makes it possible to estimate the economic impact via various modelling techniques that go beyond modelling based on expenditure levels. The following page presents the various models produced by Aviseo Consulting to quantify the economic contribution of NorFalco's activities and sulphuric acid production.

CGE modeling results

CGE modelling can be used to quantify economic impacts according to various variables. In this study, five variables are discussed:



Real GDP;



Household disposable income;



Government revenue;



Corporate income;



Total investment.

Two scenarios to demonstrate the economic importance of NorFalco and sulphuric acid

1. Estimated economic impact of Glencore's activities at H₂SO₄

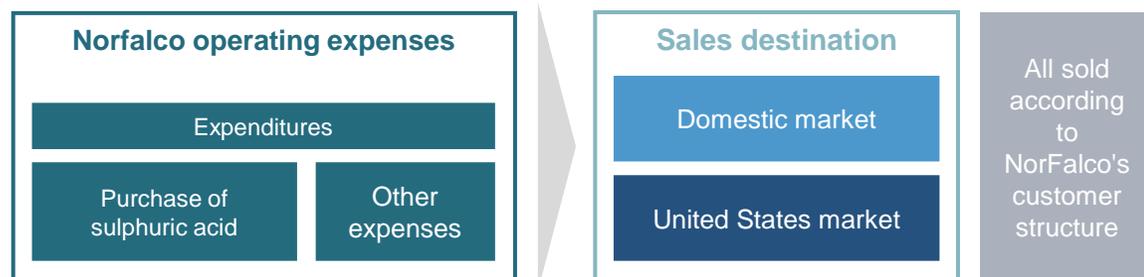
The first model involves estimating the economic contribution of Glencore's sulphuric acid activities, i.e. their production activities at INO Sudbury, Horne smelter and CEZinc, and their distribution and merchandising activities via NorFalco.

To do this, Aviseo modeled the production structure shared by NorFalco. Using a literature review and interviews, Aviseo estimated the sulphuric acid production structure to include the remuneration of labor and capital.

- To omit these components would be to grossly underestimate the true economic contribution of Glencore's sulphuric acid activities.

The sectoral distribution is based on NorFalco's customer structure, taking into account the proportion of production sold on the domestic market and that exported.

Scenario 1 representation



2. Estimated economic losses resulting from the purchase of a higher-priced substitute for H₂SO₄

The second model simulates a change in the price paid by purchasers of sulphuric acid. Since this is a product for which most substitutes are significantly more expensive, this second model highlights the "economic losses avoided" by using sulphuric acid, rather than a more expensive substitute.

The higher price translates into lower productivity for the companies and sectors that consume sulphuric acid in Quebec and Canada. **In other words, Glencore's sulphuric acid production and distribution have a positive impact on productivity.**

The simulation therefore consists of a 25% increase in the price of the product purchased by domestic sulphuric acid customers, corresponding to a more expensive substitute. Many sulphuric acid substitutes are considerably more expensive, but this level was chosen for illustrative purposes. Modeling focused on the Canadian market only, meaning that only NorFalco's Canadian customers would experience a price increase. No impact from sulphuric acid production/distribution other than the price effect was considered in this scenario.

Note: *In reality, if Glencore did not produce and distribute sulphuric acid in Quebec, the impact would be greater than that resulting from the price effect measured in this scenario. Scenario 1 describes this positive impact.*



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ECONOMIC CONTRIBUTION

The expenditure structure for sulphuric acid production is colored by the SO₂

The production method used by Glencore to produce sulphuric acid creates added value from a material which, without the transformation process, would be released into the atmosphere with all its harmful repercussions on the environment.

- Revaluing SO₂ from metal smelting and roasting means that the cost of producing a tonne of sulphuric acid is lower than for companies that produce sulphuric acid by purchasing elemental sulfur.
 - Sulfur purchases can account for up to 80% of the variable costs of companies producing sulphuric acid, when it is not produced by upgrading sulfur dioxide.

Expenditure structure for the production of one tonne of sulphuric acid by plant type

Estimate; in % of total

	Metallurgical plant producing H ₂ SO ₄	Sulfur burner plant
Electricity	52%	7%
Maintenance	19%	7%
Work	13%	5%
Service public	10%	1%
Weak acid treatment	6%	0%
Sulfur	0%	79%
Total	100%	100%



ECONOMIC CONTRIBUTION

An economic contribution of nearly \$90 million for Quebec and nearly \$140 million for Canada as a whole

NorFalco's sulphuric acid distribution and marketing activities, combined with those of Glencore's sulphuric acid-producing facilities, contribute \$89.3 million in real GDP to the Quebec economy

- Combining operations in Quebec and Ontario, Glencore's sulphuric acid activities contribute \$138.9 million in real GDP to the Canadian economy.

Economic benefits go beyond GDP

- Activities and spending in Quebec and Canada as a whole also increase the level of income for all economic agents (governments, businesses and households).

Finally, thanks to the growth in revenues generated by the current activities of NorFalco and its sister companies, total investment in the economy will also be stimulated

- Total investment in Quebec is estimated to increase by \$120 million, and by \$216 million in Canada
- Investment is one of the main determinants of long-term economic growth
- In the current context, where governments and economic players are highlighting productivity issues in Canada, such an impact is all the more significant.

The effect of savings on the economy

Savings play an important role in the economy, as they are a sign of total investment levels in the medium and long term. Indeed, the higher companies' savings, the greater the incentive to invest in the future, in R&D or machinery, for example.

The level of investment is one of the main drivers of long-term economic growth and is heavily dependent on the growth of savings by businesses, households and government.

Economic benefits

Quebec and Canada; in \$ millions

	Quebec	Canada
Real GDP	89.3	138.9
Government revenues	74.5 ¹	106.2 ²
Household disposable income	91.4	141.9
Corporate income	49.5	117.9
Total investments	120.2	215.5

(1) Aggregation of government revenues from the governments of Quebec and Canada. (2) Aggregation of government revenues from the provincial and Canadian governments. Sources: NorFalco, Aviseo Consulting analysis based on computable general equilibrium model simulations of Quebec and Canada, 2024

ECONOMIC CONTRIBUTION

The use of a substitute for H₂SO₄ could cause economic losses

One of the advantages of sulphuric acid is its competitive price

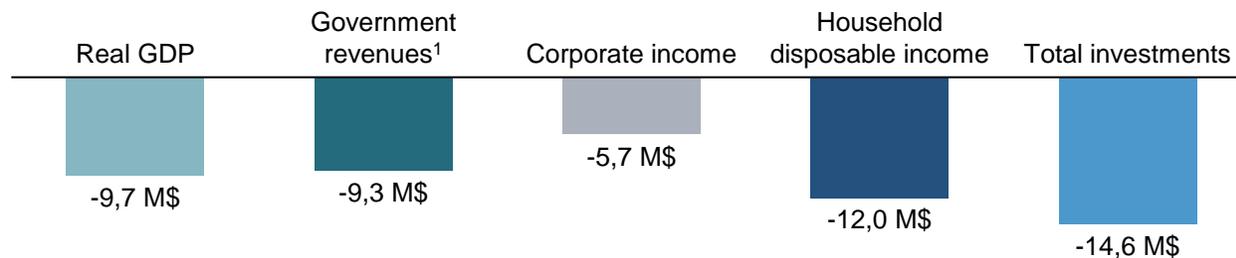
- Some other acids can substitute it, but they are generally more expensive, which means that companies have to devote a greater proportion of their expenditure to it, thus negatively affecting their productivity.

It has been estimated that the real GDP of the Quebec economy would be reduced by nearly \$10 million if NorFalco's Canadian customers had to buy a substitute product selling for 25% more

- In addition, all economic agents would be negatively affected. Government revenues, business revenues and household disposable income would fall by \$9.3 million, \$5.7 million and \$12.0 million respectively
- Ultimately, investment in the economy as a whole would be reduced, which could affect Quebec's long-term productivity.

Economic losses resulting from the use of a more expensive substitute product instead of H₂SO₄

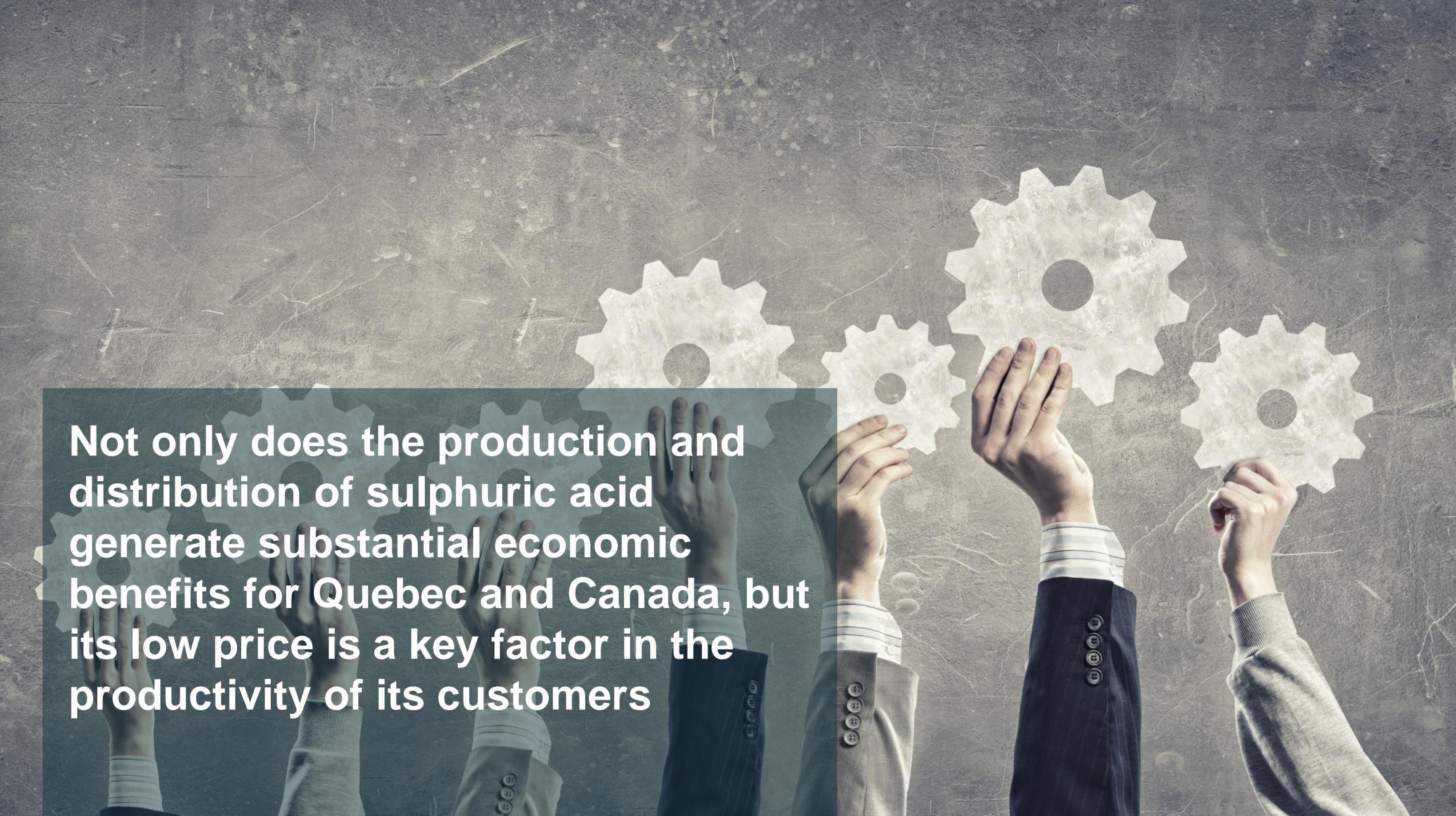
Quebec; in \$ millions



(1) Aggregation of government revenues from Quebec and Canada.

Sources: NorFalco, Aviseo Consulting analysis based on simulations of Quebec's computable general equilibrium model, 2024





Not only does the production and distribution of sulphuric acid generate substantial economic benefits for Quebec and Canada, but its low price is a key factor in the productivity of its customers



Structuring effects

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An impact on the economy that goes beyond numbers

In addition to sulphuric acid's economic contribution to Quebec and Canada as a whole, the product contributes to many other benefits that are harder to quantify, but just as important.

Five structuring effects have been documented in connection with Glencore's sulphuric acid activities:

<p>1 Safety and environmental impact</p>	<ul style="list-style-type: none"> – Transport safety it's a priority for Glencore to protect the environment and the population. – Glencore's sulphuric acid production is based on metal roasting who produce sulfur dioxide, which is a gas that if not captured, contributes to acid rain.
<p>2 Circular economy</p>	<ul style="list-style-type: none"> – The recycling of sulfur dioxide into sulphuric acid is in line with the principles of the circular economy.
<p>3 Integration into the EV battery chain</p>	<ul style="list-style-type: none"> – The government wants to develop the EV battery industry in Quebec, from the extraction of metals for battery manufacture to battery recycling. – Sulphuric acid comes into play at various points in a battery's life cycle, including recycling.
<p>4 Essential product</p>	<ul style="list-style-type: none"> – Sulphuric acid is an essential product, as it is used in sectors that are key to human life, such as water treatment. Glencore's sulphuric acid activities were able to continue operating during the COVID-19 health crisis.
<p>5 Security of supply</p>	<ul style="list-style-type: none"> – Canada is the world's leading exporter of sulphuric acid. In addition to making a positive contribution to the country's balance of trade, local production and distribution means that local companies can count on a local supply.



Structuring effects

The structuring effects address elements that are difficult to quantify, but are no less important, particularly in terms of their strategic impact. The economic environment has changed in recent years, which means that many governments no longer pay exclusive attention to the jobs created or supported, mainly because of the tense labor market conditions that are likely to persist throughout the next decade. This new reality means that the structuring characteristics of a project or a company are still important to decision-makers.

Transport safety is a priority

NorFalco transports sulphuric acid in a safe environment governed by the highest safety standards

- All shipments are made using equipment certified and dedicated to the transportation of sulphuric acid
- Approximately 14,900 rail tanker shipments and 12,700 truck tanker shipments were completed by NorFalco in 2022
- NorFalco can also distribute sulphuric acid by ship. These depart from the CEZ refinery.

Safety is a priority, to protect both the environment and the public.



Sulphuric acid production in line with government ambitions to control acid rain

In the 1970s, scientists made the first links between environmental damage and the deposition of acidifying pollutants carried by winds far from their sources

- These discoveries have prompted governments to implement various measures to remedy the situation
- In 1985, the Government of Canada and seven eastern provinces signed a declaration establishing the *Eastern Canada Acid Rain Program*
 - The objective of this program was to limit the amount of sulfur dioxide emitted in the seven eastern Canadian provinces to 2.3 million tons.
- A few years later, in 1991, Canada and the United States signed the *Canada-U.S. Air Quality Agreement* to combat transboundary air pollution
- In addition to international agreements and federal programs, the various provinces have also set up measures to limit emissions of pollutants that contribute to acid rain.

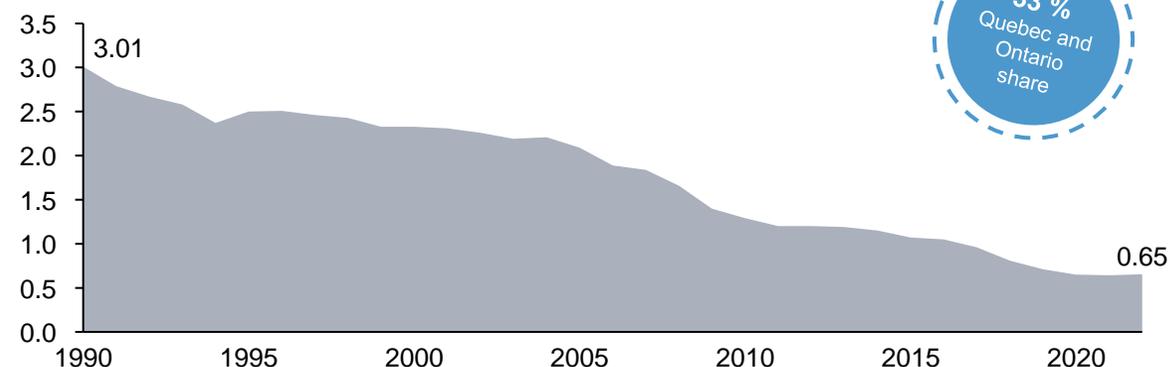
As one of the largest sulphuric acid producers in Eastern Canada, Glencore is helping to reduce sulphur dioxide emissions and thus limit the negative impact of acid rain on plant and animal ecosystems such as lakes and rivers, forests and fish populations.

Since 1990, Canadian sulphur dioxide emissions have fallen by 78%, from 3.1 million tonnes to around 650,000 tonnes

- In 1990, the minerals industry was responsible for 49% of SO₂ emissions. By 2022, its share will have fallen by more than 88% to 27%
- Despite a 50% drop in emissions between 1990 and 2022, the oil and gas industry was the main emitter in 2022
- In Quebec and Ontario, where Glencore's sulphuric acid production facilities are located, emissions fell by 62% and 89% respectively
 - In both provinces, the mining sector is the main emitter. Moreover, since August 23, 2022, Quebec has banned the exploration and production of hydrocarbons. **It is therefore reasonable to attribute part of this decrease to Glencore's efforts to reduce its SO₂ emissions.**

Trends in Canadian sulfur dioxide emissions

Canada, in millions of tonnes; 1990 to 2022





Capturing sulphur dioxide and converting it into sulphuric acid helps improve Canada's environmental performance

The case of the Horne Smelter

- Sulphuric acid production at the Horne smelter began in 1989. Since then, the quantity of SO₂ released into the air has fallen by more than 41 times, from 600,000 tonnes to just under 14,500 tonnes. Although sulfur dioxide emissions are still above zero, the company has significantly improved its balance sheet and is continuing to invest in this area.

The Sudbury INO case

- The environmental balance of SO₂ emissions from Sudbury's facilities is also positive. Over the past 30 years, the smelter has seen a 90% reduction in SO₂ emissions and is continuing its efforts to improve its environmental performance.

Sulphuric acid produced by Glencore is in line with the circular economy

The circular economy concept was born in the early 2000s in opposition to the linear economy, the dominant model in today's global economy. The circular economy can be broken down into nine strategies, the aim of which is to produce and consume goods that minimize the need for raw materials or maintain those used in a circular loop.

More specifically, it means using resources responsibly, treating waste as a resource rather than a cost, and finding ways to improve both the economy and the environment.

With its production of sulphuric acid, Glencore's activities are in line with one of the strategies of the circular economy, i.e. the valorization of waste.

- In fact, the process used by Glencore to produce its sulphuric acid relies on capturing sulfur dioxide in order to transform it into sulphuric acid, thus recovering a waste product that would otherwise have been released into the environment.
- The creation of a closed-loop system for the production and disposal of sulfur is a feature of the circular economy.
- While roasting elemental sulfur only produce one output (sulphuric acid), metal smelting makes two outputs, a metal (e.g. copper) and sulphuric
 - Horne Smelter sulphuric acid plant is among the world's most efficient, with a sulfur capture rate of over 96%



While the recovery of sulphuric acid is in line with the principles of the circular economy, other initiatives implemented by Glencore's facilities are also in line with these strategies, particularly with regard to recycling. For more information on Glencore's various structuring effects, readers are invited to consult the Glencore Canada Ecosystem Economic Impact Study.

Nine circular economy strategies

	Valuation		
	Rental		Responsible consumption and sourcing
	Maintenance and repair		Optimizing operations
	Donation and resale		Recycling and composting
	Reconditioning		Ecodesign

Sulphuric acid becomes part of the EV battery value chain

Whether at the battery manufacturing or recovery stage, sulphuric acid plays a key role in the EV battery value chain

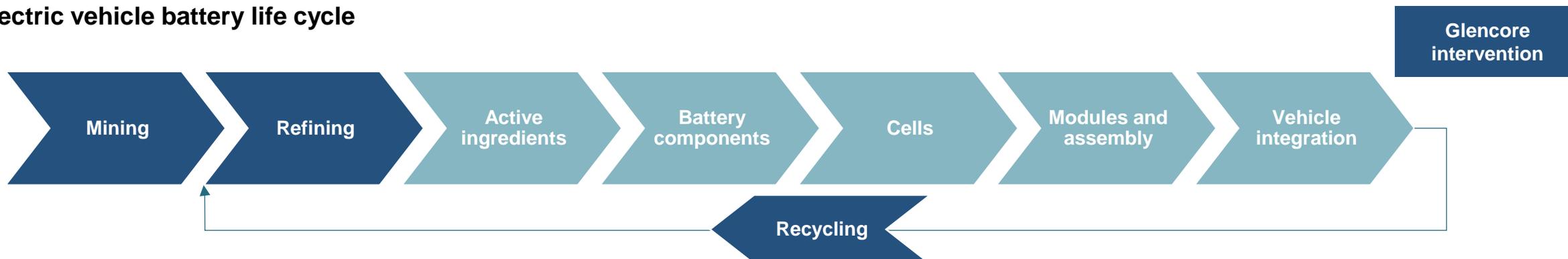
- For example, sulphuric acid is used to produce nickel, cobalt and manganese sulfates, three essential products for the production of cathodes for nickel-manganese-cobalt (NMC) batteries
 - The battery market has also seen the emergence of lithium-iron-phosphate (LFP) batteries. Their production requires phosphoric acid, a product made from sulphuric acid.
- In addition to the use of sulphuric acid in manufacturing, the product is also used at the recycling stage
 - The product recovers strategic metals from batteries and converts them back into sulfate to produce the cathodes needed for batteries.



Activities at the Horne Smelter and CCR Refinery are at the heart of the EV battery value chain

- The Horne smelter processes 700,000 metric tons of copper concentrate from mines every year. It transforms this concentrate into copper anodes, which are then transformed into copper cathodes at the CCR refinery.
- Together, activities at Horne smelter and CCR form the only copper value chain in Quebec, making them a central player in the EV battery industry.
- In addition to producing from copper concentrate, Horne recycles a large number of electrical products to recover copper, gold, silver, platinum and palladium, all metals needed in the energy transition.

Electric vehicle battery life cycle



The government is committed to developing the EV battery industry

In Quebec, the government intends to set up a battery industry for electric vehicle that will enable batteries to be manufactured and recycled 100% in Quebec

– To achieve a comprehensive and structuring battery industry, the Quebec government has a development strategy for the Quebec's Battery Industry, which is divided into three parts:

1 Extract and process Quebec minerals to manufacture battery components

2 Produce commercial electric vehicles

3 Develop battery recycling using cutting-edge Quebec technology

Sulphuric acid is used in the manufacture of essential components for NCM and LFP batteries, the two most common types used in electric cars

- However, it should not be forgotten that sulphuric acid plays a central role in the manufacture of lead-acid batteries. The electrolyte in lead-acid batteries is made up of sulphuric acid and water, while the electrodes are lead-based
 - Lead batteries are mainly used in vehicles to help them start, to store energy generated by solar panels or wind turbines, and so on.

Government efforts set Canada apart



Government efforts seem to be paying off, as in February 2024, strategic research firm BloombergNEF ranked Canada as the best place in the world, among 30 countries analyzed, to build a supply chain for lithium-ion batteries. Canada surpassed China for the first time in the history of this ranking.

The availability of resources, proximity to the US market and political commitment are three key factors that have brought Canada to the top of the list.

Sulphuric acid, a product declared essential during the pandemic

During the COVID-19 health crisis, Glencore's sulphuric acid plants were all allowed to continue operating because of the importance of sulphuric acid in several industries, while several other companies had to temporarily cease operations

- For its use in water treatment, sulphuric acid has been declared an essential good
- de facto, NorFalco continued its transportation and marketing activities
- Sulphuric acid was also used in the production of masks.

Sulphuric acid has a multitude of uses, and although its importance remains relatively unknown, its uses and multiple spheres of impact, particularly economic, make it a promising product for Quebec and Canada.



Global sulphuric acid supply issues have already been highlighted

Kazakhstan Kazatomprom, the world's largest uranium producer, announced in February 2024 that it might reduce its uranium production due to difficulties with the availability of sulphuric acid

- In fact, the price of uranium reached its highest level in 17 years, exceeding US\$100 in early 2024
- According to experts, Kazakhstan, the main uranium producer, has had to curb its supply due to a shortage of sulphuric acid. **The revival of nuclear energy due to the energy transition is, for its part, accentuating demand for uranium.**

As the world's leading sulphuric acid exporter, Canada can count on a secure supply of sulphuric acid.

- Remember that if a Quebec or Canadian company has to use a more expensive substitute for sulphuric acid, the economy as a whole will be affected.
- Knowing that domestic and global demand will be on the rise in the coming years, it's even more strategic for Quebec and Canada to be able to rely on local supply.

Economic losses avoided in Quebec by using H₂ SO₄ instead of a more expensive substitute.

	In M\$
Real GDP	9.7
Government revenues	9.3
Household disposable income	12.0
Corporate income	5.7
Total investments	14.6

(1) Aggregation of government revenues from Quebec and Canada. Sources: Natural Resources Canada, ZoneBourse, Aviseo Consulting analysis based on simulations of Quebec's computable general equilibrium model, 2024

"Despite the active and ongoing search for alternative sources of sulphuric acid supply, current forecasts indicate that the company may have difficulty achieving production levels of 90% over contracted underground usage levels."

- Kazakhstan Kazatomprom, February 2024



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Sulphuric acid is essential to our economy, and demand is set to continue growing, driven by the energy transition

Sulphuric acid plays an important role in the Quebec and Canadian economies. This study sheds light on the economic contribution of this product and its structuring effects for Quebec and Canada.

An analysis of the economic and fiscal benefits shows that the economic contribution of Glencore's sulphuric acid operations is significant for the Quebec and Canadian economies

- Given that demand for sulphuric acid is set to grow in the years ahead, the fact that it is produced in Canada is a major advantage.

Economic spinoffs in Quebec

Quebec, in millions of \$

	Glencore's sulphuric acid activities	
	Quebec	Canada
Real GDP	89.3	138.9
Government revenues	74.5 ¹	106.2 ²
Household disposable income	91.4	141.9
Corporate income	49.5	117.9
Total investments	120.2	215.5

In addition to the more quantitative economic benefits, Canada and Quebec benefit from the structuring effects of sulphuric acid. These structuring effects are strategic now and in the future.

- 1 Security and environmental impact**
Glencore's sulphuric acid production is based on metal roasting, which produces sulfur dioxide. Sulfur dioxide is a gas which, if not captured, causes acid rain.
- 2 Circular economy**
The recycling of sulfur dioxide into sulphuric acid is in line with the principles of the circular economy.
- 3 Integration into electric vehicle battery chains**
The government is keen to develop the battery industry in Quebec for electric vehicle, from the extraction of metals for battery manufacture to battery recycling. Sulphuric acid comes into play at different points in an electric vehicle battery's life cycle.
- 4 Essential product**
Sulphuric acid was declared an essential product during the COVID-19 pandemic.
- 5 Security of supply**
Canada is the world's leading exporter of sulphuric acid, which means that local companies can count on a local supply. Demand for sulphuric acid is expected to grow in the short to medium term. Canadian companies will be able to count on a local supply.

(1) Aggregation of government revenues from the Quebec and Canadian governments. (2) Aggregation of government revenues from the provincial and Canadian governments. Sources: NorFalco, Aviseo Consulting analysis based on simulations of Quebec's computable general equilibrium model, 2024



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