Energy Diversification in the Americas

Understanding the Cost of Energy Production in the Americas: A Tailored Approach for Ak Nacional del Monte

Abstract

In a world increasingly driven by data, the ability to analyze and interpret complex information has become critical to the success of businesses and nations alike. At the heart of this transformation lies the energy industry, a sector undergoing rapid change as the demand for sustainable alternatives to traditional energy sources continues to grow. It is within this context that Ak Nacional del Monte emerges as a trailblazer, determined to harness the power of data-driven insights to unlock new opportunities and address the unique challenges faced by countries across the Americas.

As a leading consultancy, Ak Nacional del Monte has recognized the urgent need for a comprehensive analysis of energy production, consumption, and distribution trends in North, Central and South American countries. By delving into both renewable and oil energy data, the consultancy seeks to identify potential markets for expansion and to provide tailored solutions that cater to the specific energy requirements of each nation.

This in-depth analysis will take into consideration a myriad of factors, including infrastructure, geography, and political stability, to ensure that Ak Nacional del Monte's recommendations are grounded in a thorough understanding of each country's unique context.

In this report, we'll explore the rate of production, consumption, and distribution of energy, both fossil fuels and renewable, in different countries of the American continent. Through this comprehensive analysis, we'll dive into the data-driven world of energy diversification in the Americas, investigating various trends, opportunities, and challenges that lie ahead. We'll also shed light on the crucial role that Ak Nacional del Monte plays in shaping the future of energy production and management, and consider which decision is best for the company's future.

Executive summary

The primary proposal for Ak Nacional del Monte centers on the diversification of energy production, encompassing both renewable energy sources and oil across North, Central, and South American countries. This approach aims to tailor energy production and consulting services to the unique requirements of each nation. Initially, the focus will be on striking a balance between oil and renewable energy production. Over time, however, the emphasis will shift towards predominantly providing renewable energy services and solutions.

Ak Nacional del Monte recognizes that each country has distinct energy needs and challenges. As a consultancy, our core objective is to collaborate closely with every nation in the Americas to address their specific energy concerns and deliver customized, efficient solutions for energy production and management. By adopting this tailored approach, we strive to facilitate a smooth and effective transition towards sustainable energy production across the region.

Context and project objectives:

Since the 1950s, oil has been the predominant resource for electricity production, with oil energy representing 25% of the total energy at that time. However, in recent years, there has been a growing global awareness of

climate change and the urgent need for sustainable energy solutions. Consequently, renewable energies have gained significant traction in the energy market, particularly in developed countries, leading to substantial changes in energy production and consumption patterns.

In this project, we will address the case of Ak Nacional del Monte, a consultancy founded by Pedro Ramirez, which specializes in advising international power supply companies and medium to small businesses. The consultancy currently operates in Mexico, Canada, Brazil, Venezuela, and Haiti. With the increasing prominence of renewable energy production, Pedro is contemplating whether to continue focusing on traditional energy sources or to adapt to the emerging renewable energy trends.

The main objective of this project is to conduct a comprehensive analysis of energy consumption, production, and distribution data related to both renewable and oil energy in North, Central, and South American countries over the years. This analysis will help identify potential markets and countries for Ak Nacional del Monte's expansion. Furthermore, it will consider the unique energy needs and challenges of each country, taking into account factors such as infrastructure, geography, and political stability, to provide tailored solutions and strategies for a successful energy transition.

Methodology:

It is important to mention that the previously described objective requires several research and hard data about how energy consumption and production was behaving in American countries, due to each country having different necessities and interests. By this, the planted objective will be divided in two parts:

Descriptive: The first step will involve conducting a thorough descriptive analysis of the energy data for each country, focusing on oil and renewable energy production, consumption, and trade. Statistical methods such as mean, median, mode, standard deviation and variance will be employed to summarize the data. Additionally, visualizations such as bar charts and line charts will be created to represent the trends in energy production and consumption across different countries, making the analysis more accessible and engaging for the reader. Furthermore, the descriptive analysis will incorporate additional data sources, including national energy policies, investment in renewable energy infrastructure, and public opinion on energy transition, to provide a more comprehensive understanding of each country's energy context.

Inferential: Building on the descriptive analysis, the second step will involve making future estimates and projections for energy consumption and production in the American countries. Time series forecasting techniques such as ARIMA or exponential smoothing will be employed to predict future trends in renewable and oil energy. Additionally, regression models will be used to understand the relationship between various factors (e.g., GDP, population, technological advancements) and energy consumption and production. The inferential analysis will also involve utilizing the Central Limit Theorem and standard normal distribution to make inferences based on small samples from each country, aiming to achieve the highest level of confidence possible.

These steps will be done by professional visualization tools such as R programming language, Python, Excel and other Business Analytics tools.

However, as it was mentioned before, America is the principal market for AKM, therefore the main countries that will be researched are: Canada, Mexico, United States, Haiti, Colombia, Ecuador, Venezuela, Brazil, Argentina, Peru and Chile (thanks that this are the most active countries according renewable and old fashion energies, according to the bp Statistical Review of World Energy June 2022)

Value added:

Here at JDA Consulting, we prioritize the client over everything. Our main objective is to work with Ak Nacional de Monte as one, and help them analyze every different scenario in order for them to have the information possible so that they can make a good and justified strategic decision on whether they should keep producing energy the old fashion way or to shift to different production methods. JDA will make

customized visual tools like bar graphs or statistics, based on the context that ANM is giving us, this will help to create a detailed descriptive analysis. Also, JDA will create accurate and efficient projections for ANM including a regression analysis that will be used to comprehend various factors that are fundamental for decision taking.

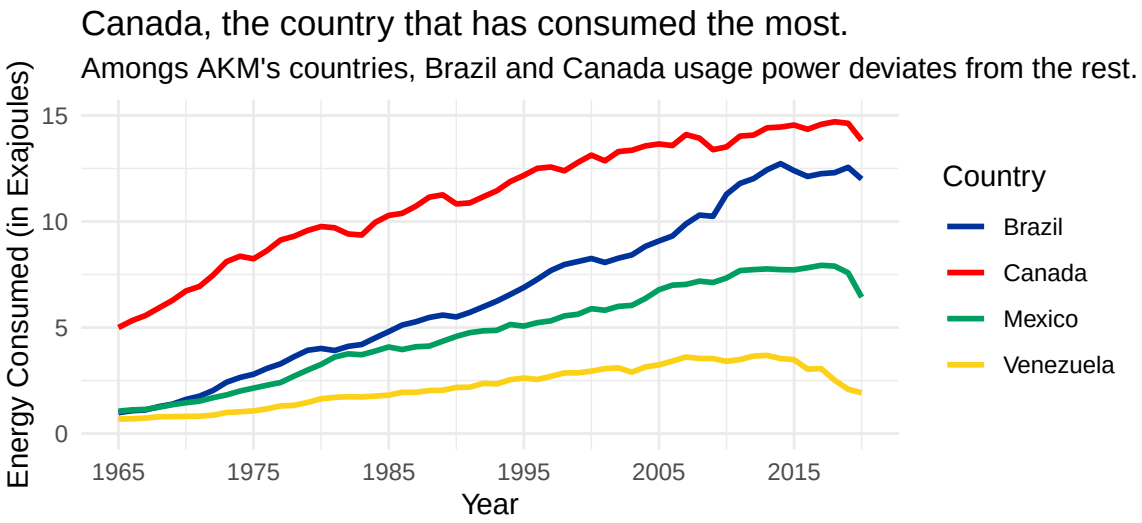
Primary Energy Consumption

Energy primary consumption refers to the total amount of energy consumed in its original form, before any conversion or transformation takes place. This includes energy sources such as coal, oil, natural gas, nuclear, hydro, biomass, and renewables like solar and wind.

Canada has the most primary energy usage out of the countries where AKM has presence. The following graph shows the relationship bewteen the countries and their energy consumption throughout the years (1965-2020). We can observe a general rising constant among these countries; we can adjudicate this to the growth in population and many technological advances. Nonetheless, this represent the sum of the energy consumed troughout the years. In 2020, Canada had an energy usage of 13.82 exajoules, that compared to other countries like China's 147.58 exojoules consumption seems like nothing. Nonetheless, it still represents a significant amount of energy consumption, especially considering the population size and the energy-intensive industries present in Canada.

The vast natural resources available in Canada, such as oil sands, natural gas, and uranium contribute to its high primary energy consumption. These resources not only support domestic energy needs but also contribute to the country's export economy. The energy-intensive industries, such as mining, forestry, and manufacturing, further drive the demand for primary energy.

Canada's position in primary energy consumption is notable, especially among the countries where AKM has a presence. The increasing demand for energy is driven by population growth, technological advancements, and energy-intensive industries.



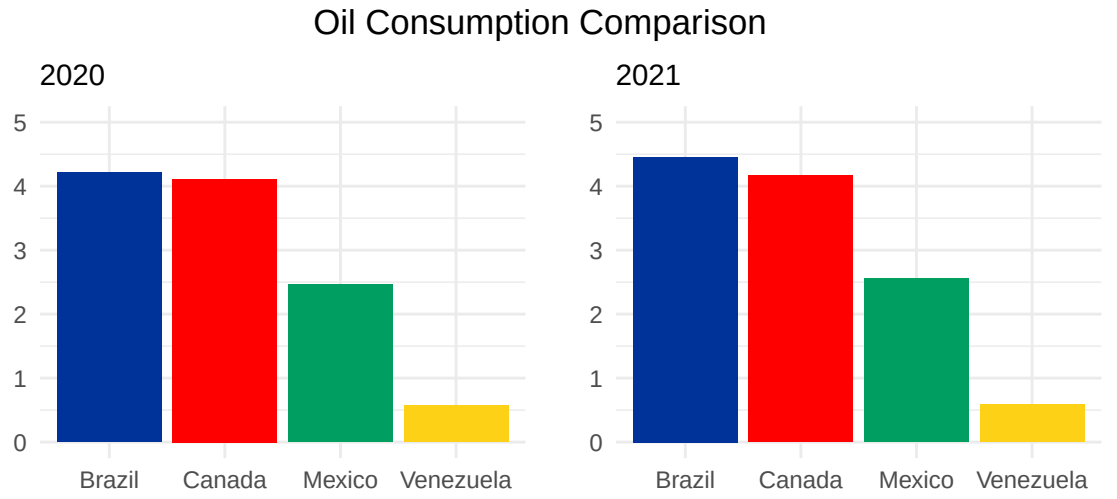
Source: bp Statistical Review of World Energy, June 2022

For further understanding of the situation, we must take a look at these countries energy consumption. First, we can analyze Oil consumption during recent years.

In this case, Brazil is the country with the most Oil consumption among the countries where AKM has presence. Brazil is one of the top oil producers and consumers in Latin America. The country has significant oil reserves, primarily located offshore, and has been increasing its oil production in recent years. Brazil's

domestic oil consumption has been steadily increasing over the past decade, driven primarily by transportation and industrial sectors. The country also imports a significant amount of crude oil and refined products to meet its domestic demand. This was approximately **37%** of the country's energy consumption.

Oil Consumption



Source: bp Statistical Review of World Energy, June 2022

Canada is also one of the world's top oil producers and exporters, with significant oil reserves primarily located in the oil sands of Alberta. Oil is a crucial part of Canada's energy mix and economy, supporting jobs and investment across the country. This was approximately **32%** of the country's energy consumption.

Mexico's oil consumption accounted for approximately **38%** of the country's energy consumption. Mexico is also a significant oil producer and exporter, with significant reserves located offshore in the Gulf of Mexico and onshore in the southeast of the country. Oil is a critical part of Mexico's economy and government revenues.

In the case of Venezuela, it is important to note that the countries's oil consumption was approximately **90%** of the country's energy consumption. Venezuela is one of the world's top oil producers and has significant oil reserves, primarily located in the Orinoco Belt. Oil has historically been the backbone of Venezuela's economy, but the country has faced significant economic and political challenges in recent years that have affected its oil production and exports.

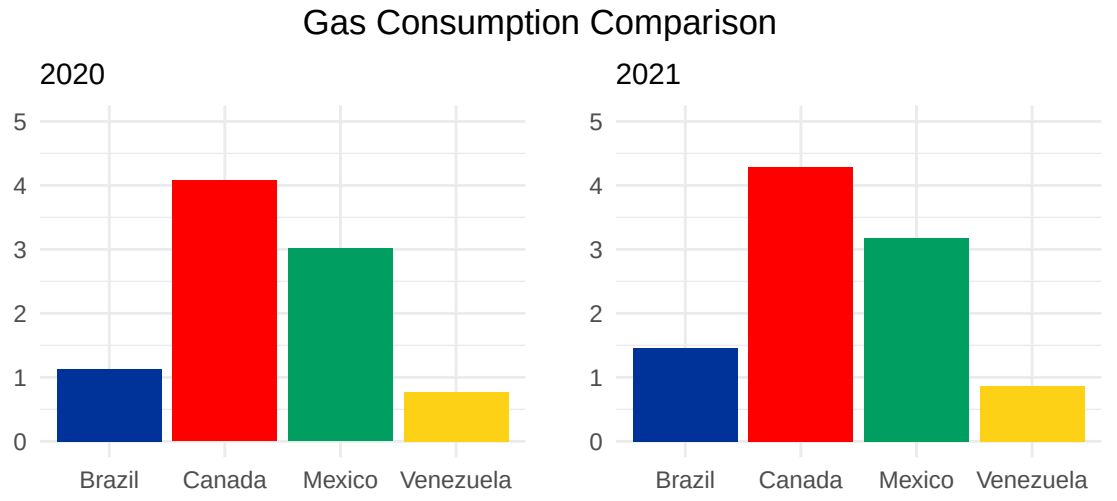
As of today, Venezuela remains heavily reliant on oil as its primary source of revenue. However, the country's political instability presents a significant obstacle to private investment. Nevertheless, AKM's proven ability to establish itself as a stable consultancy within Venezuela positions the company for success in the oil sector. Given the uncertain political climate and the enduring relevance of oil for the next seven years, AKM should focus its efforts on investing in oil production or distribution. This strategy aligns with a long-term vision for sustainable growth and success in Venezuela.

Natural Gas Consumption

Natural gas is an important part of Canada's energy mix, accounting for approximately **35%** of the country's primary energy consumption in 2021. Their production of natural gas production was 157 billion cubic meters (bcm), making it the world's fifth-largest producer of natural gas. Canada's natural gas consumption in 2021 was 99 bcm, with the country exporting the remaining 58 bcm to other countries.

Natural gas is used for a variety of purposes in **Canada**, including electricity generation, heating, and industrial processes. The largest consumer of natural gas in Canada is the industrial sector, which accounted for approximately 42% of the country's total natural gas consumption in 2021. The residential and commercial sectors are the second-largest consumers of natural gas, accounting for approximately 33% of the country's total natural gas consumption in 2021. The remaining natural gas consumption is attributed to the transportation sector, which primarily uses natural gas as a fuel for heavy-duty trucks.

For **Mexico**, gas is an important part of the country's energy mix, accounting for approximately **38%** of the country's primary energy consumption in 2021. Natural gas is used for a variety of purposes in Mexico, including electricity generation, industrial processes, and residential and commercial heating.



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Despite being a significant natural gas producer, Mexico also imports a significant amount of natural gas from the United States to meet its domestic demand. In 2021, Mexico imported approximately 45 bcm of natural gas from the United States, accounting for approximately 58% of its total natural gas consumption. This represents a big opportunity for AKM, since the country investment does not met the neccesary quota for the whole population. Nonetheless, Mexico's natural gas production in 2021 was 71 billion cubic meters (bcm), which is approximately 22% lower than its natural gas production in 2011.

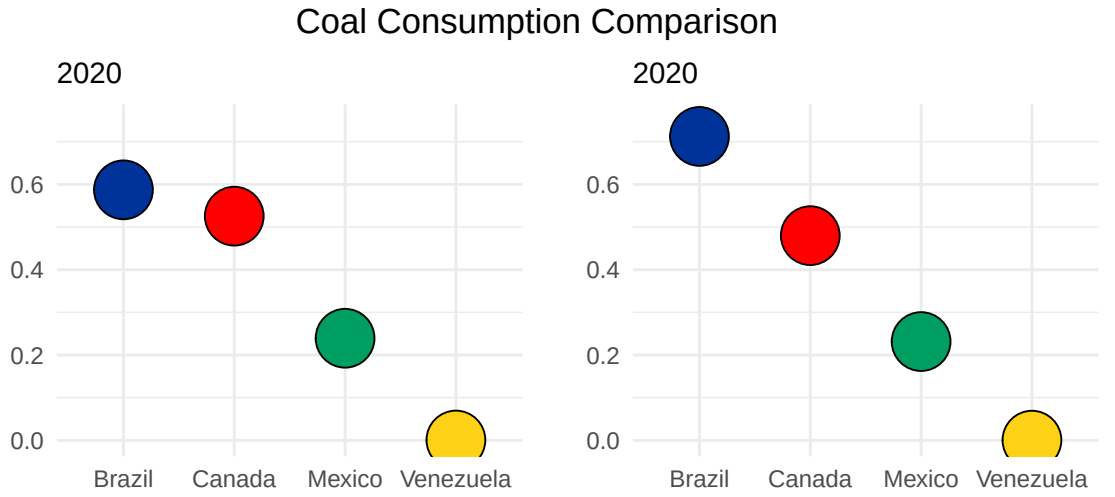
We can understand the decline in Mexico by these factors:

- Decline in investment:
  - According to a report by the International Energy Agency, Mexico's energy sector has suffered from a lack of investment in recent years, which has led to a decline in production. The report notes that investment in the sector fell by 10% between 2012 and 2018, and that this has had a significant impact on natural gas production.
- Aging infrastructure:
  - Mexico's natural gas infrastructure is aging and in need of modernization. According to a report by the U.S. Energy Information Administration, Mexico's natural gas pipelines have an average age of 35 years, and many of them are in need of repair or replacement. This could lead to a decrease in production as older equipment becomes less efficient or fails altogether.
- Decreased exploration:
  - Mexico has seen a decline in natural gas exploration in recent years. According to data from the National Hydrocarbons Commission of Mexico, the number of exploration wells drilled in the country fell from 62 in 2013 to just 11 in 2020. This could be due to a lack of investment or government policies that make it difficult for companies to explore for new sources of natural gas.

- Environmental concerns:
  - Mexico's natural gas industry has faced increased scrutiny from environmental groups and regulatory bodies in recent years. According to a report by the Natural Resources Defense Council, Mexico's government has been slow to adopt regulations to protect the environment and public health from the impacts of natural gas development. This could lead to restrictions on exploration and production activities that could decrease natural gas output.

Coal Consumption

We can also see the consumption of these countries compared to each other , as well analyzing their levels of consumption. In the case of AKM countries, they have all have a coal consumption minor to .75 exajoules.



Source: bp Statistical Review of World Energy, June 2022

Coal consumption has been experiencing a downward trend among these countries. As of today, the usage of this energy source has seen a significant reduction. Analyzing historical consumption patterns would reveal a consistent decline. Key factors contributing to this trend include:

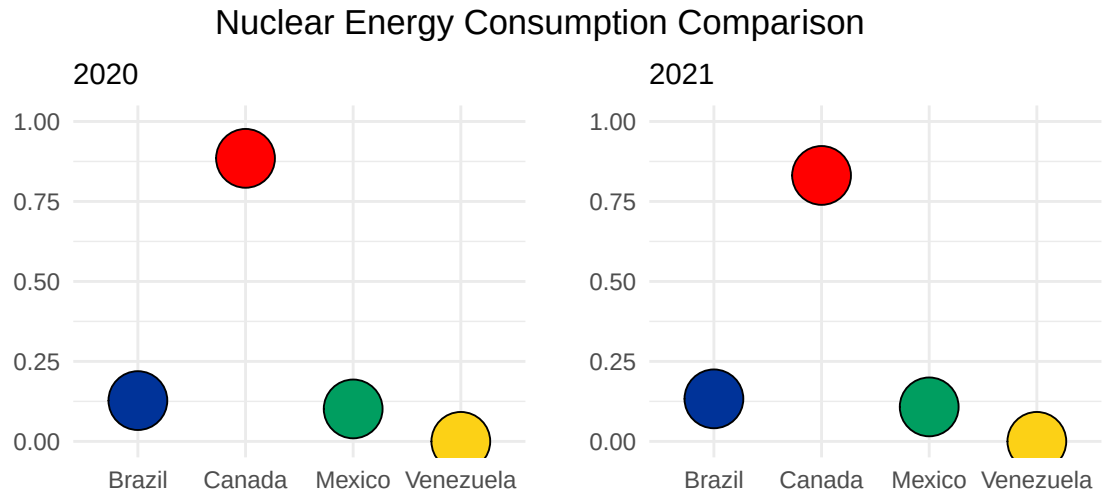
- Government Policies:
  - Many governments have implemented policies and regulations aimed at reducing carbon emissions and promoting the use of cleaner energy sources. For example, some countries have introduced carbon pricing mechanisms, subsidies for renewable energy development, and strict emissions standards for power plants.
- Technological Advances:
  - Technological advances have led to more efficient use of energy and improved energy storage, making it easier to integrate renewable sources into the grid. In addition, coal-fired power plants have become more expensive to operate and maintain, making them less competitive compared to other sources.
- Public Awareness:
  - Public awareness about the environmental impacts of burning fossil fuels has increased, leading to a shift in consumer preferences and pressure on businesses to adopt more sustainable practices.

Nuclear Energy Consumption

Nuclear energy remains a contentious source of energy around the world due to past accidents and concerns over waste management and contamination. Among AKM's countries, Canada has the highest usage of nuclear energy. However, its usage remains below one exajoule.

According to the Canadian Nuclear Association, nuclear energy provides approximately 15% of Canada's electricity generation, making it the second-largest source of low-carbon electricity in the country after hydroelectricity. As of 2021, Canada has 19 nuclear power reactors in operation at four nuclear power plants, located in Ontario and New Brunswick. These reactors have a total installed capacity of approximately 13.5 gigawatts (GW). Canada's nuclear energy industry is primarily focused on the production of electricity, but nuclear technology is also used for a variety of other purposes, including medical and industrial applications, as well as research and development. The country has a strong domestic nuclear industry, with several companies involved in the design, construction, operation, and maintenance of nuclear power plants, as well as the supply of nuclear fuel and other equipment.

Canada is also a major producer and exporter of uranium, which is a key fuel for nuclear power plants. As of 2021, Canada was the world's second-largest producer of uranium, after Kazakhstan, accounting for approximately 13% of global uranium production. The country's uranium reserves are primarily located in Saskatchewan, where several large-scale uranium mines are located.

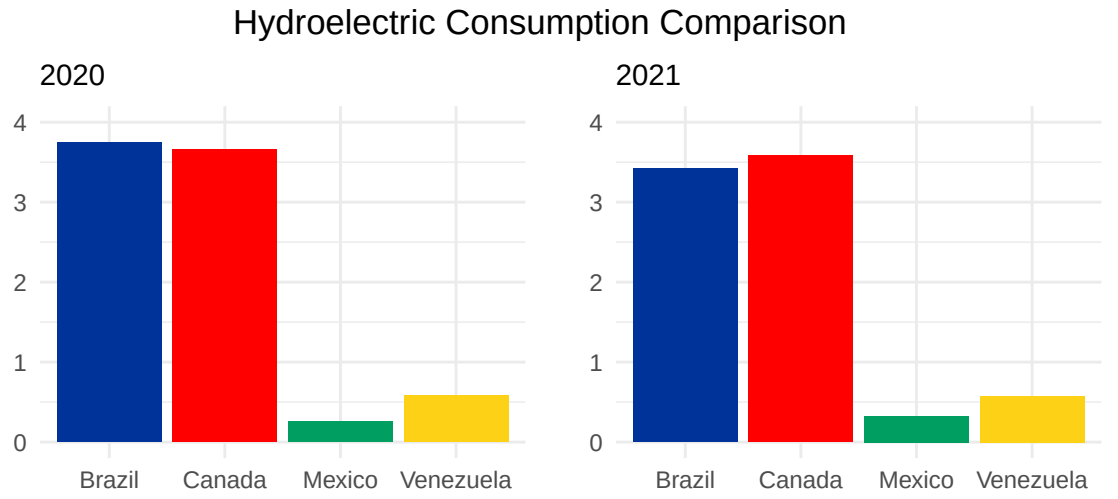


Source: bp Statistical Review of World Energy, June 2022

- Nuclear safety:
  - The potential risks of nuclear accidents, such as the Chernobyl and Fukushima disasters, have raised concerns about the safety of nuclear power plants. According to the International Atomic Energy Agency (IAEA), there have been three major accidents in the history of commercial nuclear power: Three Mile Island in 1979, Chernobyl in 1986, and Fukushima in 2011. These accidents have highlighted the importance of nuclear safety and the need for continuous monitoring and maintenance of nuclear facilities (IAEA, 2021).
- Waste management
  - The storage and disposal of nuclear waste is a significant challenge for the nuclear industry. According to the World Nuclear Association, there are currently over 450,000 tonnes of spent nuclear fuel in storage around the world, and this amount is expected to increase as more nuclear power plants come online. In addition, the management and disposal of nuclear waste is a long-term challenge, as nuclear waste can remain hazardous for thousands of years (World Nuclear Association, 2022).

- Proliferation of nuclear weapons
  - The use of nuclear technology for energy production raises concerns about the potential proliferation of nuclear weapons. According to the IAEA, there have been cases of the misuse of nuclear materials and technology for non-peaceful purposes. As of 2021, the IAEA reported a total of 26 incidents of theft or loss of nuclear or other radioactive material, and 60 incidents of unauthorized activities and events (IAEA, 2021).

Hydroelectric Energy



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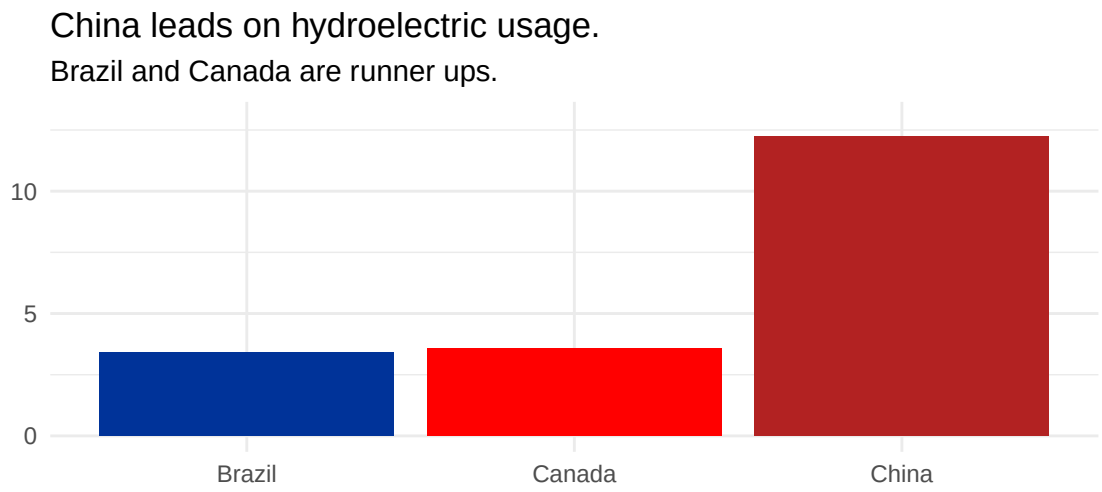
In the case of **Mexico**, hydroelectricity plays a relatively minor role in the country's energy mix, compared to other sources such as natural gas and oil. However, there has been increasing interest in developing Mexico's hydroelectric potential, particularly through the development of small-scale and micro-hydro projects.

Hydroelectricity plays a crucial role in **Venezuela's** energy mix, due to the country's abundant water resources and the development of large-scale hydroelectric projects such as the Guri Dam and the Caruachi Dam. However, the country has faced significant challenges in maintaining its hydroelectric capacity in recent years, due to a combination of factors including droughts, lack of maintenance and investment, and political instability. As a result of these challenges, Venezuela has been forced to rely more heavily on other sources of energy such as natural gas and oil. However, there is still significant potential for further hydroelectric development in the country, particularly through upgrades to existing facilities and the development of new small-scale hydro projects.

Overall, while Venezuela's hydroelectric capacity has faced challenges in recent years, hydroelectricity remains a crucial component of the country's energy mix and has significant potential for further development in the future.

Hydroelectricity is a major source of energy in **Brazil**, due to the country's abundant water resources and the development of large-scale hydroelectric projects such as the Itaipu Dam and Belo Monte Dam. In recent years, there has been growing interest in expanding Brazil's hydroelectric capacity through new projects and upgrades to existing facilities. However, there have also been concerns about the environmental and social impacts of large-scale hydroelectric projects, particularly with regards to the displacement of local communities and the impact on aquatic ecosystems. As a result, there has been increasing interest in developing alternative sources of renewable energy in Brazil, such as wind and solar power. Nonetheless, in terms of consumption, Brazil consumed a total of 494.1 TWh of hydroelectricity in 2021, which represents 66.5% of the country's total electricity generation. This makes Brazil the largest consumer of hydroelectricity in the world.



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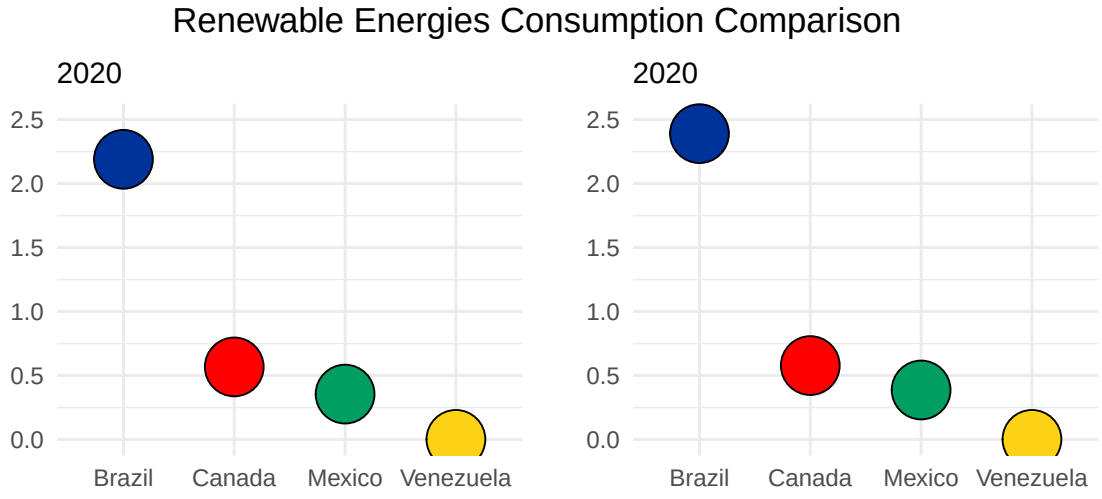
Hydroelectricity is a major source of energy in **Canada**, due to the country's abundant water resources and the development of large-scale hydroelectric projects such as the James Bay Project and the Churchill Falls Project. In recent years, there has been growing interest in expanding Canada's hydroelectric capacity through new projects and upgrades to existing facilities. There's also been concern about environmental issues.

Hydroelectric energy appears to have a bright future in both of these countries, where water is abundant and can be harnessed to its fullest potential through careful manipulation. The section on inferential analysis will include predictions and speculations about the future growth of these energy sources.

Renewable Energy (Solar, Wind, Biofuels)



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Renewable energy plays a crucial role in **Brazil's** energy mix, due to the country's abundant natural resources and the development of large-scale renewable energy projects. In recent years, there has been increasing interest in developing new sources of renewable energy in Brazil, particularly in the areas of wind and solar power. However, there are also challenges facing the renewable energy industry in Brazil, including issues

related to financing, regulation, and infrastructure. Nevertheless, the Brazilian government has set ambitious targets for renewable energy development, with a goal of reaching 45% renewable energy in the country's energy mix by 2030.

The graph shows that Canada, Mexico, and Venezuela all have renewable energy consumption below one exajoule. In the inferential analysis section, we will explore the potential for investment in this sector. At present, these countries may seem to have an incentive to adopt renewable energy sources due to global pressure and the perception that they are better for the environment. However, the current technology may make some of these alternatives neither affordable nor environmentally friendly.

General Insights

The analysis of primary energy consumption in the countries where AKM has a presence, highlights the importance of understanding each country's unique energy landscape. Factors such as natural resources, government policies, technological advances, and public awareness play a significant role in shaping the energy consumption trends in these countries.

Canada stands out for its high primary energy consumption, driven by its vast natural resources and energy-intensive industries. Brazil, on the other hand, leads in oil consumption among AKM countries, with its robust oil reserves and increasing production. Venezuela's reliance on oil for revenue presents both opportunities and challenges for AKM, as political instability may affect investment prospects. Mexico, with its extensive oil reserves and potential for renewable energy development, offers diverse opportunities for AKM to explore.

Renewable energy, particularly hydroelectricity, plays a crucial role in the energy mix of Brazil, Canada, and Venezuela. In Mexico, there is potential for growth in renewable energy consumption, as the country aims to diversify its energy sources and transition towards cleaner alternatives. Concerns about the environmental and social impacts of large-scale hydroelectric projects have led to growing interest in alternative renewable energy sources like wind and solar power in these countries.

Overall, understanding the energy consumption patterns and future growth potential in these countries will enable AKM to make informed decisions and tailor its strategies to the specific needs and opportunities in each market. By focusing on the right sectors and anticipating future trends, AKM can position itself for long-term success in these energy markets.

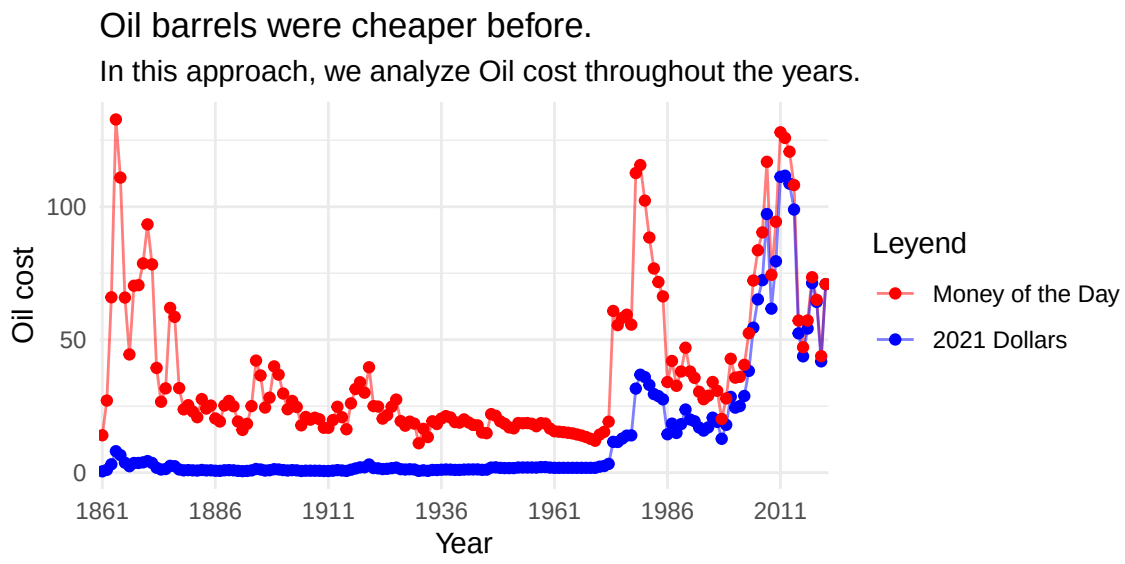
Prices

Let's examine the historical prices of energy.

Oil Prices since 1861

We can see that oil prices have risen throughout times. In order to adjust for inflation, we've added the price if it was in 2021 dollars. We can see that, from 1861 to 1970 oil barrels started to rise considerably. In recent history, the world has witnessed several significant fluctuations in oil prices that have had far-reaching economic and geopolitical impacts. Here are some of the modern most significant oil price crises:

- 1986: Oil Price Collapse
  - In 1986, oil prices experienced a significant drop from $27.56 in 1985 to $14.43 in 1986 (adjusted to $66.29 and $34.08 in 2021 dollars, respectively) due to an oversupply of oil in the market. This was a result of increased production from non-OPEC countries and OPEC's inability to maintain production cuts.



- 2008: Oil Price Peak
  - Oil prices reached an all-time high of $97.26 in 2008 (adjusted to $116.91 in 2021 dollars) due to a combination of factors. These included high demand from emerging economies, geopolitical tensions, and a weak U.S. dollar. However, the global financial crisis that occurred later in the year led to a sharp drop in oil prices.
- 2014-2016: Oil Price Decline
  - Oil prices declined significantly from $98.95 in 2014 to $43.73 in 2016 (adjusted to $108.17 and $47.16 in 2021 dollars, respectively) due to an oversupply of oil resulting from increased production by countries such as the United States and a slowdown in global demand.

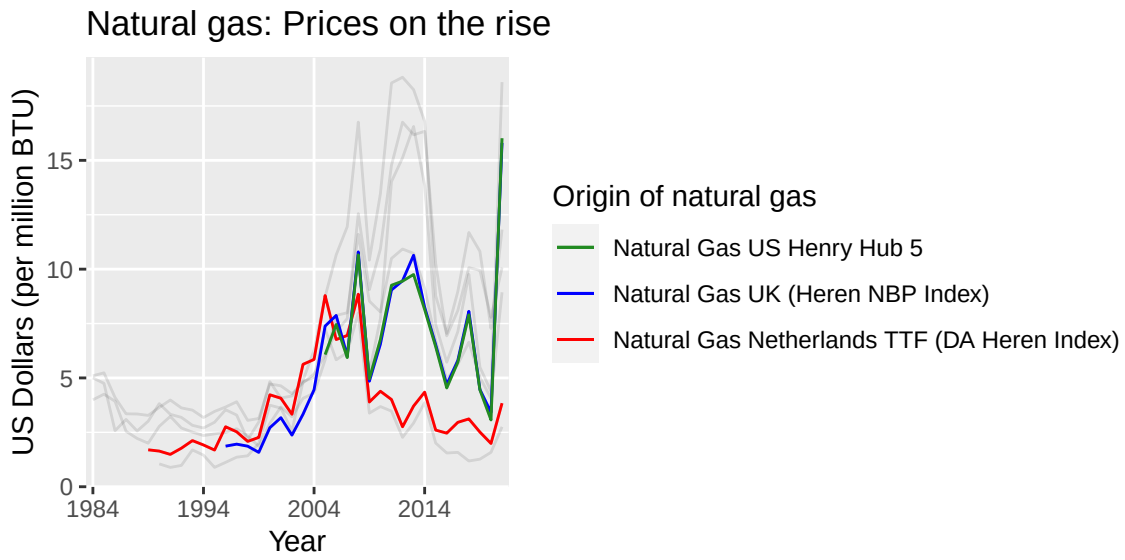
These fluctuations in oil prices have impacted the global economy, international relations, and energy policies of different countries. Understanding the underlying causes and implications of these oil price crises is essential in creating strategies to mitigate their effects in the future.

Gas Prices

Natural gas prices have experienced significant fluctuations over the years due to various factors, such as changes in supply and demand, geopolitical events, and advancements in extraction technologies. Analyzing the trends in the data we can identify key trends and events that have influenced these price changes.

From the early 2000s to 2010, natural gas prices rose steadily, driven by increasing demand from emerging economies like China and India, as well as a growth in the use of natural gas for power generation in developed countries. During this period, prices reached a peak in 2008, with the U.S. Henry Hub spot price averaging around $8.86 per million British thermal units (MMBtu). This peak was also influenced by the global financial crisis and disruptions in supply from geopolitical events, such as conflicts in the Middle East.

In the following years, prices began to decline due to the expansion of unconventional gas production, particularly in the United States. The advent of hydraulic fracturing (fracking) and horizontal drilling technologies significantly increased the supply of natural gas, pushing prices down. By 2012, the U.S. Henry Hub spot price had dropped to an average of $2.75 per MMBtu.



The period from 2012 to 2021 saw a more volatile natural gas market, with periods of both rising and falling prices. This volatility can be attributed to factors such as weather-related demand fluctuations, changes in storage levels, and geopolitical events. However, the overall trend has been one of price stabilization, with the U.S. Henry Hub spot price averaging around $3.00 to $4.00 per MMBtu during this time.

Looking ahead, it is anticipated that natural gas prices will continue to be influenced by a multitude of factors, including global economic growth, the pace of the energy transition, and the development of new extraction technologies. As the world moves towards more sustainable energy sources, the role of natural gas as a bridge fuel is likely to be a key determinant of its price trajectory in the coming years.

Coal Prices

Coal prices, like those of natural gas, have also experienced significant fluctuations over the years due to various factors such as changes in supply and demand, environmental regulations, and geopolitical events. Examining data from sources like the BP Statistical Review of World Energy allows us to identify key trends and events that have influenced these price changes.

From the early 2000s to 2008, coal prices experienced a rapid increase, driven primarily by robust demand from emerging economies like China and India. These countries' rapid industrialization and urbanization led to a surge in demand for coal as a source of energy for power generation and steel production. During this period, the price of thermal coal peaked at around $140 per metric ton in 2008.

However, following the 2008 peak, coal prices began to decline as a result of several factors. The global financial crisis led to a reduction in demand for energy and industrial commodities, which put downward pressure on coal prices. Additionally, technological advancements in natural gas extraction, such as hydraulic fracturing (fracking) and horizontal drilling, made natural gas a more cost-effective and environmentally friendly alternative to coal in many regions.

From 2012 to 2021, coal prices remained relatively volatile, with periods of both rising and falling prices. This volatility can be attributed to factors such as weather-related demand fluctuations, changes in global economic growth, and geopolitical events. However, the overall trend during this period has been a gradual decline in coal prices, as the world increasingly shifts towards cleaner energy sources and countries implement stricter environmental regulations.

Looking forward, it is expected that coal prices will continue to be influenced by a range of factors, including global economic growth, the pace of the energy transition, and the implementation of climate change policies. As the world moves towards more sustainable energy sources, the role of coal in the global energy mix is expected to diminish, which will likely have an impact on coal prices in the coming years.

Hydroelectric Prices

Hydroelectric power, as a renewable energy source, has experienced growth over the years due to increasing concerns about climate change and a global push for cleaner energy. While it is difficult to provide specific historical pricing data for hydroelectric power, as its cost structure differs significantly from that of natural gas and coal, we can discuss its trends, investment, and future prospects.

Hydroelectric power generation involves harnessing the kinetic energy of flowing water to produce electricity. The cost of hydroelectric power depends on several factors such as construction costs, maintenance, and the natural resources available at a given site. It is worth noting that once a hydroelectric plant is built, its operational costs are relatively low, and the power generated is considered to be among the most cost-effective renewable energy sources.

Over the years, investment in hydroelectric power has increased as countries have sought to diversify their energy portfolios and reduce their reliance on fossil fuels. The International Energy Agency (IEA) and other reputable sources have documented the steady growth of hydroelectric power capacity worldwide. According to the IEA, hydroelectric power accounted for roughly 16% of global electricity generation in 2020, making it the largest source of renewable energy.

The future of hydroelectric power looks promising, as governments and organizations continue to invest in its development. Technological advancements in areas such as pumped-storage hydropower and small-scale hydroelectric projects are expected to increase the efficiency and accessibility of hydroelectric power. Furthermore, the global commitment to combat climate change, as evidenced by the Paris Agreement and other international initiatives, is likely to create a favorable environment for the growth of hydroelectric power.

However, there are challenges associated with hydroelectric power, such as its dependence on water resources, which can be affected by climate change and seasonal variations. Additionally, the construction of large-scale hydroelectric dams can have significant social and environmental impacts, such as displacement of local populations and disruption of ecosystems. These factors will need to be carefully considered and addressed as the world continues to invest in and develop hydroelectric power infrastructure.

In summary, while specific pricing information for hydroelectric power is not readily available, its growth, investment, and future prospects appear positive. The increasing global focus on renewable energy sources and the fight against climate change are expected to drive further development and adoption of hydroelectric power in the coming years.

Conclusions

Brazil

According to the latest available data from BP Statistical Review of World Energy and other reputable sources, Brazil's two best choices for energy are hydropower and bioenergy, primarily from sugarcane-based ethanol. These choices are based on the country's abundant natural resources, current production and consumption patterns, and global trends in energy markets.

Hydropower: Brazil has significant hydropower potential due to its extensive river network and favorable topography. The country is currently the third-largest producer of hydroelectricity in the world, and hydropower accounts for more than 60% of Brazil's electricity generation. This renewable energy source has several advantages, including low operating costs, minimal greenhouse gas emissions, and the ability to provide stable baseload power. Moreover, global expectations suggest a continued shift towards renewable energy sources, making hydropower a viable long-term option for Brazil.

Bioenergy: Brazil is a global leader in bioenergy production, particularly in the form of sugarcane-based ethanol. The country has a well-established ethanol industry, with a long history of government support and infrastructure investment. Ethanol currently accounts for a significant share of Brazil's transportation fuel

market, contributing to reduced reliance on imported oil and lower greenhouse gas emissions. Additionally, the global demand for biofuels is expected to grow, driven by concerns about energy security and climate change. This trend positions Brazil's bioenergy sector for potential expansion in the coming years.

In summary, Brazil's best energy choices are hydropower and bioenergy, given the country's resource endowments, existing infrastructure, and global energy trends. These energy sources align with the growing demand for clean and renewable energy, offering Brazil an opportunity to capitalize on its strengths while addressing environmental concerns and meeting its energy needs.

Canada

In the case of Canada, the country's two best choices for energy are hydropower and wind power. These choices are determined by the country's available resources, current production and consumption patterns, and global trends in energy markets.

Hydropower: Canada has an abundance of hydropower resources due to its extensive river systems and favorable topography. The country is currently the third-largest producer of hydroelectricity globally, with hydropower accounting for more than 60% of its total electricity generation. This renewable energy source offers several advantages, such as low operating costs, minimal greenhouse gas emissions, and the ability to provide stable baseload power. Furthermore, global expectations suggest a continued shift towards renewable energy sources, making hydropower a viable long-term option for Canada.

Wind Power: Canada has significant potential for wind energy development, thanks to its vast land area and extensive coastlines. Wind power has experienced rapid growth in recent years, driven by technological advancements, declining costs, and government support for renewable energy projects. The country has already established itself as a significant wind energy producer, with wind power accounting for a growing share of its electricity generation. Additionally, global trends indicate a continued expansion of wind power capacity, positioning Canada well to capitalize on this renewable energy source.

In summary, Canada's best energy choices are hydropower and wind power, given the country's resource endowments, existing infrastructure, and global energy trends. These energy sources align with the growing demand for clean and renewable energy, offering Canada an opportunity to capitalize on its strengths while addressing environmental concerns and meeting its energy needs.

Mexico

Mexico's two best choices for energy are natural gas and solar power. These choices are determined by the country's available resources, current production and consumption patterns, and global trends in energy markets.

Natural Gas: Mexico has abundant natural gas reserves and is well-positioned to benefit from the increasing global demand for cleaner-burning fossil fuels. The country has been investing heavily in natural gas infrastructure, including pipelines and power plants, which has led to a steady increase in natural gas consumption. As a result, natural gas has become the primary fuel for electricity generation in Mexico, accounting for more than 60% of the country's total energy production. Additionally, natural gas prices have been relatively stable in recent years, making it an attractive option for meeting Mexico's growing energy needs.

Solar Power: Mexico has considerable solar energy potential due to its favorable geographic location and abundant sunshine. The country has witnessed a rapid growth in solar power installations in recent years, driven by government incentives and declining costs of solar photovoltaic (PV) technology. Solar power offers a clean and renewable source of energy that can help Mexico reduce its greenhouse gas emissions and diversify its energy mix. Moreover, global expectations indicate a continued shift towards renewable energy sources, positioning solar power as a promising long-term option for Mexico.

In conclusion, Mexico's best energy choices are natural gas and solar power, given the country's resource endowments, existing infrastructure, and global energy trends. These energy sources align with the growing

demand for cleaner and renewable energy, offering Mexico an opportunity to capitalize on its strengths while addressing environmental concerns and meeting its energy needs.

Venezuela

Based on the latest available data from the BP Statistical Review of World Energy and other reputable sources, Venezuela's best choice for energy is oil. This choice is determined by the country's available resources, current production and consumption patterns, and global trends in energy markets.

Oil: Venezuela has one of the largest proven oil reserves in the world, making it a critical resource for the country's economy. Despite facing challenges such as political instability and underinvestment in the oil sector, oil production and export remain crucial to Venezuela's energy strategy. The country has vast heavy crude oil reserves in the Orinoco Belt, and developing these reserves could significantly increase oil production. Ensuring the stability and efficiency of the oil sector will be vital to meeting Venezuela's domestic energy needs and generating revenue through exports.

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