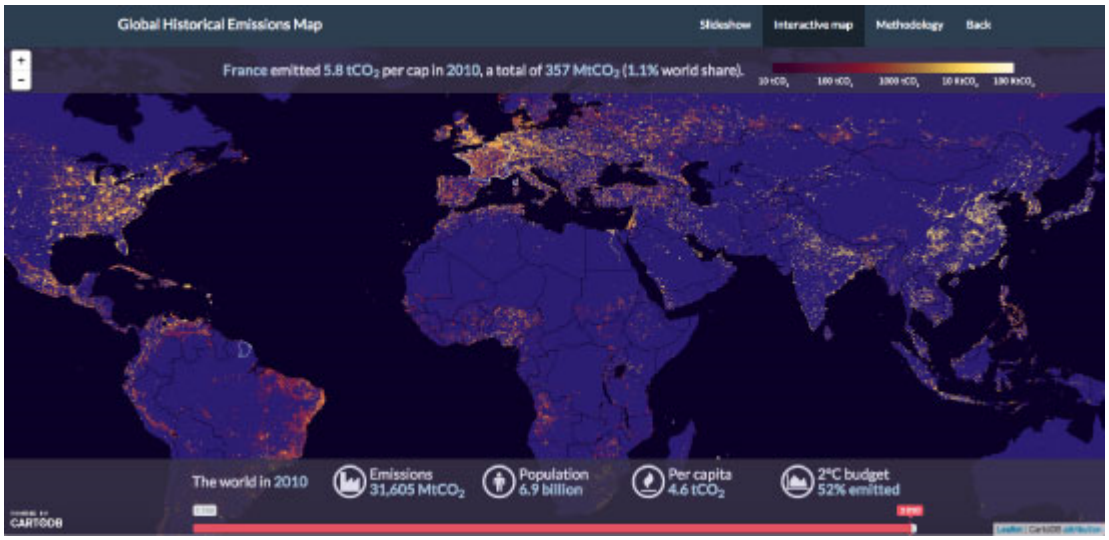
From the suburbs of London to global conflagration: a brief history of emissions

By Aurélien Saussay

A new interactive map of global CO2 emissions from 1750 to 2010 is helpful in understanding the historical responsibilities of the world's different regions for the climate crisis.

The 21st Conference of Parties (COP 21) ended on 12 December 2015 with a historic agreement. As 195 countries come to an accord on the need to limit global warming to 2 degrees by the end of the century, it is a good time to review the history of CO2 emissions since the beginning of the Industrial Revolution. Right to the end of the negotiations, the question of the historical responsibility of the different countries has remained one of the main obstacles blocking the path to a global climate agreement. The recently industrialized emerging countries and the developing countries that are just beginning their economic take-off rightly refuse to provide efforts comparable to those of the developed countries.

This feeling is confirmed by a new interactive map retracing 260 years of CO2 emissions from fossil fuel combustion and cement production on the surface of the planet[1]. This map can be used interactively to explore the emissions of each country and their distribution in space over the last two centuries, both in their entirety and per capita. It can also be used to follow trends in global emissions and the gradual consumption of the total carbon budget for holding global warming to below 2 degrees.



By combining historical data on emissions per country issued by the CDIAC (from 1750-2010) with decadal data on population density produced by the European HYDE project (also 1750-2010), it is possible to estimate the distribution of emissions over space and time around the planet's surface – on a grid with a resolution of 5' of arc (5′ being equal to 1/12th of a degree, i.e. about 10 km by 10 km at the equator).

This interactive map shows the contribution of each of the world's regions since the mid-18th century – while at the same time offering a gripping account of the gradual spread of the industrial revolution over the last two centuries.

These data illustrate several key points that help to understand the debate about differentiated historical responsibilities:

– Up to the mid-20th century, only Europe and the United States (and to a lesser extent Japan) contributed significantly to global emissions.
– It was only in the last 30 years that, led by China, the rest of the world "turned on".
– Driven by rapid economic growth in the emerging countries, emissions have taken off in the last fifteen years.
– When weighted by distribution of the world population, emissions are highly concentrated spatially. This conclusion

is bolstered when using even finer data, notably the location of power stations and the most energy-consuming manufacturing plants (cement, aluminium, and paper, for example).

This brief history of CO2 emissions across the globe reminds us of the West's special responsibility in the fight against global warming. The precocity of the Industrial Revolution in the West allowed the economy to take-off much earlier than in the rest of the world, but it also led to the emission of a disproportionate share of the total emissions budget that we are entitled to if we are not to exceed the target of two degrees of warming.

This differentiated historical responsibility, which was recognized by the Paris Agreement, requires Western countries to make a special effort in the fight against global warming. This responsibility must thus be reflected in a greater effort in terms of financial and technological transfers so as to ensure that the emergence of the developing countries minimizes the use of fossil fuels, without hindering their economic take-off.

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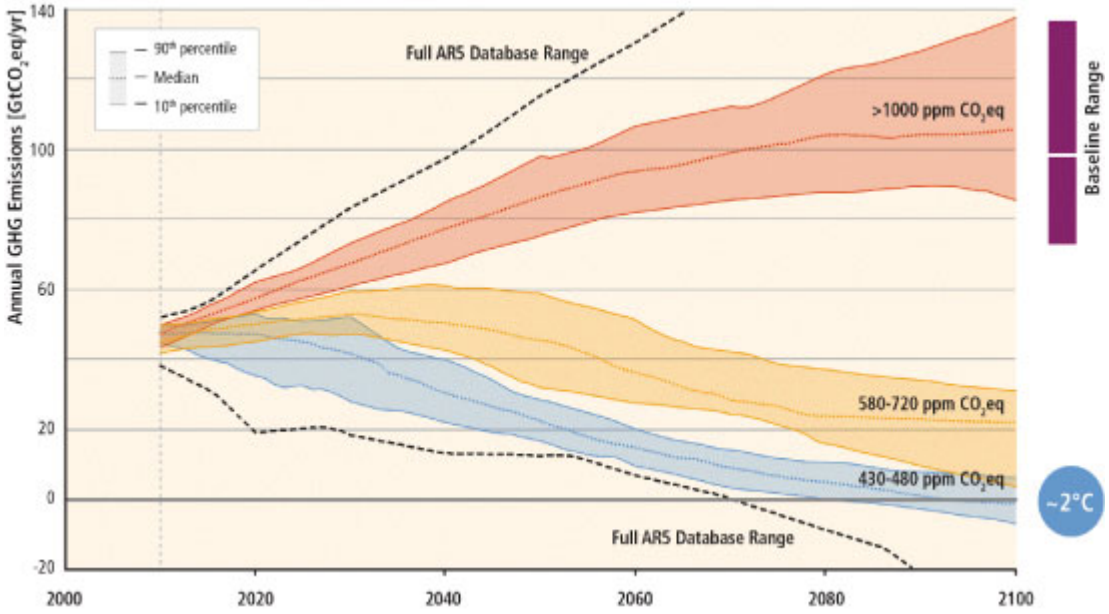
[1] These emissions do not include emissions from changes in land use (LUCLUF) or fertilizer use. Unfortunately, it is very difficult to reconstruct these emissions for the period under consideration.

The end of oil and coal

By Xavier Timbeau

The idea that we must put an end to the use of oil and coal is not new. It has been pushed for a long time by NGOs like 350.org and its gofossilfree campaign. What is more striking is that the Democratic primary candidate Senator Bernie Sanders has put the proposal at the heart of the US presidential election debate. Institutional investors and large fund holders have also announced their intention to limit or terminate their investments in coal (for example, Allianz and ING) and oil (the Dutch pension fund ABP). The urban development policies of some large cities are also leaning in that direction. Asked about this option, the head of the US Environmental Protection Agency (EPA), Gina McCarthy, noted (cautiously) that this option was not irrational.

Figure: Scenarios of CO_2 emissions



Source: Figure SMP 11, AR5, IPCC, p. 21.

That said, Figure SPM 11 of the 5th IPCC report says much the same thing. If global warming is to be kept to 2 degrees, our

carbon budget since 1870 amounts to 2900 ± 250 GtCO2e; we have consumed around 1900 GtCO2e up to now. So staying below the 2°C level (relative to pre-industrial times) with a probability of 66% leaves about 1000 GtCO2e. Given an annual flow of emissions of about 50 GtCO2e, a simple rule of three give us 40 years of linearly decreasing emissions. The inclusion of carbon sinks, climate inertia and negative radiative forcings on the climate extends the time horizon to 2090 ± 10 years, but it would be prudent to get down to zero emissions earlier. For the record, there are still about 5000 ± 1400 GtCO2 of recoverable reserves in coal alone, enough to greatly exceed our current carbon budget. Note that stopping the use of fossil fuels does not solve everything. A portion of current greenhouse gas emissions (of CO2, but also of methane and other gases) is not linked to fossil fuels but to farming, deforestation and industrial processes. In the case of a nearly 100% system of renewable energy, the gas would be necessary during consumption peaks. These non-fossil emissions can be cut down, but not eliminated. It is possible to have negative emissions, but the only "technology" available today is reforestation, which can help lower emissions by only 2 GtCO2 annually. Carbon capture and storage is also a way to conserve the use of fossil fuels provided that it works and that it has enough storage capacity (once the storage capacity is depleted, the problem remains).

The principle of "common but differentiated responsibility" would lead the developed countries to apply constraints more quickly (by say around 2050). Some see this prospect as the explanation for the fall in oil prices. Since not all fossil fuel reserves will be burned, the only ones worth anything are those that will be exploited before 2050, meaning that this price is lower than what would result from rising demand. Saudi Arabia therefore has an interest in increasing production rather than keeping worthless reserves. Mark Carney, Governor of the Bank of England and Chairman of the Financial Stability Board, has evoked "stranded reserves" in

the same way that a coal plant is a “stranded asset”, i.e. a blocked asset that has to be depreciated prematurely.

The end of oil and coal is no longer just a fad of a handful of green activists. This is also seen in the persistent and nearly convergent calls of many economists about a carbon price. A high and rising price of carbon would force economic agents to disinvest in the capital that emits carbon or even to prematurely depreciate existing facilities. When a high carbon price is demanded (say between 50 and 100 € / tCO2, with the price of carbon steadily increasing over time as the carbon budget runs out), the point is that this sends a strong price signal to economic agents, with the consequence of this price being that emissions are reduced in an amount consistent with warming of less than 2°C compared to pre-industrial times. So, from this viewpoint, saying that “the price of carbon should be 50 € / tCO2 or more” is equivalent to saying “everything must be done so that we stop using coal and oil within the next half century”. The price of carbon thus gives us valuable information about the cost of the transition. It will be on the order of (a few) 1000 billion euros per year (on the scale of the global economy). Proposing a price means proposing the “polluter pays” principle (carbon emitters must pay), even though it is not clear exactly whom the polluters must pay. Hence the debate on the Green Fund and climate justice that is at the centre of COP21.

It would be a shame to focus on the carbon price and make it the central issue of COP21. A zero-carbon economy is our future, and we will have no excuses if we continue to burn fossil fuels. As Oscar Wilde remarked: “Nowadays people know the price of everything and the value of nothing.”

Investing in the zero carbon economy in order to escape secular stagnation

By Xavier Timbeau

What the downward revisions of various forecasts (IMF, OECD, OFCE) presented in early autumn 2015 tell us about the euro zone is not very comforting. A recovery is underway, but it is both sluggish and fragile (see: "A very fragile recovery"). The unemployment rate in the euro zone is still very high (almost 11% of the labour force in the second quarter), and a sluggish recovery means such a slow fall (0.6 point per year) that it will take more than seven years to return to the 2007 level. Meanwhile, the European Central Bank's unconventional monetary policy is having difficulty re-anchoring inflation expectations. The announcement of quantitative easing in early 2015 pushed up the 5-year/5-year forward inflation rate [1], but since July 2015 the soufflé has collapsed once again and medium-term expectations are 0.8% per year, below the ECB target (2% per year). Underlying inflation has settled in at a low level (0.9% per year), and there is a high risk that the euro zone will be frozen in a state of low inflation or deflation, strangely resembling what Japan has experienced from the mid-1990s to today. Low inflation is not good news because it is triggered by high unemployment and slowly rising nominal wages. The result is real wages growing more slowly than productivity. Little or no inflation means both real interest rates that remain high, which increases the burden of debt and paralyzes investment, but also an unconventional monetary policy that undermines the ability to measure risks and which gradually loses its

credibility for maintaining price stability, i.e. to keep inflation within declared targets. At the Jackson Hole Symposium in August 2014, Mario Draghi announced that, in the face of persistent unemployment, monetary policy cannot do everything. Structural reforms are necessary (what else could a central banker say?). But a demand policy is also needed. Not having one means running the risk of secular stagnation, as was formulated by Hansen in the late 1930s and recently brought up to date by Larry Summers.

Europe does not, however, lack investment opportunities. The COP21 commitments, though timid, assume a reduction in CO2 emissions (equivalent) per capita from 9 tons to 6 tons within 15 years, and investment will need to pick up pace in a big way if the change in global temperature is not to exceed 2°C. This means aiming to put an end to the use of petroleum and coal (or the large-scale development of carbon capture and storage) within 35 years. Achieving this will require investment on a massive scale, which is estimated in the European Commission's Energy Road Map at over 260 billion euros (nearly 2% of GDP) per year by 2050. The social profitability of such investments is substantial (since it helps to avoid climate catastrophe and makes it possible to meet the EU's commitments to the world's other countries), but – and this is the problem posed by our sluggish recovery – their private profitability is low, and uncertainty about future demand together with poor coordination could give pause to the "animal spirits" of our entrepreneurs. Secular stagnation results from the very low profitability of investments, particularly after taking into account the real rates anticipated and the risk of a more serious depression. To avoid this trap, the social returns on investment in a zero carbon economy need to become evident to all, and in particular they need to coincide with private returns. There are numerous tools that can do this. We can use carbon pricing and markets for trading in emission rights; we can use a carbon tax; we can develop certificates for new investments

(assuming we know how to ensure that they reduce CO2 emissions compared to an opposing counterfactual) or impose standards (if these are followed!). The difficulties of the transition and the acceptance of a relatively painful change in prices can be eased by compensatory measures (which have a budgetary cost, see Chapter 4 of the IAGS 2015 report, but are part of the stimulation package). It might also be desirable to draw on monetary policy to amplify the stimulus (see this proposal by Michel Aglietta and Etienne Spain). The implementation of artillery like this to reduce emissions and boost the European economy is not straightforward and would require wrenching the institutional framework. But that's the price to pay in order to avoid sinking into a long period of stagnation which, with the inequalities and impoverishment that it would generate, would certainly break up the European project.

This text was published on *Alterecoplus* on 22 October 2015.