XXXIII UNIVERSITAT D'ESTIU D'ANDORRA
DEL 29 D'AGOST A L'1 DE SETEMBRE DEL 2016

Sessió del 1 de setembre del 2016

# Fighting climate change and the social cost of carbon

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**Per citar aquest article / Para citar este artículo / Pour citer cet article :**

GOLLIER, Christian. «Fighting Climate Change and the Social Cost of Carbon» [en línia], a: Universitat d'Estiu d'Andorra (33a : 29 d'agost - 1 set., 2016 : Andorra la Vella). *Transformar el nostre món, l'agenda 2030 per al desenvolupament sostenible = Transformar nuestro mundo, la agenda 2030 para el desarrollo sostenible = Transformer notre monde, l'agenda 2030 pour le développement durable*. Andorra: Govern d'Andorra. Ministeri d'Educació i Ensenyament Superior. Universitat d'Estiu d'Andorra, 2018, p. 102-112 (978-99920-0-856-0) <http://www.universitatestiu.ad/UEA2016>

# 1. This is the Tragedy of the Commons!

Despite the emergence over the last three decades of solid scientific information about the climate impacts of increased $CO_2$ concentration in the atmosphere, the world's emissions of Greenhouse Gases (GHG) have risen (see Figure 1), due mainly to economic and population growth and to the dearth of actions to fight climate change.

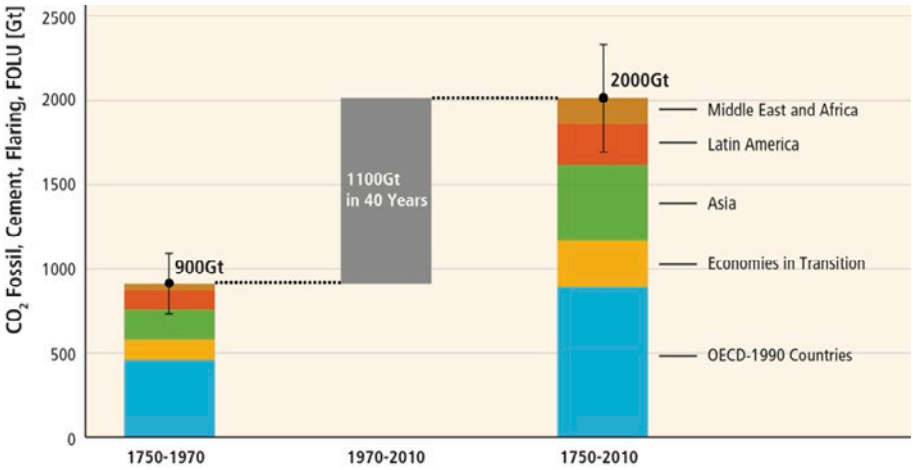


Figure 1: Emissions of CO2 since 1750. Source: IPCC (2014).

The 5th Report of the IPCC (IPCC 2014) estimates that the average temperature would increase by somewhere between 2.5°C and 7.8°C by the end of this century, after having already increased by almost 1°C over the last century. Two degrees Celsius is the target that countries have agreed on since 2010, and the minimum point after which the scientific community considers catastrophic climate change inevitable. Limiting the increase in temperature to 2°C is an immense challenge. It will require radical transformations in the way we use energy, we heat and locate our houses, we transport people, and we produce goods and services.

The geographic and temporal dimensions of the climate problem account for the current inaction. The Paris Agreement of December 2015 has not solved the problem.

Most benefits of mitigation are *global* and *distant*, they may go to other countries. While costs are local and immediate, the individual incentives for a

country to act are negligible. Consequently, countries do not internalize the benefits of their mitigation strategies. The free-rider problem is well-known to generate the "tragedy of the commons" (Hardin 1968).

A country or region which would contemplate a unilateral mitigation strategy would be further discouraged by the presence of the so-called "carbon leakages". Namely, imposing additional costs on high-emission domestic industries makes them non-competitive. This tends to move production to less responsible countries, yielding an international redistribution of production and wealth with negligible ecological benefit. Similarly, the reduction in demand for fossil energy originating from the virtuous countries tends to reduce their international price, thereby increasing the demand and emissions in non-virtuous countries. This other carbon leakage also reduces the net climate benefit of the effort made by any incomplete club of virtuous countries.

Its intertemporal version is called the green paradox. This states that a commitment to be green in the future leads oil producers to increase their production today to cater to today's non-virtuous consumers. Since carbon sequestration is not a mature technology, mitigation is a threat to the fossil fuel producers. They should be expected to react to this threat.

Eliminating or reducing revenue from oil and other fossil fuel is one of the most difficult challenges. This challenge comes from the existence of a large fossil fuels reserves and their associated revenues in resource-rich countries (see Figure 2). In a business-as-usual scenario the burning of the entire stock of fossil resources on this planet within the next two centuries or so would certainly devastate our planet by raising GHG concentration way above the acceptable limits. If an efficient and credible climate policy were to be implemented one day, this would imply the annihilation of fossil fuel revenue and the consequent generation of an economic surplus for all of society to be shared among the world's citizens.

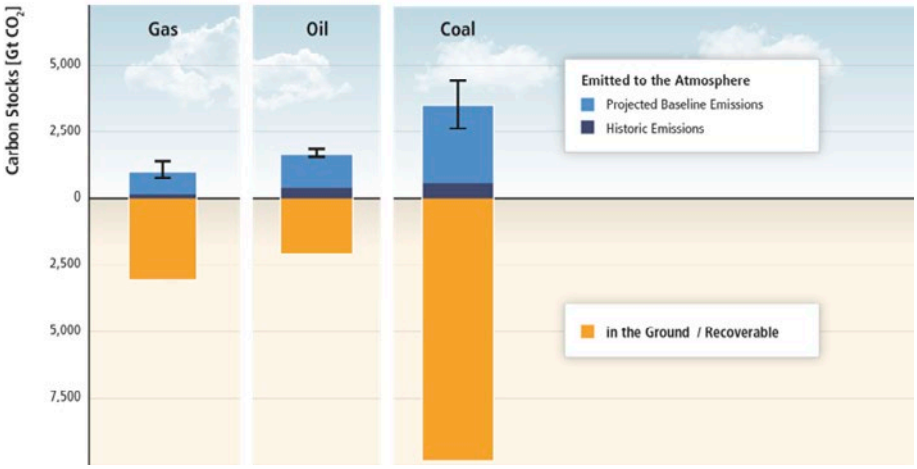


Figure 2: Past consumption and current reserves of fossil fuels. Source: IPCC (2014).

The political economy of climate change however is unfavorable: the costs of any such agreement are immediate whereas most benefits will occur in the distant future, mainly to people who are not born yet and obviously do not vote. In short, climate mitigation is a long-term investment. Why would countries sacrifice the consumption of goods and leisure to be environment-friendly? The reality is bleaker, in particular for economies in crisis and in the developing world. Fighting climate change diverts economic growth from consumption to investment, not good news for the wellbeing of the current poor.

Countries may act when they perceive some limited "co-benefits" of climate-friendly policies. For example, green choices may also reduce emissions of other pollutants (coal plants produce both $CO_2$ and $SO_2$, a regional pollutant) and could have enormous health and environmental benefits. Some actions are to be expected from countries with an eye only on the national interest, but those will be far from sufficient to generate what it takes to keep global warming manageable.

Overall, fighting climate change yields short-term collective costs, thereby creating a political problem for benevolent decision-makers who support an ambitious international agreement. It is collectively efficient to act, but individually optimal to do little.

## 2. A uniform carbon price is necessary

The core of the climate externality problem is that economic agents do not internalize the damages that they impose on other economic agents when they emit GHGs. The approach that economists have long proposed to solve the free-rider problem consists in inducing economic agents to internalize the negative externalities that they impose when they emit $CO_2$ ("*polluter pays principle*" or economic approach). This is done by pricing it at a level corresponding to the present value of the marginal damage associated to the emission, and by forcing all emitters to pay this price. The resulting price is the implicit price of carbon. All tons of $CO_2$ should be priced equally as GHGs generate the same marginal damage regardless of the emitter and of the nature and location of the polluting activity. By imposing the same price on all economic agents around the world, all actions to abate emissions that cost less than that price should be implemented. This least-cost approach minimizes the global cost of reducing emissions.

In contrast to this economic approach, Western countries have made some attempts at reducing GHG emissions, notably through direct subsidization of green technologies: generous feed-in electricity tariffs for solar and wind energy, fuel efficiency standards, subsidies to the biofuel industry, etc. These "command-and-control" approaches are not based on actual pollution and usually create wide discrepancies in the implicit price of carbon put on different emissions. In the electricity sector, OECD (OECD 2013) estimates that these implicit prices vary widely across countries ranging from less than $0 to $900. In the road transportation sector, the implicit carbon price can be as large as $1,000, in particular for biofuels.

This high heterogeneity of implicit carbon prices is inefficient and has been shown empirically to lead to substantial increases in the cost of environmental policies. Similarly, any global agreement that would not include all world regions in the climate coalition would exhibit the same inefficiency by setting a zero carbon price in non-participating countries.

Command-and-control policies should be best avoided, although occasionally they are a second-best solution, easier to implement when direct pricing is complex and/or when consumers discount the future too much.

Income inequality is also an important issue to implement a uniform carbon pricing as international inequality raises the question of the allocation of the climate-mitigation burden. The Kyoto Protocol's attempted solution to the equity problem was to exonerate non-Annex 1 countries (those that did not commit to the aim of reducing GHG emissions) from carbon pricing. The Clean Development Mechanism (CDM) in the Kyoto Protocol was designed to alleviate the imperfect coverage problem; it met with limited success and was not a satisfactory approach due to yet another leakage problem. For example, participating countries paying to protect a forest in a less developed country increases the price of whatever the deforestation would have allowed it to sell (beef, soy, palm or wood) and encourages deforestation elsewhere. The CDM mechanism also created the perverse incentive to build, or maintain in operation longer than planned, polluting plants in order to later claim $CO_2$ credits for their reduction.

The best way to implement a uniform price of carbon is the so-called cap-and-trade strategy. Under this solution, the agreement would specify a worldwide, predetermined number (the cap) of tradable emission permits. The tradability of these permits would ensure that countries face the same carbon price, emerging from mutually advantageous trades on the market for permits; the cross-country price would not result from an agreed price of carbon, but rather from the price determined by the demand and supply of emission permits. To address compensation, permits would be initially allocated to the different countries or regions, with an eye on getting all countries on board (redistribution).

The cap-and-trade system was adopted, albeit with a failed design, by the Kyoto Protocol. Sadly enough, the Kyoto Protocol was a failure. Non-participating countries benefited from the efforts made by the participating ones, both in terms of reduced climate damages (free-rider problem) and in terms of improved competitiveness of their carbon-intensive industries (carbon leakage). Kyoto participants covered more than 65 % of global emissions in 1992 but less than 15 % in 2012.

The main attempt to implement a carbon pricing mechanism within the Kyoto agreement emerged in Europe, with the EU Emission Trading Scheme (EU ETS). Its initial design evolved to reduce emissions of the industrial and electricity sectors of the Union; however, the demand for permits has decreased over the years. The use of Kyoto offsets (mostly from the CDM) for compliance,

the deep economic crisis that hit the region during 2008 and 2009, and the large subsidies in the renewable energy sector are among the reasons for this reduction. Absent any countervailing reaction on the supply of permits, the carbon price went down from a peak of $36/tCO_2$ to around $6.5- $9/tCO_2$ today. This recent price level is without any doubt way below the social cost of carbon. It therefore has a limited impact on emissions and worse, it let electricity producers replace gas by coal[1] which emits 100 % more carbon (not counting dirty micro particles) per kWh. During the third trading period (2013-2020), the EU-wide cap on emissions was reduced by 1.74 % each year, and a progressive shift towards auctioning of allowances in substitution of cost-free allocation is implemented.

Over the last three decades, Europeans have sometimes believed that their (limited) commitment to reduce their emissions would motivate other countries to imitate their proactive behavior. That hope never materialized. Outside the Kyoto Protocol, the US, Canada and China established some regional cap-and-trade mechanisms. In the US, two initiatives are worth mentioning. In the Regional Greenhouse Gas Initiative (RGGI), 9 Northeast and Mid-Atlantic US states created a common cap-and-trade market to limit the emissions of their electricity sector. Here also, the current carbon price is way too low at around $5/tCO_2$ (up from the price floor level of $2/tCO_2$ during the period 2010-2012). Over the period 2015-2020, the $CO_2$ cap will be reduced by 2.5 % every year. The system will release extra carbon allowances if the carbon price on the market exceeds $6/tCO_2$. A similar system exists in California to cover the electricity sector, large industrial plants and more recently fuel distributors, thereby covering more than 85 % of the state's emissions of GHGs[2]. In 2014 China established 7 regional cap-and-trade pilots, officially to prepare for the implementation of a national ETS scheme. The fragmented cap-and-trade systems described above cover almost 10 % of worldwide emissions, and observed price levels are too low to generate meaningful GHG savings. This is another illustration of the tragedy of the commons.

1 In Germany for example, gas was displaced by coal after the closure of nuclear plants

2 Since early 2014, this market has been linked to a similar one established by the Province of Quebec. The current price of permits in California is $12/tCO2, at the minimum legal price. This fragmented scheme illustrates the strange economics of climate change in the US, where the minimum carbon price in California is larger than the maximum carbon price in RGGI.

Some countries have implemented a carbon tax (see Figure 3). The most aggressive of these taxes is in Sweden, where a carbon tax of approximately $\$131/tCO_2$ was implemented in 1991. France has fixed its own carbon tax at $\$19/tCO_2$. Both of these taxes are used for various purposes, such as raising revenue or addressing congestion externalities and road safety. They can also be used to comply with an international commitment to cap-and-trade or to a carbon price. Outside Europe, some modest carbon taxes exist in Japan and Mexico. Except for the Swedish case, these attempts set a carbon price that is far too low compared to the SCC (see Figure 3). As I explain in the second digest of these series, the SCC should be close to $\$40/tCO_2$.

Last December, the COP21 Paris buried the possibility of a universal price of carbon amid splendid general indifference. Suffice it to say that Venezuela and Saudi Arabia considered this as an unacceptable policy, thereby suggesting that these countries believe with "prominent" economists that this was not a credible mechanism.

In spite of the mounting evidence about global warming, the international mobilization has been most disappointing. The Kyoto Protocol and the Paris Agreement failed to build an international coalition supporting a carbon price in line with its social cost and illustrate the intrinsic instability of any international agreement that does not seriously address the free-rider problem. An international agreement must satisfy three properties: economic efficiency, incentive compatibility, and fairness. Efficiency can be attained only if all countries face the same carbon price. Incentive compatibility can be attained by penalizing free-riders. Fairness, a concept whose definition differs across stakeholders hidden behind a veil of ignorance, can potentially be reached through lump-sum transfers.

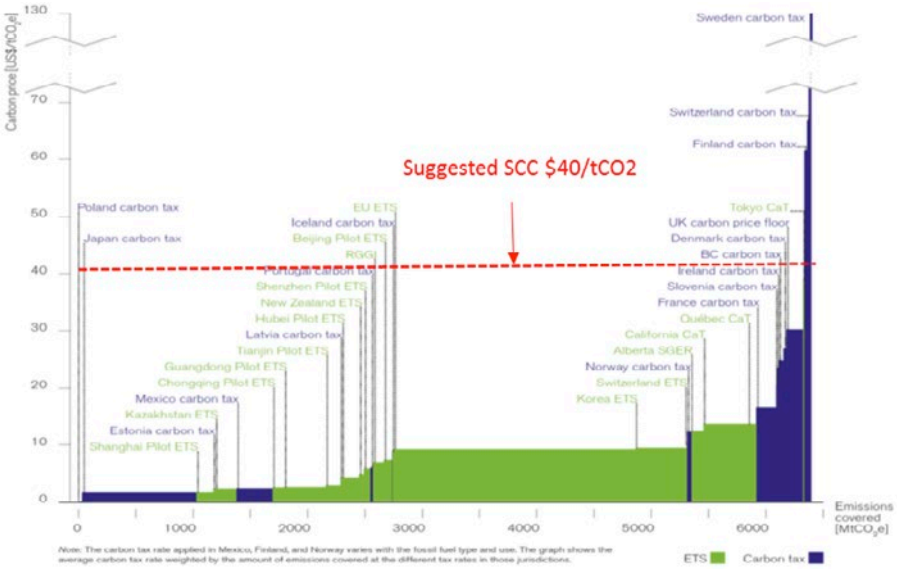


Figure 3: Carbon Price and Emissions Coverage of Existing Carbon Pricing Instruments. Source World Bank (2015), SCC from author (hyperlink to Digest 2)

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