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2017, A RECORD YEAR FOR CLIMATE

OVERVIEW OF THE MAIN EXTREME METEOROLOGICAL EVENTS OF THE YEAR

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What was the financial cost of the extreme events that occurred in 2017?

Which parts of the world were the most heavily affected?

What impact have they had on society, transport infrastructures, the economy, energy production and the environment?

An increasing number of storms, heatwaves, droughts and even floods were experienced right around the world in 2017, and the significant economic impact of such events (over $400bn!) is forcing us to take note of what is happening. Carbone 4 has put together this summary of the meteorological events that occurred over the course of the year. This publication is designed to help players to realise just how great an impact climate change is having through a series of examples taken from all around the world.

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2017 - A RECORD-BREAKING YEAR!

2017 already holds the record for the highest costs incurred as a result of meteorological disasters ever. Those costs that it has been possible to estimate have reached over $400bn[1], and insurance companies have borne a significant part of these, amounting to some $135bn, according to Munich Re[2], which indicates that the trend is not likely to be reversed any time soon and that this level of impact can be expected to become the new norm.

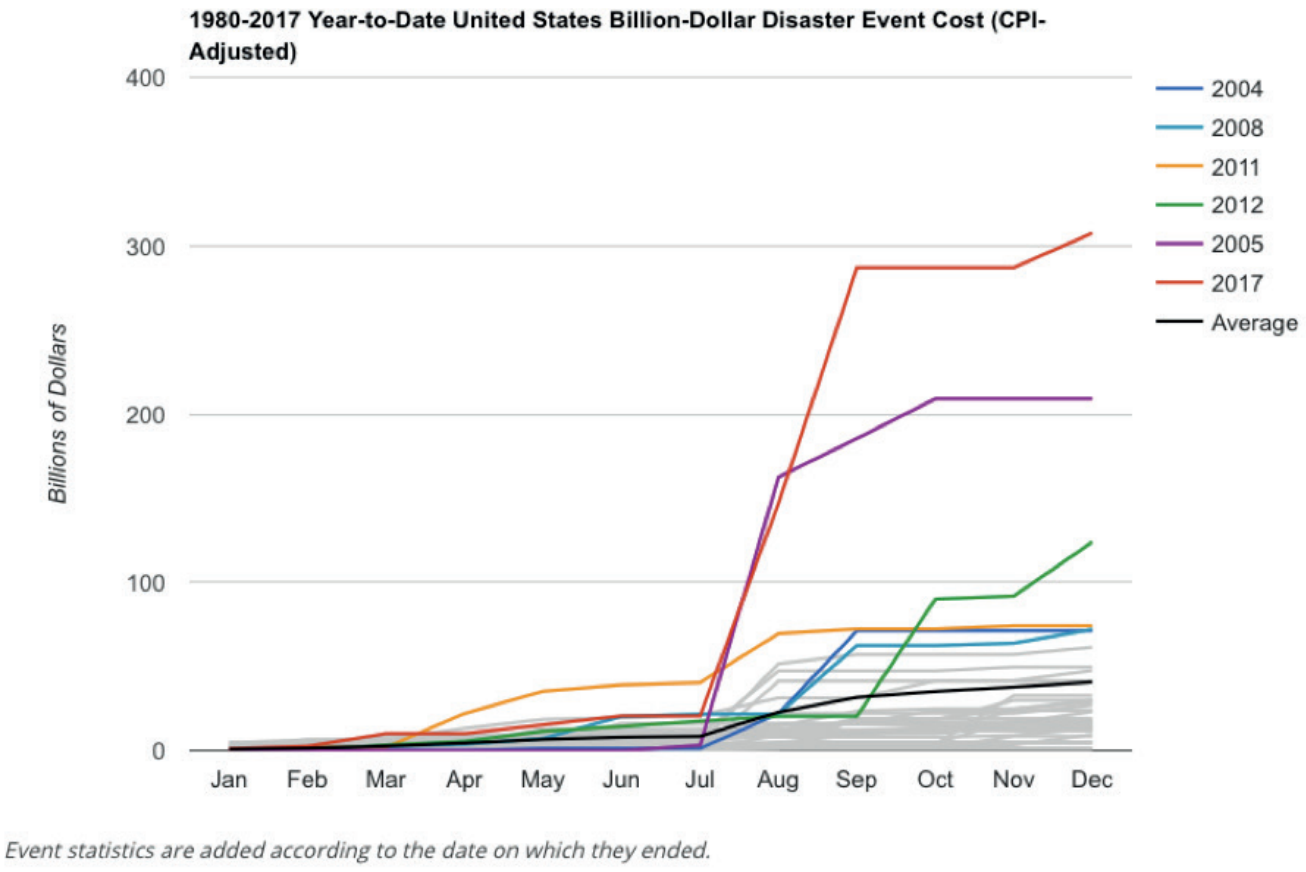

Figure 1: The cost of extreme natural events in the United States by year (NOAA)[3]

"the costs of meteorological disasters have never been so high, reaching over $400bn".

INTRODUCTION
2017 - A RECORD-BREAKING YEAR!

Second record: 2017 was the hottest year outside of El Niño conditions.
The El Niño phenomenon was very powerful in 2016, meaning that it still holds the records across all categories, but 2017 still makes the top three hottest years ever recorded, despite the fact that the phenomenon did not occur in this year.

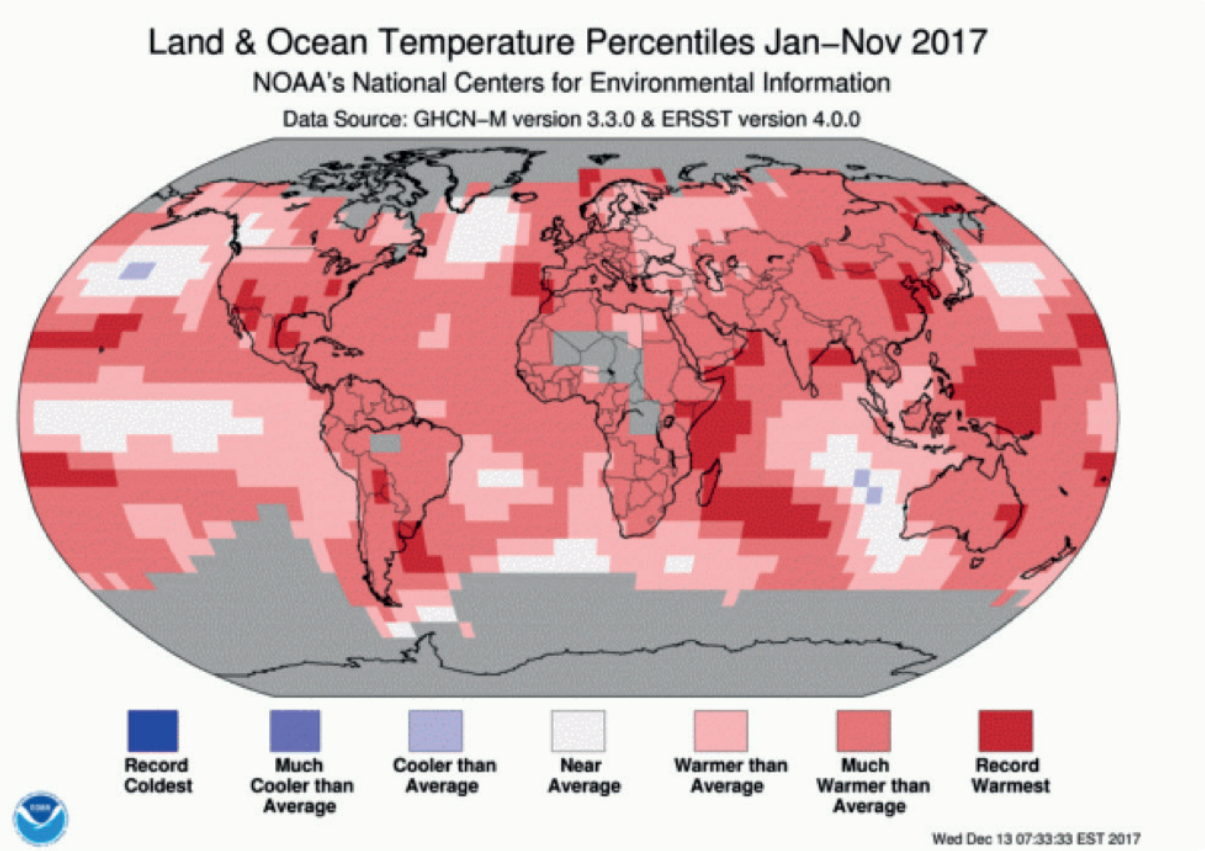

Figure 2: Temperature Land and Ocean in 2017 (Jan – Nov) NOAA

INTRODUCTION
2017 - A RECORD-BREAKING YEAR!

The effects of climate change are at the forefront of future risks, according to the Global Risks Report 2018 presented at the World Economic Forum in Davos. There is also a certain fear surrounding the major societal risks that often stem from the effects of climate change, including water crises, large-scale migration and food crises, among other things. With this in mind, Emmanuel Macron put climate change at the top of the list of challenges that require "a new global agreement" in the speech he gave in Davos on 24th January.

Figure 3: World Economic Forum - Global Risk Landscape 2018[4]

"From extreme meteorological events and natural disasters to our failure to mitigate the damage they cause and adapt accordingly, the effects of climate change are at the forefront of future risks, according to the Global Risks Report 2018 presented at the World Economic Forum in Davos".

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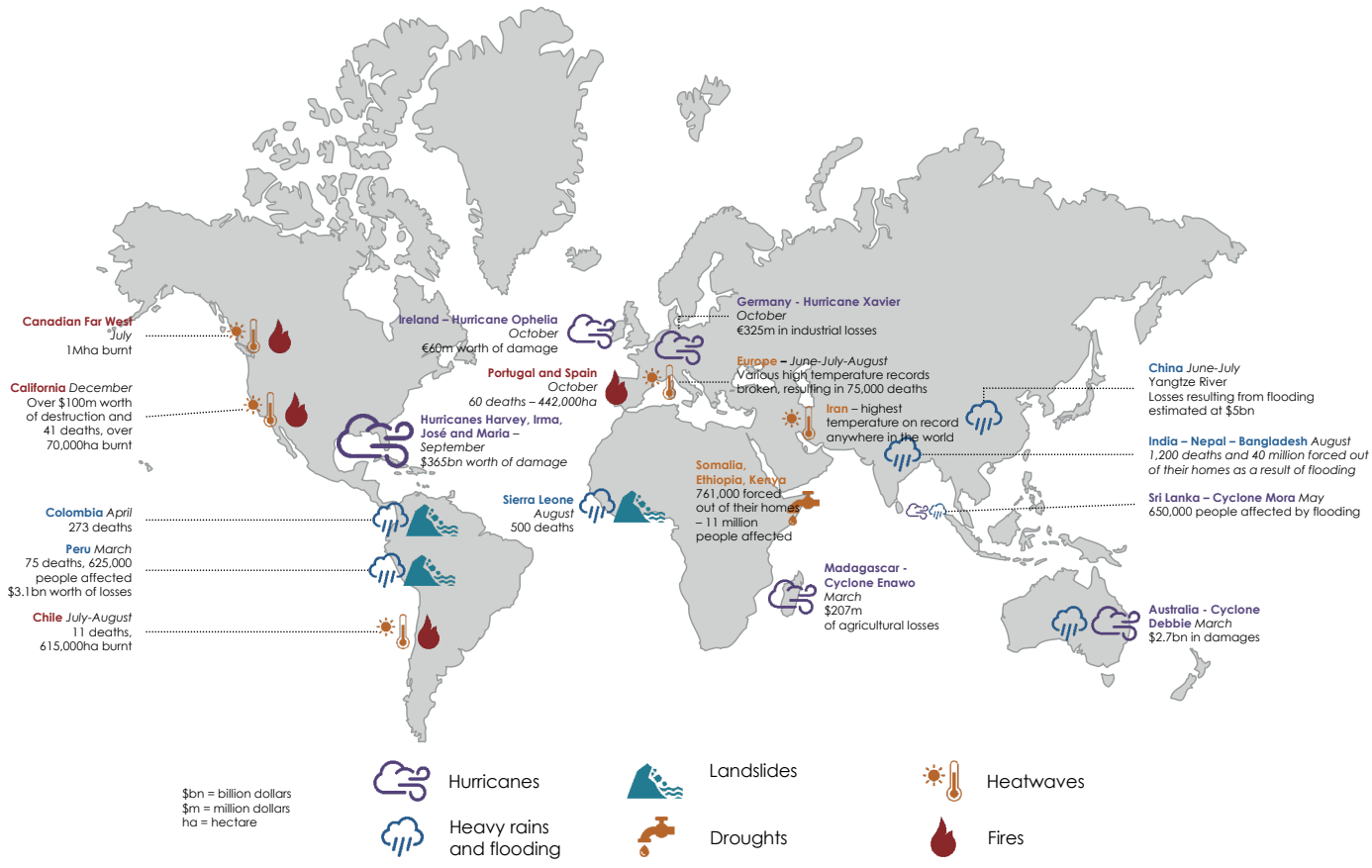
ALL PARTS OF THE WORLD AFFECTED BY VARIOUS EXTREME METEOROLOGICAL EVENTS

Map of the main extreme meteorological events of 2017



Source: Carbone 4, from multiple sources (see next page)

ALL PARTS OF THE WORLD AFFECTED BY VARIOUS EXTREME METEOROLOGICAL EVENTS

CYCLONES AND STORMS

In terms of cyclones and storms, 2017 was noteworthy for the sheer strength and proximity of a number of cyclones in the **Caribbean** and the south-east of the **United States** (Harvey, Irma and José), reaching a record cost of $265bn. Debbie hit **Australia**, causing some $3bn worth of damage[5] and Enawo ravaged **Madagascar**'s crops and infrastructures, causing $200m worth of destruction[6]. Storm Xavier caused €325m worth of damage in **Germany**[7], whilst an extra-tropical cyclone in the form of category-3 Ophelia came far enough north for the first time to hit **Ireland**.

FLOODS AND LANDSLIDES

There was no shortages of floods and landslides, either, with the **Peruvian** capital suffering damages amounting to $3bn[8] following heavy rains whilst the industrial **provinces** of southern **China**, close to the Yangtze, suffered damages amounting to some $5bn following major flooding[4]. 650,000 people in **Sri Lanka** were left suffering the long-term effects of intense flooding[4], whilst landslides in Mocoa, in **Colombia**[4], and in **Sierra Leone**[4] left 272 and 500 victims respectively in their wake. In **India**, **Nepal** and **Bangladesh**, some 40 million people were forced out of their homes[4] during one of the greatest episodes of flooding that left 35% of Bangladesh flooded[9].

EXTREME TEMPERATURES

Extreme temperatures also became amazingly intense and a number of high temperature records were broken in 2017 (the hottest summer in France since 1900[10], record temperatures in **Spain** and **Italy**[4], as well as in **San Francisco**, **Shanghai** and **Hong Kong**[4], **Chile** and **Argentina**), notably including the world record, set on 29th June in Ahwaz in **Iran** (53.7°C recorded), when the **Middle East** was experiencing extremely high temperatures.

PERIODS OF DROUGHT

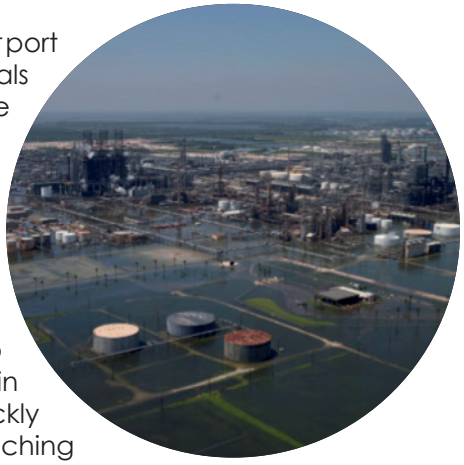
Last but not least, when it came to droughts and the resulting famines and fires, 2017 saw the worst for 35 years in **Somalia**, **Ethiopia**, **Kenya** and **South Sudan** (50% of crops and livestock lost, 800,000 people on the verge of famine by the end of November and 760,000 internally displaced)[11]. A $1bn loss was observed in Italy as a result of poor olive and almond crops caused by a record period of drought[4], and there was a similar situation in the **Balkans**, where it was estimated that **Bosnia** was going to lose up to 10% of its GDP[12]. A number of record-breaking fires were also observed in 2017, notably in **Canada** (1 million hectares burnt[4]), **Chile** (615,000 hectares[4]) and **Portugal** (60 dead and 3 times more land burnt than would usually be burnt over the course of the season[4]).

3 ECONOMIC SECTORS PARTICULARLY HEAVILY AFFECTED IN 2017

THE CONSEQUENCES OF STORM HARVEY ON INDUSTRY ON THE OUTSKIRTS OF HOUSTON (U.S.)

AN EXTRAORDINARY CONTEXT

As the 4th-largest city in the United States, Houston is known for its major port infrastructures (the 2nd-largest in the United States), its petrochemicals industrial park (the world's largest manufacturing site and also home to five of the six largest oil-producing companies) and its oil and metallurgical facilities.



Harvey reached the coast of Texas on the morning of **25th August.** The cyclone started to lose some of its strength as of 26th August and stagnated over the Houston area, causing very large amounts of rainwater to accumulate. The cyclone is, in fact, estimated to have dropped in the region of **127 billion tonnes of water** on Texas in a short space of time. The significant flooding that this caused quickly became widespread throughout the region, with water levels reaching up to 2m in some parts[13].

Photo source[28]

THE HEAVILY AFFECTED INDUSTRIAL REGION – LOSSES START TO MAKE THEIR PRESENCE FELT

Refining - The week before the cyclone hit, many Texan refineries were shut down, representing a 25% suspension[14] in America's oil capacity and resulting in a 21% drop in oil production[12]. The major disruptions that the cyclone caused to the city's port infrastructures also led to a 10% increase in the prices of oil and gas in just two days[15]. The damage that flooding can cause to a refinery takes quite a long time to repair, generally around several weeks. This meant that it took longer than it otherwise would have to return to business as usual once the cyclone had passed[14].

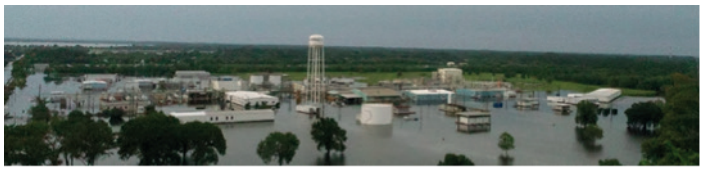
75% of **American ethylene production**, ethylene being the basic molecule used in the petrochemicals and plastics industries, takes place in Texas[16]. This, too, was reduced by 54% when the cyclone hit. The impact of this reduction was particularly great since the United States is one of the world's largest ethylene producers[17] and it would take weeks to return to pre-Harvey levels of production following the flood damage caused to the industrial infrastructures concerned[14].

Transport infrastructures were also disrupted. Generally speaking, all methods of transporting goods were challenged in the wake of Hurricane Harvey. River, sea, rail and road transport infrastructures all suffered delays, with a return to normal service expected to take several months in some cases [14].

10% of the region's employees driven from their homes – This resulted in delays and periods of under-staffing for many businesses and raised the issue of providing help and support for employees in the form of compensation or temporary accommodation, for example[14].

ECONOMIC SECTORS PARTICULARLY HEAVILY AFFECTED IN 2017

ARKEMA - A FRENCH CHEMICALS MANUFACTURER AT THE EYE OF THE CYCLONE



Source photo[24]

Arkema - a French manufacturer specialising in chemicals - has a large factory in Crosby, Texas, not far from Houston. News of the impending arrival of Hurricane Harvey led the site's managers to close it down as of 25th August[18], when the cyclone hit. Flooding submerged the site under two metres of water[19], causing its **refrigeration systems and electricity supply to malfunction.**

A number of organic peroxide stores became unstable as a result of the disruption to the refrigeration systems and caught fire[20] 6 days after Harvey struck, giving off **fumes that were harmful both to human health and to the environment**[21]**.**

'Liquids leaking from the stores into the surrounding waters forced the authorities to set fire to the remaining stores in order to prevent contamination. The regional authorities also took the decision to **evacuate the surroundings** in order to protect the local population.

No value has yet been put on the damage that Harvey caused[22]. Local populations have initiated **proceedings**[23] **against the French chemicals firm** for putting them in danger and **for failing to adequately protect the site against extreme flooding.**

Photo source[25]

ECONOMIC SECTORS PARTICULARLY HEAVILY AFFECTED IN 2017

HYDROELECTRIC PRODUCTION - AN EXAMPLE OF A SECTOR THAT IS VULNERABLE TO DROUGHTS AND FLOODS

THE RHÔNE - A RIVER OF GREAT SIGNIFICANCE TO THE HYDROELECTRIC SECTOR - FALLS PREY TO DROUGHT[26]

The drought that struck the Rhône river basin in 2017 significantly reduced the river's flow, suffering its **13th consecutive month of drought** by the end of November. As of January 2017, its flow had fallen to just 300m³/s (as opposed to the usual 1100m³/s), giving the lowest readings ever recorded (the first records dating back to 1920).

The Rhone itself is interspersed with **19 dams**, accounting for around 3% of France's electricity production.

These historically low flows led to **a reduction of around 30% in hydroelectric production** in relation to the average for the past ten years.

This is likely to have had an economic impact on the *Compagnie Nationale du Rhône*, the company that operates the dams, although it also caused various other inconveniences, such as the drops in voltage experienced by certain manufacturers in the region.

WITH THE WORLD'S LARGEST DAM, IN CHINA, RUNNING AT REDUCED CAPACITY, THE COAL INDUSTRY CASHES IN![27]

In early July 2017, the basin of China's Yangtze River (the longest river in Asia) experienced heavy rains that resulted in major flooding. This rainy region, which boasts significant hydroelectric production capacities, is home to **two major dams, including the Three Gorges Dam** - the most powerful in the world, with a capacity of 22.5GW. Both dams had their production levels reduced in order to limit the amount of water coming into the flooded regions and consequently relieve the pressure on the disaster-struck region a little. **This intentional 66% reduction in production was unprecedented.**

With hydroelectricity being the second-largest source of electricity after coal, **this reduction resulted in a dozen or so major coal-fired power plants being fired up** in an attempt to compensate and meet the demand for electricity.

Chinese demand for coal, along with the price thereof, soared, with Australian exports reaching their highest levels of the year.

4 OUTLOOK AND RECOMMENDATIONS

Current greenhouse gas emission trajectories have already put us on course to reach future temperatures of +3 or +4°C, where we can expect to experience more heatwaves in Europe, more powerful periods of drought in the Mediterranean, more violent tropical storms in the Southern Indian Ocean, more frequent intense rainfall in Asia,… Basically, the climate disruption that we are experiencing today is only going to get worse, and in order to deal with such events, or at least prepare for them as best we can, we have to be able to anticipate them. In order to anticipate them, of course, we have to be able to identity and assess them.

Carbone 4 has developed an innovative risk assessment method designed to help us understand the most critical hazards that apply to all countries and all business sectors.

Carbone 4 has developed the method for portfolios of corporate, infrastructure and sovereign financial assets ('CRIS' method) and also works directly with businesses (manufacturers, property companies, infrastructure managers, etc.) seeking to gain a better understanding of their main vulnerabilities and the solutions they need to implement in order to increase their businesses' resilience to climate change.

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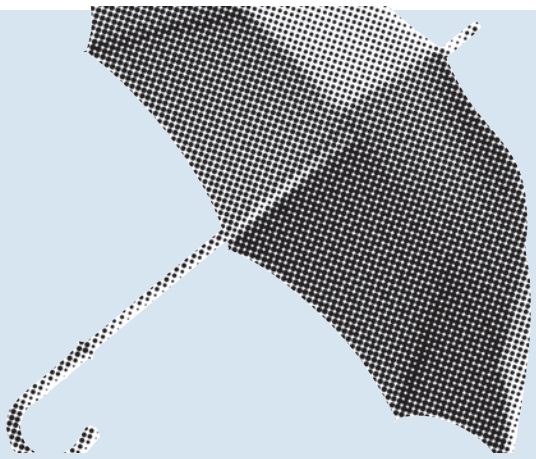
Founded in 2007 by Alain Grandjean and Jean-Marc Jancovici, Carbone 4 is an independent consultancy firm and leader in climate strategy, specialising in energy transition and climate change. Our team assists companies in their transition to a low carbon and climate resilient economy.



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