

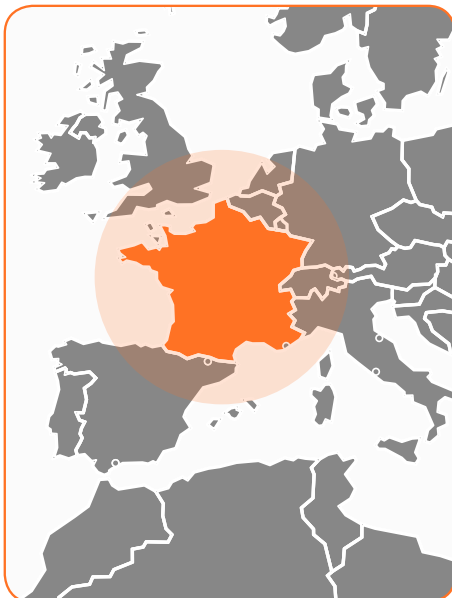
GLOBAL OIL INDUSTRY ACTIVITY MONITORING

Copernicus Sentinel data is being used by energy companies, commodity traders and oil market speculators to better understand the markets they operate in, allowing them to optimise trades and make better informed business decisions.



THE CHALLENGE

From the bustling stock exchanges of New York, London and Hong Kong, to the quiet suburban bedrooms of day traders, there is one resource that all market traders and players wish they had more of: **reliable and timely market information**. Whether you're trading crude oil, precious metals, currencies or soybeans, knowing more about who owns which resources, who is selling, who is buying and where commodities are moving gives any trader or market participant a better overall understanding of the market. The more a player understands the market, the less risk they take when placing trades and the better they can predict what is likely to happen. This, in turn, helps them to buy and sell at optimum times and ultimately make profit. In economic theory, "**perfect information**" is one of the key elements of the hypothetical market situation of "**perfect competition**", which itself describes how a perfectly efficient market should operate. "Perfect information" implies that every player in the market has perfect and instantaneous knowledge of every market movement and every price. In the real world, this can never really happen, particularly in the vast global markets of today. Although it's impossible to reach the Holy Grail of "perfect information", obtaining more information, and ideally, **more information than your competitors**, certainly **is** possible and brings with it a competitive advantage! In the volatile market of crude oil trading, commodity traders all want to know **where crude oil inventories are situated and where they are moving...** Should Venezuela's oil production and inventories suddenly begin to surge, the law of supply and demand will kick in and drop global crude prices. Conversely, the quantity of oil being stored in the Middle East during a period of international instability will proportionally dictate the rise in global crude price. Simply put; if oil can't reach the market, global supply is reduced, and prices will rise. This is precisely the type of information that commodity traders live for. But how can such colossal global oil inventories be tracked continually and accurately?



HOW SATELLITES CAN HELP

Kayros, a French startup company, has leveraged Copernicus Sentinel data to track crude oil inventories all around the world. By using Sentinel-1 data to exploit a simple feature of crude oil storage tanks, they have developed algorithms that can produce continuous and accurate estimates of where oil inventories are currently situated and how they are changing. The free and open data available from Copernicus has been instrumental in making business models like Kayros' commercially viable.

Crude oil is typically stored in large vessels or storage tanks when waiting to be processed or shipped elsewhere in the world. A common feature of these vessels is what is known as an "external floating roof". The roofs of these tanks literally float on top of the oil content inside the vessel, with the roof rising and falling as crude oil is pumped in or out of the tank. The reasons for the floating roof are twofold; it reduces the evaporation and loss of valuable hydrocarbon gases dissolved in the contained liquid and also reduces the likelihood of the emission of harmful and potentially explosive air pollutants. By understanding the size and storage capacity of a crude oil storage tank, it is a straightforward calculation to estimate the volume of contained liquid, once the roof height is known.

Sentinel-1's Interferometry SAR (InSAR) capabilities allow distance information about the Earth's terrain to be understood. Elevations, depths, heights and depressions of features on the Earth's surface, both natural and manmade, can be accurately measured and monitored remotely. It is exactly this capability that lends itself to the monitoring of the changing heights of external floating roof tanks. Sentinel-1 can map the entire Earth's surface every 6 days, meaning almost continual up-to-date information regarding the heights of oil storage tank roofs can be achieved.



Figure 1: An oil storage facility including cylindrical storage tanks. (copyright Kayros)

www.kayros.com

The satellite data:



Sentinel-1 is the Copernicus radar mission, providing an all-weather, day-and-night supply of imagery of Earth's surface. The mission consists of two satellites embarking C-band synthetic aperture radars (SARs) in continuity of the ESA's ERS-2 and Envisat missions. The mission images the entire Earth every six days for the benefit of manifold applications such as, for example, monitoring of Arctic sea ice extent, surveillance of the marine environment, monitoring land-surface for motion risks, mapping for forest, water and soil management.

Copernicus Sentinels data are available under an open and free data policy.

Sentinel-1 data can be accessed at <https://scihub.copernicus.eu>

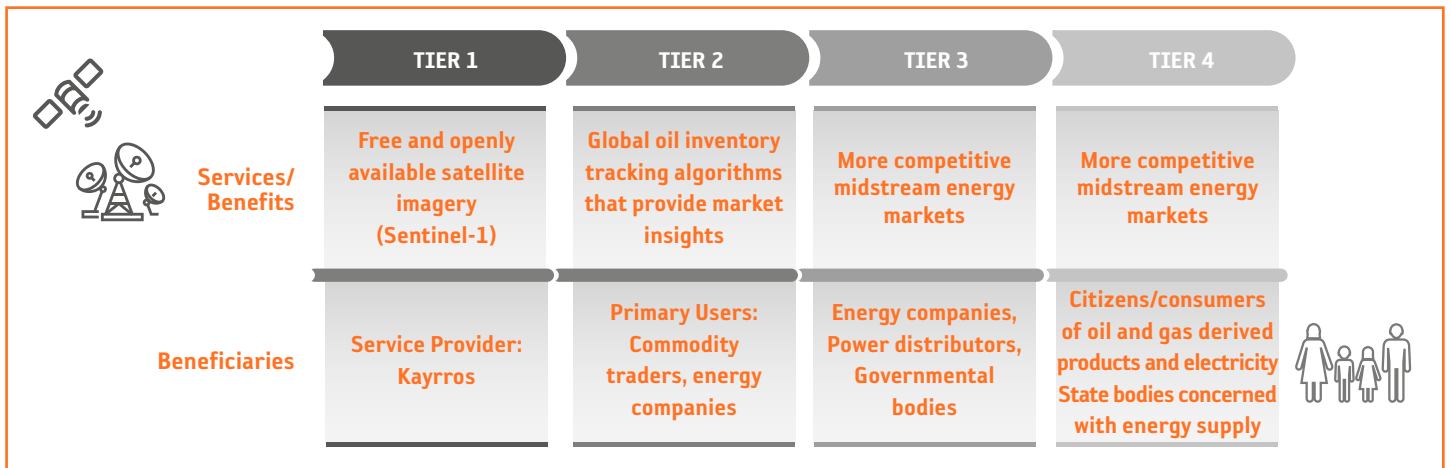
More info: <https://sentinels.copernicus.eu>

The Service Provider

Kayros is an earth observation analytics business helping asset-focused organisations make better investment and operational decisions. It delivers insight and market intelligence through its sector expertise, scientific foundation, and cutting-edge technology. A platform processes data from multiple sources including satellite imagery, natural language processing, and industry benchmarks, harnessing proprietary methodology built on artificial intelligence and machine learning. Kayros insight is delivered through sector reports, data analysis and insight solutions tailored to individual customer needs. They currently employ more than 150 scientists, engineers, and analysts in offices in Paris, Houston, New York, London, and Singapore.



KAYROS



Schematic representation of the main beneficiaries along the value chain, including the corresponding services and benefits provided.

WHO IS CONCERNED?

Amazingly, it is the simple mathematical equation of area x height = volume that is exploited, on a vast scale, to estimate crude oil reserves stored around the globe. This, in turn, can help commodity traders navigate the tricky world of oil price speculation in the lucrative global market. Who knew that the mathematics we all learned in school as children could be so useful?!

Algorithms take Sentinel-1's continuous data feed and use it to measure changes in the roof elevations of known storage vessels in key facilities. This is then automatically processed to produce an estimate of how much crude oil is stored in different locations all around the world. Roughly 95% of the world's crude oil is stored in floating roof tanks, equating to around 10 billion barrels. Interestingly, not all tanks are on land, roughly 2500 floating vessels are located at sea, each equipped with its own floating roof. All in all, using Sentinel-1 data as their primary input, these sophisticated algorithms can estimate oil inventories to an accuracy level of 98.1%.

It should come as no surprise that global oil prices are of huge concern and importance to any company involved in the oil & gas sector. Considered to be one of the oil & gas "supermajors", the French multinational TOTAL is no exception. Having multiple business units in the upstream, midstream and downstream sectors of the oil and gas industry, TOTAL is not only interested in the production of oil, but the trading of it too. Their Market Analysis team consists of analysts who use the continuous monitoring, updates and alerts provided by Kayrros to keep on top of happenings in the global crude market. The accurate and continual nature of the information allows TOTAL to make better informed decisions, not only when it comes to their trading, but for their planned production volumes as well as the short to medium term strategy of the company as a whole. Regarding the service, Frederic Lasserre, Director of Market Analysis at TOTAL Oil Trading commented "Kayrros' weekly data on inventory levels has dramatically improved the accuracy of the global and regional crude oil Supply & Demand balances, helping us to get a better understanding of the price discovery mechanism." It is clear that the tracking of crude oil inventories using satellite data has now become an essential practice for companies such as TOTAL.

The Primary Users

Founded in 1924 and headquartered in Paris, TOTAL is an energy company which produces and markets fuels, natural gas and low-carbon electricity. They currently employ over 100,000 people and are active in more than 130 countries. From oil & gas, solar and bioenergy production to the distribution and sale of end products, they operate along the entire energy value chain.

TOTAL's Market Analysis team use oil inventory tracking services, along with a number of other market analysis tools and techniques to help them build a better picture of exactly how the markets they operate in are behaving. This allows them to get a better understanding of how prices are likely to shift.



www.total.com/en



Figure 2: Typical cylindrical storage tanks.

WHAT ARE THE BENEFITS?

Companies such as Kayrros are able to build business models around the free and open Copernicus Sentinel data, allowing them to save on operating costs, meaning they can offer their services at competitive prices and ultimately expand their business.

Energy companies, commodity traders and market speculators benefit from having more precise and timely information on market movements. Having a clearer picture of the current state of play in any market allows participants and observers to more accurately predict what will happen in the future. This better informs trade, investment and business strategy decisions as potential market prices can be foreseen and adjustments made accordingly. Consequently, this helps traders and energy companies to reduce risk, maintain their business operations and generate profit.

Although the most tangible and visible benefits in this case are primarily shared between the service provider and the primary user, there are further benefits that stem from this application of satellite data, namely the following:

Not every player initially involved in crude oil market speculation will avail of services such as inventory tracking, however, players who do, will gain an advantage over those who don't. As a result, speculators and companies involved in the market are all incentivised to obtain and use such information in order to stay competitive. As more and more players in the market gain information, they collectively approach a state of **perfect information**. Although, in reality, they will never reach perfect information, with every additional increment of collective knowledge acquired by the market players, **the more competitive the market will become**. This is due to the fact that in approaching perfect information, the market as a whole is ultimately approaching the hypothetical state of **perfect competition**. Once again, perfect competition can never truly be achieved either, especially in such a gigantic and dynamic market. It not only requires all players to have perfect information, but a number of other key criteria must also be met, such as all products being homogenous, labour being perfectly mobile and market entry costs being zero.

Nevertheless, **increased market competition**, to which oil inventory tracking most certainly contributes, can only be of benefit to consumers. Both economic theory and practice has shown us time and time again that competitive markets drive prices lower for end users while simultaneously reducing the chances of monopolies forming and exploiting customers. Ultimately this contributes to consumers and society having greater access to fairer priced oil & gas derived products, lower electricity prices and greater energy security.

The key benefits are:

- **Financial:** Energy companies and traders can better understand the markets they are operating in, allowing them to buy and sell at optimum times as well as guide business strategy.
- **Societal:** End users and consumers benefit from a more competitive market which reduces end product prices.
- **Entrepreneurial:** Companies such as Kayrros can emerge, innovate and thrive as a result of the free and open Copernicus data. Their growth to over 150 employees in under 4 years is a testament to this.



Figure 3: The New York Stock Exchange.

EXTENDED IMPACT

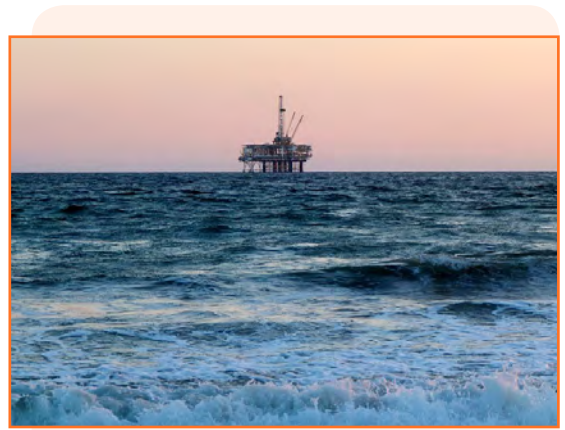
In the world of high-stakes market speculation and trading, the use of satellite data is not limited to just oil inventory tracking. Satellite data can be used in conjunction with other data sources to better understand when oil refinery outages or disruptions occur. Again, this can help speculators understand and predict the dynamics of the market. Oil well drilling operations, liquefied natural gas (LNG) plant monitoring as well as powerplant demand rates are all activities that can also be monitored using satellite imagery. Moving away from the energy industry, the production, storage and transportation of metals and minerals can also be accurately monitored by utilising satellite data. Even traders of commodities such as soybeans, wheat or corn can obtain valuable knowledge of their respective markets from the use of Copernicus Sentinel data. When it comes to obtaining more information about the world's immense and complex global commodity markets, Copernicus data can provide invaluable insights which drive both businesses and competition forward.

ABOUT THE PROJECT

The Sentinel Benefits Study (SeBS) is conducted by EARSC (European Association of Remote Sensing Companies) with partners The Greenland, IIASA (International Institute for Applied Systems Analysis) and Evenflow on behalf of the European Space Agency (ESA). It has the goal to study 20+ full cases by analysing the impact of the use of Sentinel data along a value-chain. This short-case has been prepared where there has been an interesting use made of Sentinel data, but it has not (yet) been possible to conduct a full case. It tells the story of the use of Sentinel data without going deeply into the economic or environmental benefits.



We acknowledge that the understanding of the case was supported by discussions with Antoine Rostand from Kayrros and Frederic Lasserre from TOTAL Oil Trading. We thank them for their valuable insights and availability.



Kayrros' weekly data on inventory levels has dramatically improved the accuracy of the global and regional crude oil Supply & Demand balances, helping us to get a better understanding of the price discovery mechanism

Frederic Lasserre, Director of Market Analysis at TOTAL Oil Trading



Do you know an interesting case demonstrating the benefits derived from the use of Sentinels data?

Email info@earsc.org

More Information on Sentinels Benefits Studies:

www.earsc.org/sebs



The Sentinels Benefits Study is funded by the EU and ESA. The views expressed in this study cannot be taken to reflect the official position of the EU or of ESA.