

Climate tech

NEW TECHNOLOGIES ARE ENABLING GAME-CHANGING IMPROVEMENTS IN EMISSIONS MONITORING



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Pressure on the environmental sustainability of businesses is rising sharply

" ABOUT ESG [...] THE EASIEST QUESTIONS TO ASK ARE IN S AND G, NOT IN E."

The demand for measuring asset externalities such as GHGs comes from all stakeholders: regulators. investors, NGOs, as well as consumers.

Regulators are toughening their stance

Sustainability is becoming a core issue for governments and regulators, especially in the EU. In December 2019, the European Commission launched the "European Green Deal", with new measures and investments that aim to make the EU the first climate-neutral continent by 2050. ECB president Christine Lagarde has publicly said that she is pushing for climate change to be a missioncritical priority for the central bank, and is considering using monetary policy and bank supervision to fight climate change. This shift would require assessing which firms are more polluting than others. In September, the EU Commission presented its revised environmental targets for 2030, now calling for a reduction of GHG emissions of 50 to 55% compared to 1990 levels, while

40%. To achieve this new target, the Commission will review all relevant climate and energy policy instruments with a view to making appropriate proposals by June 2021. As part of the European Green Deal, in October 2020 the Commission announced its strategy to reduce methane emissions. This strategy notably includes proposing EU legislation on compulsory measurement, reporting, and verification for all energy-related methane emissions¹.

it was initially targeting a reduction of

At the same time, governments and regulators will apply additional constraints and standards on the

sustainability of business operations. They will need the right tools to measure environmental performance, moving away from a commandand-control approach - in which they mandate equipment changes and maintenance schedules - to performance- or market-based emissions reduction schemes. NGOs such as Greenpeace or The Children's Fund will also want to be able to assess the sustainability of businesses more effectively, and will look for the best tools and measures to do this. The ability to measure environmental performance will be essential to put the right taxation mechanisms in place.

¹<u>Reducing greenhouse gas emissions: Commission adopts</u> EU Methane Strategy as part of European Green Deal. European Commission, October 2020





Pressure from the investment community is on

Shareholder awareness is also changing rapidly. Investors are increasingly placing sustainability at the core of their decisions. In a letter addressed to all CEOs², BlackRock CEO Larry Fink points out "climate risk will impact both the physical world and the global system that finances economic growth", and concludes that "In the near future-and sooner than most anticipate-there will be a significant reallocation of capital". This echoes plans outlined by Christopher Hohn,

head of London-based activist hedge fund TCI, to vote against the directors of companies that fail to reveal their carbon emissions. And it reflects letters sent to some of the world's largest GHG-emitting companies by the Climate Action 100+, an investor group whose 518 members represent USD47tn in assets under management, requesting the implementation of net-zero strategy for 2050 or earlier. A fundamental reshaping of finance is underway. Companies that do not tackle the environmental issue may end uprunning short of capital.

" SUSTAINABILITY OR **ESG INTEGRATION IN THE INVESTMENT PROCESS** HAS MOVED FROM NICE-**TO-HAVE TO PERMISSION** TO PLAY

Investors will look for the best independent tools and ratings to properly assess the environmental impact of corporations, classify low-carbon-footprint investments and make the right choices. All financial intermediaries will need the right methodology to identify environmental, social and governance (ESG) risks, report to supervisory authorities and publish their reports where necessary.

² Red A Fundamental Reshaping of Finance, Larry Fink, **BlackRock**





Companies globally have no choice but to adapt to this new environment

As pressure from all stakeholders increases, corporations face two main challenges. The first is to adapt their operations to be more environment-focused by changing their processes, providers and materials, and to control the results through appropriate measurements and monitoring. And the second is to adapt their communications to provide more insights and data on their actual ecological impact with the enriched, more reliable and more accurate ESG disclosures that growing investor scrutiny will necessitate. Data on carbon accounting will be of particular importance.

The ability to measure CO2 and other GHG emissions in a reliable and accurate way, on a global scale and in a timely manner, is therefore key to mitigating global warming and climate change challenges.

The pressure is also coming from consumers

Consumer concern and awareness is also growing, especially among the millennial generation. Consumer choices are increasingly driven by ecological concerns and sustainability. Technology and social networks enable and encourage consumers to make more environmentally conscious choices and the change is happening fast. Products and brands are adapting, with greater focus on the ecological dimension of their communications, production and operations.



Accurately monitoring GHG emissions has been a struggle so far

Carbon dioxide (CO2) is the biggest contributor to global warming, estimated to have caused around 65% of warming since the pre-industrial era. The second most relevant GHG after CO2 is methane (CH4), responsible for c. 20-25% of warming over the same time span. Despite its lower overall impact, methane is under increasing focus as it has 84x more warming impact in the first two decades from emission

than carbon dioxide. To reach the 2030 and 2050 targets set by numerous companies, governments and regulators, it is necessary to curb methane emissions.

Data for 2016, the most recent available, showed CO2 emissions at 36.7 gigatons, or 74% of the total greenhouse gas emissions, while 8.5 gigatons of CO2 equivalent methane were emitted, accounting for 17% of total GHG emissions.

FIG. 1: GLOBAL ANTHROPOGENIC GREENHOUSE GAS EMISSIONS BREAKDOWN (CO2e)



FIG. 2: 2016 BREAKDOWN OF GLOBAL ANTHROPOGENIC GHG EMISSION SOURCES





Source: ClimateWatch data



Current data on emissions relies on self-reported estimates and is often delayed

" THE CLIMATE CHANGE DEBATE GOING ALL THE WAY BACK TO KYOTO HAS BEEN PLAGUED BY A LACK OF HARD MEASUREMENTS "

> Andrew Gould former CEO of Schlumberger, 28 July 2020, Kayrros and Bryan, Garnier & Co's webinar: Stopping methane: what are we waiting for?

Laws have made carbon accounting mandatory for countries and corporations

Starting in 2003 with the European EU ETS directive, which was followed by a large number of regions, carbon accounting has become mandatory in many areas globally. The term refers to the need for corporations, generally those with emissions over a certain level, to measure and report their greenhouse gas emissions. As detailed in Fig. 3, carbon accounting splits emissions in three different scopes:

- Scope 1 refers to direct GHG emissions from a company's facilities and vehicles.
- Scope 2 adds the GHG emissions from the generation of electricity, heat or steam purchased by the company.
 - Scope 3 includes every other indirect emissions coming from the company's upstream



Depending on the regulation, geography, activity, and size, each corporation has different carbon accounting requirements. Right now, there are more than 40 countries with carbon accounting regulations in place and the number is growing.

Carbon accounting is important on several levels. The data collected means policymakers are better equipped and are more likely to set realistic targets. Carbon accounting is also the foundation on which emissions trading schemes are built.

FIG. 4: ADOPTERS OF CARBON ACCOUNTING REGULATIONS







Source: WRI

But measurement remains an issue

Most of the available data on emissions is self-reported. To date, it has not been possible so far to verify those data quickly, effectively, and cheaply. Although corporations in some countries are legally required to report their carbon emissions, the figures they report are based

on estimates, most often resulting from the use of the Greenhouse Gas protocol (https://ghgprotocol.org).

It is possible to obtain hard measurements of the concentration of carbon-bearing gases. However, measuring the concentration of these gases is not enough, as they remain in the atmosphere for decades and

are thus dispersed away from their emitting source. CO2, for example, has an atmospheric lifetime of several hundred years.

Finally, the public availability of data is delayed, with the latest global emissions data available dating back to 2016.



Reducing methane emissions has become a short-term priority

" WE THINK THAT **AROUND 80MT A YEAR OF METHANE* LEAKS TO THE ATMOSPHERE FROM OIL** AND GAS OPERATIONS. WE THINK THAT ROUGHLY 3/4 **OF THAT IS TECHNICALLY POSSIBLE TO ABATE, AND** WE THINK THAT JUST DEPENDING ON THE GAS PRICE. SOMEWHERE **BETWEEN A THIRD AND** A HALF CAN BE ABATED AT NO NET COST. IF YOU ABATE ALL THAT COMES AT NO NET COST, WE FOUND THAT IT HAS THE SAME IMPLICATIONS FOR **GLOBAL TEMPERATURE** AT THE END OF THE 21ST CENTURY AS YOU WOULD GET FROM IMMEDIATELY SHUTTING DOWN ALL OF CHINA'S COAL PLANTS AND REPLACING THEM WITH ZERO CARBON **ELECTRICITY** "

CASE STUDY

gas

According to the US organization the Environmental Defense Fund, methane is 84 times more potent than carbon dioxide in the first two decades after its release. It has a global warming potential (GWP) of 26, meaning that over a 100-

FIG. 5: GLOBAL WARMING POTENTIAL OF GREENHOUSE GASES

	300
	250
	200
	150
	100
	50
	0
Carbon did	

It is estimated that methane emissions have reached 570 million tons (or c.15 gigatons of CO2e) in 2020, 65% of which coming from anthropogenic sources, mainly agriculture and energy; and 45% from natural sources, mainly wetlands.

Methane, a potent greenhouse

year period, an equal amount of methane will contribute 26 times more to global warming than the same amount of CO2. (GWP is used to calculate CO2e, or carbon dioxide equivalent, which creates a common scale for measuring the climate impact of different GHGs. The GWP of CO2 is 1).



84X OVER THE FIRST 20 YEARS, METHANE IS 84 TIMES MORE POTENT THAN CARBON DIOXIDE.

In recent years, the discussion of GHGs has leaned towards the monitoring and reduction of methane emissions, despite the fact that it accounts for only around 17% of global annual emissions. We believe there are three reasons behind this focus:

 It is currently estimated that leaks from the oil & gas industry represent 2 gigatons of CO2e. Of those 2 gigatons, it is estimated that 1.5 can be abated at no net cost, meaning that the value of the methane captured would offset the cost to fix the leaks. It is estimated that large leaks alone are equivalent to nearly 1 gigaton of CO2e, or the combined carbon footprint of Germany and France. Since methane is the primary component of natural gas, these leaks emit large quantities of methane directly in

2. Global gas demand is forecast to increase in the next few years, as energy demand increases and the world switches from coal towards lower-emission energy sources.

the atmosphere.

 Methane persists in the atmosphere for only 10-20 years, while CO2 remains in the atmosphere for more than 100 years. However, methane's GWP is based on its impact over 100 years. So to comply with 2050 targets, reducing methane emissions is a must.

Solving the issue of large leaks in the oil & gas industry now helps avoid a bigger issue in the future, as well as contributing strongly to reaching 2050 emissions targets. It is estimated that these large leaks represent c.12% of annual anthropogenic methane emissions, but come from a limited number of sources. Fixing these leaks could prove much easier than reducing methane emissions by one gigaton CO2e from other sources, which are very numerous and feature low levels of individual emissions.





Technology advances are improving GHG monitoring

In recent years, the tech industry has delivered a broad range of solutions aimed at preventing, monitoring or reducing the emission of pollutants such as nitrogen dioxide or sulphur dioxide as well as the emission of greenhouse gases such as carbon dioxide and methane.

and knowing their source is essential for the implementation of efficient policy. It is an area that has seen profound change as multiple hardware and software solutions have been developed.

"WE'VE GOVERNMENTALLY BEEN REALLY SLOW TO SPOT NEW TECHNOLOGIES AND WORK OUT WHAT **OPPORTUNITIES THEY CAN** GIVE US TO HELP SOLVE

Claire O'Ne

Monitoring the emissions of pollutants and greenhouse gases



Sensors are nice-to-have local solutions

Ground sensors have been developed and deployed in cities and industrial facilities, while airborne LiDAR sensors continue to be used by scientists, NGOs, regulators, and sometimes corporates. These sensors make possible localized, precise and continuous monitoring of emissions and/or air quality. However, the major issue with ground and airborne sensors is the difficulty of implementing these processes at scale and – for airborne sensors - with sufficient frequency. The second issue lies in the availability of data. These sensors are generally paid for by corporates directly, and data therefore remains private. Nevertheless, they remain an important monitoring tool.

A new generation of satellites have transformed emission monitoring

The most impactful hardware advance in recent years has been the launch of monitoring satellites with much improved resolution. For example, while the Aqua/Aura satellite launched by NASA in 2002 had a spatial resolution of 50km (i.e. in a picture captured with that sensor and displayed at full

resolution, each pixel represents an area of 50km x 50km on the ground), Sentinel-5P, part of the European Space Agency's Copernicus program and launched in late 2017, offers spatial resolution of c. 5km. A number of public and private initiatives are working towards the launch of further satellites to monitor greenhouse gas emissions (see Fig. 7), with spatial resolution expected to go down to 1km, or even as low as 10m for geostationary satellites.

MONITORING

GOSAT Japan Aerospace Exploration Agency	NASA	Clai GHG
2009	2014	201





FIG. 7: TIMELINE OF SATELLITE LAUNCHES DEDICATED TO EMISSIONS



Source: Bryan, Garnier & Co technology research



Software solutions are multiplying

A range of software solutions have been developed to make sense of all the data that is being collected. We have identified two categories:

 Data analytics solutions, which collect a huge array of data and apply proprietary algorithms to extract actionable insights. In this field, companies operating in a field called asset observation are emerging. Their solutions fuse data from a large array of sources, notably Earth observation satellites, with a focus on assets such as oil & gas wells and pipelines, refineries, coal mines, or any other industrial facilities.

 Sustainability platforms, which aggregate companies' operational data, estimate their impact from an ESG standpoint, and help set targets for the future. This category also includes companies such as SAP, whose climate 21 programme helps companies to monitor the carbon footprint of their supply chain, or Ecovadis, which is a broad ESG ratings platform aimed at corporates.

	User	Used for?	Pros	Cons
Sensors	 Corporations Local governments 	 Collection of local information 	 Very reliable data 	 Expensive and difficult to scale Limited access to data
Satellite	 Corporations Regulators Governments NGOs Investors 	 Collection of data on a very large/global scale 	 Ubiquitous Data is often public 	 Accuracy remains weaker than local sensors
Data analytics	 Corporations Regulators Governments NGOs Investors 	 Extract actiona- ble insights out of big data 	 Data fusion provides great- er insights and greater reliability 	 Often operated by data scientists only
Sustainability platform/ reporting	 Corporations 	 Monitoring of ESG/Sustaina- bility metrics 	 Often based on data coming directly from corporate ERP systems 	 Based on self- reported and/or estimated data

" TO TAX EMISSIONS, THEN YOU NEED TO KNOW WHAT THEY ARE, WHERE THEY ARE, WHO'S DOING IT "

Lord Browne of Madingley former CEO of BP, 28 July 2020, Kayrros and Bryan, Garnier & Co's webinar: Stopping methane: what are we waiting for?



FIG. 8: MAPPING OF THE ECOSYSTEM



Source: Bryan, Garnier & Co ests.

Investment remains mostly limited to the venture stage for now

In this part of the climate tech market, investment has this far

largely been limited to the venture stage, with only a few scale-ups emerging. However, we expect investment in this field to materially gain momentum in the upcoming years as regulatory requirements increase, investors demand more non-financial information from listed companies and consumers seek more transparency.

FIG. 9: RECENT DEALS IN THE SPACE

DATE	COUNTRY	TARGET	ACQUIRER/INVESTORS	TRANSACTION
Aug-20	US			Fundraising
Aug-20	US	overstory	PALE BLUE DOT	Fundraising
Jul-20	US	∛climacell	pitango Square Peg ^O	Fundraising
Jun-20	FR	ecoact	Atos	Acquisition
Jun-20	FR	envea	THE CARLYLE GROUP	Acquisition
Jun-20	US	Satelytics	Ö	Fundraising
Jun-20	CAN	GHGSat	∠ Investissement Québec	Fundraising
Apr-20	US	AEROSPACE	CCCC	Fundraising
Apr-20	US		Persei Venture	Fundraising
Apr-20	SWE	ClimateView	<norrsken></norrsken>	Fundraising
Apr-20	GER	.planetly	Si Speedinvest	Fundraising
Feb-20	FR	ecovadis	CVC CANTAL PARTINES	Fundraising
Feb-20	FR	s¢ CLS		Acquisition
Dec-19	US	Honeywell	FEBELLION	Acquisition
Dec-19	SWE	worldfavor	spintop brightly	Fundraising
Oct-19	US	Descartes Labs		Fundraising







Source: Bryan, Garnier & Co technology research

Asset Observation: a new paradigm for measuring and addressing climate change

Satellite imagery solutions such as the ESA's Sentinel-5 are already monitoring pollutants or greenhouse gas hotspots. And the release of new data from other satellites such as Tempo, Gems, Sentinel-4, GHGSat and MethaneSat is expected in the future. However, observing the concentration of a gas in one location is not enough to identify the emitting asset. Non-satellite-based solutions such as rolling out sensors and deploying inspectors throughout operational sites are neither costeffective nor available globally. For example, the prevention and abatement of methane leakage faces daunting challenges. Measurements rely heavily on ground sensors,

whose placement requires prior detection and identification of the leaks and more often than not, the emitters' consent.

However, several companies are working on solutions to accurately detect, quantify and attribute a source to emissions. For reliable and trustworthy measurements, emissions observations must be analyzed alongside industrial assets, using data fusion technologies and a combination of complex skills. This helps provide reliable, frequent, accurate, georeferenced and time-stamped information on the status of selected physical assets.

CASE STUDY

The asset observation skillset

- Industry knowledge: mapping of assets and facilities, and process understanding
- Remote sensing asset activity monitoring
- Atmospheric models and gas chemistry
- Machine learning and attribution models from concentrations to emissions





Here, the new paradigm of Asset Observation brings a definitive advantage. It leverages data analytics and Earth observation technologies, with an asset-centric approach. Asset Observation focuses on specific assets, collecting and fusing data from Earth observation satellites as well as aerial imagery, mobile operator data, IOT sensors, public data from the web and social networks. Only with a combination of multiple complex technologies and know-how is it possible to both detect emissions and identify the source.

The collection and fusion of data requires a deep understanding of the source data, robust data

science infrastructure to scale and automate the various processes, and scientific knowledge to interpret satellite imagery and structure the data. But Asset Observation also requires in-depth knowledge of the assets observed - for example what an industrial unit does and when it is active - as well as a fundamental understanding of the behaviour of GHG plumes, including the way they disperse based on wind data and chemical composition. Typical customers for these solutions include governments and public organizations, asset managers, rating agencies and industrials wishing to better monitor and control their environmental impact.

The impact of Asset Observation technologies will be significant in all business activities related to natural resources, such as oil & gas, energy and mining. But Asset Observation is also fueled by the urgency of moving to a cleaner and more efficient energy system. The main player in Asset Observation

FIG. 10: ASSET OBSERVATION

right now is Kayrros, a Paris-based scale-up company.

The first company to commercialize Asset Observation is likely to benefit from a tremendous first-mover advantage and become a reference in the market: trusted and endorsed by policymakers; identified as a provider of monitoring, reporting and enforcement tools; and becoming a chosen supplier for private sector buyers seeking to comply with their obligations.



Source: Bryan, Garnier & Co technology research



Conclusion

Planets are aligning. As regulators and consumers are pushing companies to better monitor their environmental impact, both hardware- and software-based solutions are creating the means to do it more cheaply, reliably and frequently than before. In particular, emerging deep-tech companies with expertise in asset observation are leveraging technological advances in the satellite ecosystem.

In the short-term, the focus should be on monitoring methane emissions, above all on large methane leaks from oil & gas operations, because identifying and fixing these could lead to a reduction in methane emissions the size of the combined carbon footprint of Germany and France.

These are still the early stages of investment in the climate tech field. But the increased focus on sustainability, especially in the aftermath of the Covid-19 pandemic, is likely to play in favour of these technologies.





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What gets measured gets managed





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