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THE PARIS CLIMATE AGREEMENT: LET THE NEGOTIATIONS BEGIN!

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Adopted in plenary session on 12 December 2015 by the 196 Parties meeting under the auspices of the United Nations, the Paris Agreement was a success for French diplomacy. Twenty-five years after the start of the negotiations, the international community has established a new framework for applying the 1992 Climate Convention, with a view to accelerating cooperation to combat climate disruption. Can the diplomatic success in Paris end the "slow race" (Dahan and Aykut (2015)) or "waiting game" (Tirole and Gollier (2015)) of negotiations?

The Agreement's wager is that the new framework for cooperation will generate virtuous competition in terms of climate policies, which will penalize the "lowest bidder" and reward the "highest bidder". Such a dynamic would gradually increase the ambition of the contributions submitted by each country to the common basket and thereby produce an emissions trajectory limiting the risk of average warming to 2°C or even 1.5°C. The intention is laudable. In the absence of agreement on the instruments to be used, its implementation is contingent on the willingness of governments, the proactivity of stakeholders and the pressure exerted by civil society.

To end the "waiting game", it is essential to agree on the instruments deployed. Our contribution focuses solely on economic and financial instruments. It advocates greater coordination among nascent carbon pricing instruments in order to reduce the cost of their fragmentation and to remove disincentives. It calls for the establishment of two ad hoc instruments: a universal excise duty, levied upstream of production chains, proportionately to the CO2 content of the various fossil fuels; and a transfer mechanism following a rule of "bonus-malus"(reward-penalty) rule calculated from the emissions per capita to encourage developing countries to join the common system of measurement and verification.

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Climate negotiations under the auspices of the United Nations began in 1990 with the publication of the First Assessment Report by the Intergovernmental Panel on Climate Change (IPCC), a quarter century before the Paris conference. During this period, awareness of climate risks has grown. Scientific knowledge of the phenomenon has advanced and has been made available to decision-makers through the five IPCC Assessment Reports. The first effects of global warming have been observed, confirming the predictions of climate models. Twenty-five years of climate negotiations have, however, had no observable effect on greenhouse gas emissions trajectories. Global emissions even accelerated between 2000 and 2013, reaching a growth rate not seen since the first oil shock.

If ratified by enough Parties, the Paris Agreement will represent a twofold advance on the "one-legged" Kyoto Protocol and the "self-service" system introduced in Copenhagen. But it will only provide a framework, admittedly scalable, designed to encourage action. Its ability to reverse emissions trajectories will depend on how this framework is now fleshed out. This is where the role of economic instruments and carbon pricing comes into play. Since the outset, climate negotiations have come up against the difficulty of agreeing on economic instruments that can make credible the good intentions proclaimed from one diplomatic summit to the next.

1. Twenty-five years of climate negotiations: the "slow race"

As with the ozone layer, society was alerted to the risks of global warming by scientists, working within the framework of the IPCC, which was established in 1988 under the dual auspices of the World Meteorological Organization and the United Nations Environmental Programme. The IPCC's mission was to assess the state of knowledge on the climate and to relay it on a regular basis to decision-makers.

1.1 Off to a flying start

As soon as the IPCC was formed, the first stages of international negotiations rapidly followed: the first IPCC Assessment Report in 1990; UN Framework Convention on Climate Change (UNFCCC) in 1992; and the Kyoto Protocol in 1997.

Adopted in 1992 by over 120 countries at the World Earth Summit in Rio, the Climate Convention (UNFCCC) entered into force in March 1994. Ratified since then by 196 parties, it lays the foundation for international cooperation on climate change.

Its supreme body, the Conference of Parties (COP), brings together representatives of all states that have ratified the Convention. Following the United Nations mutualist principle, all countries, big or small, have an equal voice, with the rule of consensus for any decisions taken. With 196 Parties, one can imagine the complexity of the process and the risk of deadlock. The COP meets once a year, traditionally in early December. The first COP was held in Berlin in December 1995. The Paris meeting, in December 2015, was thus the 21st COP.

The COP has an operational secretariat which implements the decisions taken and ensures the collection and monitoring of the information that each Party to the Climate Convention undertakes to provide. This component is of great importance: the credibility of any environmental agreement is based on a reliable and independent system of Monitoring, Reporting and Verification (MRV) of pollutant sources and each country's commitments.

The Climate Convention not only provides a multilateral framework for discussion between countries and an administrative monitoring organization, It also

lays down three principles that must underpin international cooperation in the face of climate risk.

Box 1

The United Nations system for governance regarding climate change

The United Nations Framework Convention on Climate Change (UNFCCC), adopted in December 1992 at the Earth Summit in Rio, came into force in March 1994. The UNFCCC has since been ratified by 195 countries and the European Union, which constitute the Parties to the Convention. The supreme body of the Climate Convention is the Conference of Parties (COP), which brings together representatives of all states that have ratified the Convention. These procedures give all countries, large or small, an equal voice in accordance with United Nations principles. With 196 parties, one can imagine the complexity of decision making and the associated risks of deadlock.

The COP is required by statute to meet once a year. The annual climate conference is usually held at the end of each year. Some COPs have left little trace, while others have marked the history of the negotiations, such as the third COP which met in Kyoto in 1997 and in the closing plenary adopted the Kyoto Protocol. The Paris conference was COP-21. The 196 parties adopted the Paris Agreement, which aims to establish a new climate regime from 2020. Like the Kyoto Protocol, the Paris Agreement was adopted under Article 7 of the 1992 Convention. Both the Kyoto Protocol and the Paris Agreement are international treaties in accordance with the Vienna Convention of 1986 on the law of treaties (Article 2), adopted pursuant to the UNFCCC.

The COP has an operational secretariat based in Bonn, Germany. The secretariat implements the decisions adopted by the COP and carries out various coordination and monitoring tasks. It has two subsidiary bodies:
- the Subsidiary Body for Scientific and Technological Advice (SBSTA)
- the Subsidiary Body for Implementation (SBI).

SBSTA's role is to provide the COP with information on scientific, technological and methodological matters. SBI's role is to advise the COP on all matters relating to the implementation of the Convention.

1.2 The three fundamental principles

The first principle of the Climate Convention is the recognition by international law of the existence of global warming and its link to human emissions of greenhouse gases. By ratifying the Convention, a state recognizes these phenomena in theory, which are documented in more detail in the assessment reports transmitted by the IPCC to decision-makers.

The second principle assigns the international community the ultimate goal of taking action on global warming to prevent "dangerous anthropogenic interference with the climate system". The 1992 Convention is vague as to how this long-term target should be operationalized. As of the Copenhagen conference (2009), the target was defined in terms of limiting global warming to 2°C compared to pre-industrial times. It is an ambitious objective, but it has remained abstract because none of the world's governments acts directly on the temperature. Much of the discussion at COP-21 focussed on the level of this objective and how it is expressed in terms of emissions trajectories.

The third principle concerns the "common but differentiated" responsibility with regard to climate change. In ratifying the Convention, each state recognizes that it shares in this collective responsibility. Differentiated responsibility means that not all parties to the agreement have the same degree of responsibility, depending on their level of development. The differentiation of the degree of responsibility is an equity criterion whose foundations are not really open to discussion. The art of climate negotiations therefore lies in coming to an agreement on its operational implementation.

The Climate Convention classifies countries into two groups: the industrialized countries and the developing countries. The former, at the origin of three-quarters of global greenhouse gas emissions accumulated between 1850 and 1990, bear a preponderant historical responsibility. They are listed in Annex I, which includes the developed countries, as well as Russia, Ukraine and the countries of Eastern Europe. The remaining "non-Annex I" countries do not have the same historical responsibility and the Convention recognizes their right to development as a priority. This binary division of the world, already questionable in 1992, is totally out of phase with contemporary reality. It was, however, set in stone by the Kyoto Protocol, signed in 1997 after a diplomatic marathon between the top two emitters at the time, namely the United States and the European Union.

1.3 Kyoto: a one-legged agreement

The Kyoto Protocol was the first application text of the Climate Convention. It introduced two innovations into international life: at a legal level, binding commitments regarding greenhouse gas emissions; and at an economic level, a system for trade allowances between countries, combined with two project mechanisms.[1]

The legally binding nature commitments on emissions was regarded at the time as a major innovation (Guesnerie, 2003). The debate around the legal status of the agreement raged at the Copenhagen conference, where a successor to Kyoto should have emerged. In fact, the legally binding character of an international

[1] The Clean Development Mechanism (CDM) and Joint Implementation (JI).

treaty is very limited. A country can exit from an agreement such as the Kyoto Protocol simply by notifying the Convention secretariat in writing, which frees it from any obligations after one year. This is precisely what Canada did in 2011. However, the legal form of the Kyoto Protocol made its ratification by the United States impossible, because of the hostility of the Senate.

Kyoto's 'binding' commitments applied to the Convention's Annex I countries (before the withdrawal of the United States and excluding Turkey). They cover anthropogenic emissions of six greenhouse gases[2] and apply to emission sources (excluding international transport) located in the territory of the countries concerned, subject to very strict Monitoring, Reporting and Verification (MRV) obligations. These countries are allowed to credit carbon storage by their forests and, under certain circumstances, agricultural land. On average, they were required to reduce their emissions over the period 2008-2012 by 5.3% compared to 1990.

Kyoto's second innovation was to link these emissions caps to an international allowances trading system and subsequently to come up with an international carbon price. Though attractive on paper, this system had little concrete impact because of the withdrawal of the United States and the excessive granting of rights to Russia.

Regarding the application of the principle of differentiation of responsibility, developing countries (non-Annex I) are exempt from all emissions reduction commitments and virtually any reporting obligation to the Climate Convention. They can, however, benefit from the Clean Development Mechanism (CDM), which allows the high-income countries to credit emission reductions obtained by projects carried out in countries not subject to the constraint (Hagen & Holtsmark, 2009).

The CDM has generated some 300 billion dollars of investment in non-Annex I countries. The balance sheet of emission reductions in these countries is nevertheless difficult to establish. During the period concerned, emissions by China, which issued nearly 60% of the credits, accelerated, as did those by Korea and India, the other major users of the mechanism. The aim of using the CDM to attract investment to the least developed countries has remained in the experimental stage.

With hindsight, it is clear that the Kyoto Protocol did not deliver the expected results. Its intrinsic weakness, exacerbated by the US withdrawal, was largely due to its one-legged character. By making the developed countries alone subject to all the obligations, it left the field open for increased emissions elsewhere in the world. Moreover, it encouraged emerging countries to increase emissions in the short term in order to strengthen their medium-term negotiating position (Tirole, 2009). The architects of Kyoto imagined they could overcome this weakness by progressively integrating other countries into the Kyoto structure.

1.4 Copenhagen's self-service approach

Convened to establish the rules for the "post-Kyoto" period, Copenhagen (2009) was a diplomatic setback for the European Union, whose ambition had been to broaden the Kyoto system to other countries.

This failure, sometimes attributed to the conference's "poor organization", stemmed from a basic issue. The Kyoto architecture was based on "grandfathering", whereby emission rights are allocated on historical grounds. Once one assigns a value to these rights through carbon pricing, one accords a high economic rent to the historical polluters: the United States, Europe, Russia. This makes it impossible to

[2] Carbon dioxide, methane, nitrous oxide and three types of fluorinated gases.

extend the commitments to new emitters, except by changing the distribution of rights rule, something that Europe has never seriously considered. A "super-Kyoto" based on an equal distribution of rights per capita would be welcomed by India, Africa and all the other developing countries. It is the rich countries that are opposed to such an architecture, because it would cost them dearly.

To find an honourable way out, the conference came up with a three-page document, the "Copenhagen Accord", rapidly drafted in consultation with representatives of the major emerging countries – China, India, South Africa, Brazil – and the United States. Europe and Japan gave their consent to this text written without them, along with a majority of developing countries, lured by promises of funding. The Conference of the Parties "took note" of the Copenhagen Accord, which in non-diplomatic language means it did not adopt it, for want of consensus, since only 119 Parties out of 196 supported the text. The main provisions of Copenhagen were, however, reintroduced in the framework of the Climate Convention at the Cancún conference (2010).

Apart from the 2°C reference point as the long-term target, Copenhagen introduced a decentralized method for setting "pledge and review" objectives, whereby each country determines its contribution to the common effort. Emerging countries, particularly China, Brazil and India, announced (modest) objectives for reducing their own emissions. This was the first departure from the binary interpretation of the principle of differentiation of responsibility – and arguably the second leg so lacking in the Kyoto Protocol.

Progress remained largely limited to declarations of intent in the absence of agreement on a common MRV system. As in a self-service restaurant, each country could compose its contribution menu. Emission reduction targets could cover different areas, base years that did not match, and emission inventories drawn up piecemeal. Reconciling the decentralized mode of climate cooperation with a rigorous and independent MRV system became one of the stumbling blocks of the negotiations.

The other major component concerned the economic and financial instruments. In return for their commitments on emissions, the major emerging countries obtained from the developed countries the promise to transfer $100 billion a year to developing countries from 2020. The objectives were to thereby facilitate the implementation of emissions reduction strategies and adaptation to the impacts of climate change. An ad hoc structure, the Green Climate Fund, was created under the auspices of the Climate Convention, whose form of governance then became the subject of lengthy discussions.

2. Behind the diplomatic success of Paris

Two years after Copenhagen, Durban (2011) set out a timetable to produce a synthesis between the one-legged Kyoto formula and Copenhagen's self-service approach. The negotiators were given four years, until the end of 2015, to conclude a universal agreement, which would come into force in 2020. The mission was accomplished on 12 December 2015, with the adoption in plenary of the 29 items of the Paris Agreement and a "Decision" that specifies the conditions for its entry into force.

2.1 Overview of the Paris Agreement

The Agreement follows the bottom-up approach inaugurated in Copenhagen. It drops any hint of binding targets connected to economic

instruments, but creates a new framework for implementing the Climate Convention, moving away from the binary division of the world set in Kyoto, in the name of differentiation of responsibility.

At the request of the island nations most threatened by global warming, the long-term target has been tightened to a temperature increase of between 2°C and 1.5°C, the lower limit to be documented by an IPCC special report. The Agreement contains no numerical target in terms of emissions, but aims "as soon as possible" to get past a global peak and then for emissions to decline rapidly, reaching carbon neutrality during the second half of the century, with residual gross emissions offset by the CO_2 absorption capacity of natural or artificial sinks. This trajectory is inspired by the work of the Fifth IPCC Assessment Report (October 2014), omitting, however, the 2050 intermediate objectives, removed at the request of the oil producing countries.

The overall trajectory is not broken down by country or group of countries in the text of the Agreement, which refers to Nationally Determined Contributions (NDCs). The large majority of countries provided the secretariat of the Agreement with a first set of Intended Nationally Determined Contributions (INDCs) before the start of the conference. According to the secretariat of the Agreement, full implementation of these INDCs would result in global emissions of about 55 billion tonnes of CO_2e in 2030, 10% above the current level and well above the 40 billion tonnes required to limit the risk of warming to no more than 2°C.

This 55 billion tonnes figure should be viewed as the baseline to which implementation of the announced policies would lead. The Paris Agreement is structured so that the baseline derived from countries' stated intentions is established with increasing rigour and approximates to a trajectory consistent with long-term targets.

The first lever for achieving it is to strengthen MRV, which should gradually be applied to all Parties, with special flexibility for small island nations and the least developed countries. The process is based on governments' voluntary participation and mutual monitoring within the multilateral framework. With regard to NDCs, all Parties are required to submit an updated set of contributions to the secretariat from 2018. The Agreement then provides for a process of five-year reviews on the basis of a preliminary Global Stocktake, with a ratchet effect prohibiting any downward revision of targets.

The second lever concerns the financial component, for which the Paris Agreement sets a goal aiming to align the financial flows with the new low-carbon trajectories, though it does not translate the formula into operational recommendations. In terms of international transfers, developed countries are urged to go beyond existing commitments. Emerging countries are expected to provide additional resources on a voluntary basis. Setting a new quantitative target, in excess of the $100 billion a year already promised, is postponed until 2025. In addition to the adaptation and mitigation needs of the least developed and island countries, part of the financing will facilitate technology transfers. However, the Agreement excludes any financial compensation for "loss and damage" due to climate change.

Box 2
Limiting average warming to 2°C or to 1.5°C

An ambitious climate change mitigation strategy should aim to limit the risks that today's emissions present for the functioning of future societies. Given the inertia of the climate system, the impacts of the accumulation of greenhouse gases are very long-lasting. It is therefore essential to formulate very long-term goals, along with short and medium term commitments. How to do this has been is a recurring problem in climate negotiations since 1992.

- The 1992 Climate Convention merely sets out a long-term target, defined as a level of concentration of greenhouse gases in the atmosphere that averts "dangerous anthropogenic interference with the climate system". As the level is not specified, the goal remains academic.

- In 1997, the Kyoto Protocol posted a medium-term objective by specifying an emissions reduction target for the developed countries for 2008-2012. It made no mention of a long-term target, an omission that constitutes a major weakness.

- In 2009-2010, the objective of limiting global warming to below 2°C was introduced as a long-term Climate Convention target, without specifying what this entails in terms of emission reductions for each country.

- In 2015, the Paris Agreement strengthened the long-term target by setting the goal of limiting average global warming to "significantly below 2°C" and, if possible, to 1.5°C. This long-term target is linked to the goal of reaching "as early as possible" the global emissions peak and then carbon neutrality by the end of the twenty-first century.

Lowering the extent of warming from 2°C to 1.5 °C will be far from easy. 2015 was the warmest year on record, with an average surface temperature for the planet that for the first time exceeded a 1°C increase compared to the pre-industrial era. To limit warming to 1.5°C, there only remains a margin of half a degree, which the greenhouse gases already present in the atmosphere may be sufficient to exceed given the inertia of the climate system. To clarify the issue, the COP has commissioned the IPCC to prepare a special report by 2018.

2.2 The Paris Agreement and carbon pricing

The term "carbon price" has divisive connotations that are not conducive to consensus building. The negotiators therefore carefully removed any explicit reference to carbon pricing from the text of the Agreement, leaving the term to appear only in a peripheral text on measures taken by voluntary actors[3] and alluding to the "social cost" of carbon so as to encourage early action[4]. At a first reading, the Paris Agreement seems therefore to disregard the use of carbon pricing.

[3] Article 136 of the Decision.
[4] Article 109 of the Decision.

Such a conclusion would, however, be premature. Article 6 of the Paris Agreement refers to several possible ways of using carbon pricing, but in sufficiently convoluted language to pass surreptitiously through the filters of diplomats. Nothing new in this, since the term is no more explicit in the text of the Kyoto Protocol, that was nevertheless at the origin of a rather sophisticated formulation of carbon pricing on the basis of industrialized countries' emissions reduction commitments.

Article 6 aims to promote voluntary cooperation between the parties to the Paris Agreement with a view to strengthening the ambition of their national contributions. Such cooperation may be based on non-economic instruments, such as coordination in terms standards or the joint development of research and development programmes.

Cooperation can also involve transfers of "mitigation outcomes" between parties, provided that there is no double counting, and that various administrative and financial conditions are met. Such transfers could, for example, result from such the exchange of allowances or emission credits between countries. Such a system would, under the aegis of the United Nations, allow "clubs" of countries to be formed, which could integrate their allowances markets (Jaffe & Stavins 2010), agree on a minimum level of carbon taxes (Weitzman, 2015) or more generally harmonize their carbon pricing systems (Nordhaus, 2015).

Article 6 also provides a mechanism to replace the Kyoto Protocol's project mechanisms. It foresees setting up an organization dedicated to its management that would need to be operational by the time the Paris Agreement comes into force. This creates a framework that could be used to test proposals for the development of financial instruments based on remuneration for emissions avoided (Hourcade & Shukla, 2013; Aglietta & Espagne, 2015).

The Paris Agreement does not make any recommendations in terms of carbon pricing. It simply introduces a framework that governments can voluntarily use to increase the credibility and ambition of their contributions in future stages of implementation.

2.3 The post-COP 21 agenda: filling a still empty basket

Twenty-five years after the start of negotiations, the Paris Agreement creates a coherent framework for the implementation of the Climate Convention. A stark contrast to the two short years that sufficed to organize the framework to respond to the destruction of the ozone layer! Can the diplomatic success of Paris put an end to the "slow race" of climate negotiations, produced by what Aykut and Dayan call the "reality split" ("schisme de réalité"), in other words, the isolation in which the world of climate negotiations sometimes seems to immure itself (Aykut & Dayan, 2015)?

It all depends on what the various players now do. The Agreement is a lovely basket, carefully woven by the negotiators so as not to offend anyone. It now remains to be filled!

The first condition for filling the basket is to get through the stage of ratification by governments, a process that opens at the UN headquarters on 22 April 2016. To come into force, the Agreement must be signed by at least 55 parties together accounting for a minimum of 55% of global emissions. This rule is inspired by the Kyoto Protocol – whose ratification took seven years. It could be less restrictive because the legal form and the text of the Paris Agreement have been calibrated to allow in particular ratification simply by presidential decree in the United States.

There is nevertheless a risk linked to the political context of the major emitters. With its sharp slowdown in growth, concern regarding the climate might wane among the Chinese leadership. The United States is dominated by a Congress hostile to the Agreement, as are the Republican candidates in the upcoming presidential election. Europe, weakened by internal inertia, has lost its influence in climate diplomacy. India dropped its previous opposition at the conference, but will require something in return for signing the Agreement. Japan is backpedalling. Little can be expected from Russia and the oil-producing countries, which have reluctantly supported a document from which they previously helped to remove any potentially binding formulation.

Once the Agreement is ratified, filling the basket will entail integrating by 2020 the national contributions of the various countries, based on the intentions filed prior to the conference. A process of "dialogue" between the parties should improve these contributions in 2018 and 2019. In the spirit of the promoters of the Agreement, mutual trust and the multilateral framework should enable it to escape the "lowest bidder" race, classic in this kind of situation.

In practice, any increase in these contributions by 2020 is unlikely. There is even a risk of reduced ambition, because many developing countries have made their intended contributions conditional upon financial support provided by the high-income countries. But the diplomatic success of Paris has brought little visibility in this respect. In addition, the following stages of the process prohibiting any backsliding may encourage governments to submit timid initial contributions.

In the medium term, the Paris Agreement provides a comprehensive review process of national contributions every five years, made on the basis of a Global Stocktake. The first Global Stocktake must be implemented in 2023 and be able to establish a new set of national contributions from 2025. In principle second rounds should follow in 2028 and 2030.

The rules of the five-year review processes operate on the principle of the ratchet effect, which prohibits any party reducing the ambition of its contribution. The idea is that virtuous competition will be established between countries through the new cooperative framework thereby created and the reputational risks to which governments would expose themselves by refusing to enter this new "highest bidder" race.

Box 3
The post COP-21 agenda

April 2016	Start of the signing of the Agreement at the United Nations Secretariat in New York. 55 signatures representing at least 55% of global emissions are required for the entry into force of the Agreement in 2020.
May 2016	First meeting of the Ad Hoc Working Group on the Paris Agreement (APA), the body responsible for the implementation of the Paris Agreement.
Nov. 2016	COP-22 in Marrakesh
2018	- Publication of the IPCC special report on emission trajectories associated with the aim of limiting warming to 1.5°C. - Facilitation dialogue to increase the ambition of national contributions from the entry into force of the Paris Agreement.
2020	- Entry into force of the Paris Agreement (if a quorum of signatures is reached) - First five-year cycle of Nationally Determined Contributions (NDCs).
2021	Publication of the Sixth IPCC Assessment Report
2023	First Global Stocktake assessing the extent to which the objectives of the Agreement have been met.
2025	- Implementation of the new funding target. - Second five-year cycle of revised Nationally Determined Contributions (NDCs).
2028	Second Global Stocktake assessing the extent to which the objectives of the Agreement have been met.

2.4 The wager on a "highest bidder" competition

The five-year process of raising ambitions reflects the underlying challenge of the Paris Agreement: to organize, on the basis of the new application framework of the 1992 Climate Convention, competition in terms of climate policy where the lowest bidder would be sanctioned by loss of reputation and the highest bidder would be rewarded by more rapid progress than its competitors in transforming its economy to a low-carbon regime.

In many respects, the opportunities are unprecedented. Thanks to technical progress and local experiments, alternatives to fossil fuels are multiplying. New economic sectors are emerging that will counterbalance the weight of traditional lobbies. Alliances are being formed among economic and territorial actors who wish

to move faster than governments. Another important consideration is the growing awareness of the almost immediate health benefits associated with an acceleration of climate policies, in particular reduction in the use of coal – a key factor for gaining the support of populations in emerging Asia. Many of the least developed countries are realizing the potential of decentralized energy systems for quickly improving universal access to energy at least cost.

Such a context is conducive to the formation of new coalitions in favour of accelerating climate policies. According to Belis et al. (2015), it helped to overcome many obstacles prior to the Paris conference in aligning the positions of China, the United States and the European Union. But does such working in concert for a diplomatic agreement presuppose a genuine resolve to accelerate action once the Agreement is signed? The answer will only emerge later, depending on the ability of these three countries to concretely increase the coordination of their climate policies and make them more ambitious.

More generally, the Agreement emphasizes the importance of multi-actor coalitions, constructed at the interfaces of civil society, the business community, the financial sector and non-governmental public stakeholders. Maljean-Dupois & Waemer (2015) argue that this type of coalition should eventually help open up the climate regime by steering it toward polycentric climate governance following the approach advocated by Elinor Ostrom (Ostrom, 1990). Desirable though it may be, this shift is not necessarily easy to imagine. Ostrom's work has so far been applied to the protection of local public goods, achieved through the alignment of strategic interests within micro-communities. Its transposition to a global scale to protect a planetary public good is an audacious bet.

To win the wager of the shift to competition to be the highest bidder, it is not enough to set up an online portal where multi-actor initiatives can be registered. It is essential to develop common metrics with MRV imposed on stakeholders and to deploy incentives that motivate them to cooperate. In both cases, the lever of international carbon pricing constitutes a powerful catalyst.

3. Economic instruments to end the "waiting game"

One recurring problem in climate negotiations is to find a set of incentives that aligns strategic interests and counteracts "free-rider" behaviour (Olson, 1965). In the face of climate risk, it is in the interest of each party to delay its contribution to the collective effort until all the others reduce their emissions. To end this "waiting game" (Gollier & Tirole, 2015), a new variable needs to be introduced into the economy, namely a carbon price, reflecting the value that the community actually attaches to protecting the climate.

3.1 The price of carbon in the negotiations: a two-sided issue

The utilization of pricing externalities as a environmental policy instrument is usually justified by the efficiency argument: if markets are functioning properly, it allows the objectives to be achieved at the lowest cost. In the case of climate negotiations, carbon pricing also appears as a condition for moving from words to deeds. The Paris Agreement sets out two major objectives: moving quickly to a low-carbon economy and realigning financial flows, particularly by allocating additional resources to the least developed countries. With no carbon price, these two desired goals may simply not be attained.

To move towards the goal of limiting warming to 2°C or even 1.5°C, our societies must within the next few decades reconfigure the energy system, which is

responsible for 70% of global greenhouse gas emissions, and the way of valuing agricultural and forest resources, which account for nearly 30% of emissions. The primary function of the carbon price is to make the energy transition compatible with the management of climate risk.

The direct integration of the agricultural and forestry sectors into a common carbon pricing mechanism is neither realistic nor desirable. The reorientation of these sectors will, however, be greatly facilitated by the introduction of hybrid instruments that can combine insurance and carbon pricing (Dequiedt, 2016) or payment for environmental services and the price of carbon (Simonet, 2016).

The main problem with regard to achieving the required transformation of the energy system lies in the excess of fossil fuels available. In the absence of large-scale CO_2 capture and storage technologies, we must abandon exploiting 60% of the available stock of coal and 40% of oil and natural gas.

Such a scenario is not feasible in the framework of the current functioning of the markets. The "carbon down there", in underground deposits, acquires an economic value as soon as we transform it into energy. After combustion, it accumulates in the atmosphere and creates climate disruption. This "carbon up here" is only marginally priced, by means the nascent cap-and-trade or taxation systems with a view to internalizing the costs of climate damage. Overall, the value given to the climate externality remains well below the cumulative subsidies supporting the use of fossil fuels. The collective net value thus associated with climate protection is therefore negative (De Perthuis & Trotignon, 2015). In this system of incentives, it is possible to implement an energy transition by adding renewable sources to the energy supply and accelerating efficiency gains. This is what some European countries, Japan and more recently China and some US states have started doing. In the absence of a carbon price, these sources are liable simply to be added to fossil fuels rather than replacing them completely, an eventuality that is not consistent with a scenario for controlling climate risk.

International carbon pricing changes the rules of the game. By putting a price on "carbon up here", it creates a new value, "carbon rent", the ramping up of which with the increase in the CO_2 price lowers the value of fossil assets by reducing their use. A decisive step forward in introducing such pricing would be to come up with an agreement with holders of fossil energy sources, who would claim their share of this new value that threatens their traditional rents.

The second function of the carbon price is to make credible the objective of alignment of financial flows aimed at by the Paris Agreement. Part of the financial community seems to be committed to this path, with the backing of militant regulators such as the governor of the Bank of England (Espagne, 2016). It is very useful to conduct experiments along these lines, particularly by trying to incorporate climate risk into prudential rules or to refinance low-carbon projects from central banks. Technically, these experiments are difficult to implement and their large-scale deployment is impossible in the absence of an effective carbon price, which is an irreplaceable marker for selecting projects and incorporating climate risk into the balance sheet of financial institutions.

From the financial angle, an international carbon price amounts to a new resource that can give credibility to the transfers to the most vulnerable countries due to be implemented by 2020 and 2025. In the absence of an additional resource of this type, the strong suspicion, often justified, remains of large-scale "greening" of existing transfers (Dasgupta & al., 2015). This distributive aspect of international carbon pricing is crucial in building a climate agreement able to combine efficiency and equity.

In practice, a global carbon price is unlikely to be introduced straightaway, in a kind of "big bang" suddenly redirecting the economy towards a low-carbon regime. The process may result from the cooperation of the parties to the Paris Agreement (Article 6) with a view to better coordinating existing mechanisms or introducing new tools.

3.2 Improved coordination of existing pricing tools

As regards carbon pricing, strengthening international coordination involves three instruments: CO_2 allowances markets; subsidies for fossil fuels, which amount to negative carbon taxes; taxation of these fuels. Article 6 of the Paris Agreement, within which increased coordination can fall, does not include any incentives for moving forward. The levelling down of fossil fuel prices between 2014 and 2016 on the other hand has opened a window of opportunity for policy-makers, since pricing the climate externality is easier to implement in a context of weak oil, gas and coal prices.

- *CO_2 allowances markets*. Although the Kyoto Protocol failed in its attempt to introduce an international allowances market, it nonetheless helped the deployment of cap-and-trade systems applying to companies, that in 2016 cover around 10% of global greenhouse gas emissions. Developed without coordination, these markets cannot be directly interconnected because of the incompatibility of their respective rules, thereby reducing their overall effectiveness. Lack of coordination also results in a race to the bottom in terms of ambition, every government being paralyzed by the fear of losing competitiveness if it unilaterally increases the carbon price.

Initiatives to promote the expansion and integration of these markets, such as the Carbon Pricing Leadership coordinated by the World Bank, flourished with the approach of the Paris conference. The three main post-COP 21 issues concern the integration of Chinese regional markets into a national system in 2017, the regeneration of the EU emissions trading scheme and the development of subnational markets in North America. The European experience underlines the impossibility of ambitiously managing a multinational system without stronger governance (Trotignon et al., 2016). Such governance must in particular manage the complex interactions between the rules of the carbon market and other energy policy instruments (Goulder, 2013).

- *Subsidies to fossil fuels.* These subsidies have been estimated at over 400 billion dollars for 2013, of which 150 billion in OECD countries. The decline in the price of fossil fuels automatically reduced the figures in 2015 and 2016, because part of these subsidies makes up the difference between the market price of energy and a fixed selling price.

To make sure that this decline becomes a long-lasting feature, further structural reforms need to be implemented, like those that Mexico, India and Indonesia have begun introducing. These reforms involve either removing public support if they are not justified in economic or social terms or replacing them with other support techniques that no longer generate the wrong environmental incentives. For example, replacing price support with lump-sum transfers to low-income households, or aid to coal mining through public assistance redevelopment programmes.

- *Harmonization of taxation on fossil fuels.* The first taxes on the use of fossil fuels were introduced in Western countries between the two world wars, for tax revenue reasons. They are currently still the main lever of implicit carbon pricing throughout

the world. They mainly concern fuel used for land transport, whereas 60% of other fuels are not taxed at all (OECD, 2015). Harmonization of these tax systems with the introduction of the CO_2 content of each fuel into the tax base, initially with low rates but progressing over time, is a sensible recommendation. However, it is far from easy to implement, as is shown by the failure of attempts to do so in the European Union since 1990.

The incremental progress previously described may be situated within the framework of international cooperation, which the Paris Agreement is likely to strengthen. However, all these advances already existed prior to the adoption of the Agreement in December 2015, which introduces no incentives to speed up the process. Merely "streamlining" the existing measures is therefore likely to take time, postponing until later the end of the "waiting game." This is why we recommend examining two new tools: universal carbon excise and a reward-penalty (bonus-malus) system.

3.3 Universal carbon excise duty: a twofold reversal of perspective

Attempts to price CO_2 emissions have so far focused primarily on consumer countries, at the end of supply chains. With few exceptions, they have been half-hearted and raise numerous questions of coordination. Such measures give rise to interminable debate on the risks of carbon leakage and the difficulty of introducing corrective devices such as carbon inclusion mechanisms at borders. Measurement of emissions comes up against the problem of evaluating "grey" emissions embodied in products that are traded internationally. The large number and the wide variety of emission sources present a major challenge.

A radical way of overcoming this problem would be to price CO_2 upstream of production chains, during the extraction of the three products responsible for all emissions related to energy use: coal, oil and natural gas. Technically, there are two possible ways to achieve this. The first would be to set up a transferable allowances market on the basis of a cap on the amount of fossil energy extracted from beneath the ground. Recommended by Sinn (2012), this option would give rise to intractable haggling between producers, with a very low probability of reaching a viable and verifiable agreement. The other option would be to institute a Universal Excise Duty (UED), in other words an intrinsic carbon tax prior to extraction and not an extrinsic tax after the emission of CO_2.

For example, a barrel of oil will emit approximately 400 kg of CO_2, whether it is burned to produce heat energy, propelling a vehicle, or providing electricity. A UED of 25 \$/tCO_2-eq would represent \$10 (0.4 x 25) for each barrel of oil extracted anywhere in the world – an amount easily absorbable by the global economic chain if the measure were applied universally. Oil prices have undergone changes of much greater magnitude in recent decades.

Technically, such an upstream pricing mechanism gives rise to a radical change of perspective. There are only three products to be taxed, at the time when they are initially put on the market, the CO_2 content of which accounts for 70% of global emissions.[5] This option is a far simpler to implement than pricing downstream in the form of a carbon tax, which theoretically would have the same property of non-distortion of competition between economic actors (Courchene & Allen, 2008), but

[5] Certain adjustments would need to be made in the event of deployment of carbon capture and storage technologies and for the use oil or gas as non-energy commodities (petrochemicals).

would pose intractable problems of technical feasibility as long as companies fail to provide accounts recording the carbon flows associated with their activities.

Taxing carbon upstream introduces a further reversal of perspectives. By construction, a UED would be levied in fossil energy producer countries, thereby entailing that this group of countries is placed at the core of climate negotiations. These countries have traditionally been opposed to carbon pricing systems, because they view these mechanisms as attempts by the consumer countries to capture some of the energy rent (Wei et al., 2011). Implicating them with the management of carbon rent by introducing a UED would reverse the issue: what fraction of the carbon rent would they be prepared to redistribute in the framework of a climate agreement if they became its producers?

The question arises quite differently depending on whether or not the extracted fossil fuels are consumed locally. If they are consumed locally, which applies particularly to China, the United States and India, the main effect of introducing a UED is to force up domestic costs. Economic rationality advocates recycling internally the proceeds of the UED so as to ease other outgoings weighing on production and to compensate low-income households. In the negotiations stage prior to the institution of the UED, one can only reasonably aim for limited use of revenues in respect of international climate solidarity, and solely for producing countries that have reached a certain level of development.

With regard to fossil fuels that are exported, the question arises differently. Through the UED, exporting countries (the Gulf countries, Nigeria, Russia, Australia, Canada, etc.) have in the short term an additional carbon rent, the growth of which will result in a decline in the revenues they were expecting to obtain solely from the exploitation of their underground resources prior to pricing the climate externality. It would strictly be in their interest to spend their entire carbon rent on diversifying their economies, starting with the energy sector, so as to increase their resilience. Such an option would, however, not be accepted by the consumer countries. Altruism alone would lead the exporting countries to transfer all of this carbon rent to those consumer countries most vulnerable to climate change. This option is not very realistic either. Any room for negotiation, therefore, lies between these two extremes.

Negotiations around the introduction of a UED would shake up the traditional geopolitics of energy by complicating rent capture strategies. In any case, the main unknown is the rate at which the ramping up of the UED would reduce the value of the rent from the extraction of fossil fuels before their full exit from the energy mix (or their use with carbon capture and storage techniques).

Negotiations around the proportion of the UED having to be recycled domestically and how this could feed transfers in the name of climate solidarity would be facilitated by the establishment of precise rules governing the distribution of these transfers.

3.4 Priming by means of a "bonus-malus" type redistributive mechanism

In the orthodox economic approach, the question of effectiveness is distinct from that of equity, which sometimes takes second place, as if it were a residual concern. To introduce carbon pricing in the real world, experience shows that the order of priority should be reversed. It is preferable to organize the negotiations by seeking an agreement between stakeholders on distribution rules at the outset, before addressing the question of the carbon price level determining the amounts to be redistributed (Cramton, Ockenfels & Stoft, 2015). It is in this light that we recommend carrying out a study of a "bonus-malus" (reward-penalty) mechanism

to initiate negotiations aimed at incorporating developing countries into the common MRV system.

The Paris Agreement urges developing countries to join the common MRV system on a voluntary basis, without simultaneously introducing economic incentives. The price of carbon could be used initially to give credibility to promises of financial transfers to these countries by setting distribution rules that encourage them to join the common MRV system. One simple rule would be that in exchange for entering the common MRV framework, each country becomes eligible to a transfer in the name of global solidarity, a "bonus" calculated from a carbon price multiplied by difference between its per capita emissions and the global average. As well as the initial incentive to join the common MRV system, the mechanism when fully operational would reduce or even eliminate transfers to any country that used this new resource to increase its per capita emissions compared to the average.

The distribution rule could be introduced as part of an integrated bonus-malus system. Transfers would be funded by a penalty levied on countries with high emissions per capita, calculated symmetrically to the bonus (Jouvet & Perthuis, 2015). A price of $7 per tonne of CO_2 applying to all emissions exceeding the world average, for example, could finance the $100 billion promised to the most vulnerable countries. But the introduction of the bonus could be conveniently coupled with a universal carbon excise duty. Applied to the three fossil fuels, a UED of fifteen dollars per tonne of CO_2 would raise some $530 billion a year at the start-up. By redistributing 5% of the amount collected on fossil energy consumed in the home market way and 50% of the energy exported, it can finance the same transfer of $100 billion under climate solidarity.

Like the UED, the bonus-malus system has the advantage of great simplicity, since it is based on a rule of equal emission rights per capita, which is a simplified notion of fairness with regard to the climate (Godard, 2015).

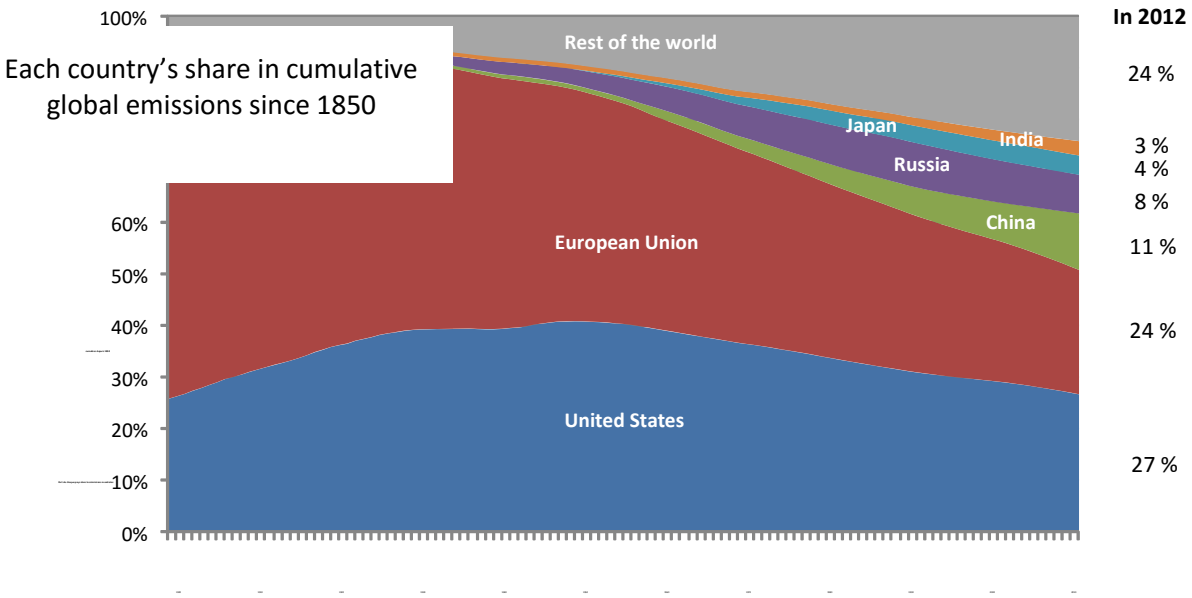
This simplicity should take precedence at the beginning of the negotiation process. However, it might suffer in the arrangements that various countries could encounter during the negotiation process. It is therefore useful to have multi-criteria indicators of equity (Bretschger, 2013) that can serve as safeguards in the initial stages so as to avoid every compromise between the parties resulting in additional complexity and, at the end of the process, a high degree of opacity.

Conclusion

Having been excluded from the negotiating table for diplomatic reasons, the question of instruments returns in force as soon as one asks how the framework of the Paris Agreement can be used to speed up cooperation between climate policies. Our contribution has focused solely on economic and financial instruments. It shows the urgency of coordinating nascent carbon pricing instruments in order to reduce the cost of their fragmentation and to remove adverse incentives. It calls for the introduction of two ad hoc instruments: a universal excise duty levied upstream of production chains in proportion to the CO_2 content of the different fossil fuels; and a transfer mechanism in accordance with a "bonus-malus" (reward-penalty) rule calculated from the emissions per capita that would encourage developing countries to join the common system of monitoring, reporting and verification (MRV).

The introduction of these ad hoc instruments can accommodate a plurality of carbon prices, since the lump-sum transfers influencing the creation of ambitious pricing of the climate externality have not been established. It will be more complex to link carbon pricing with the tools protecting the other natural regulatory systems constituting "Green Capital" (De Perthuis & Jouvet, 2015). The pricing of energy CO_2 may, for example, encourage excessive use of the energy from forests, to the detriment of biodiversity. Likewise, atmospheric aerosol emissions adversely impact atmospheric quality, but slow down global warming. The introduction of ambitious carbon pricing instruments involves entering into discussions with groups of countries so far kept at the periphery of the process. Reintegrating these countries into the core of the negotiations around the instruments is the major challenge of the post-COP21 period. In a way, climate negotiations are only just beginning.

Graph 1. Weight of the different economic blocs in cumulative CO_2(*) emissions since the beginning of the industrial era



Source : Climate Economics Chair from the WRI database

(*) All CO_2 emissions from energy use and industrial processes, excluding emissions from changes in land use and international transport.

From 1900 to 1950, the cumulative weight of the United States and the European Union in historically accumulated global emissions declined very slowly, but was still greater than 80% in 1950. The shift then accelerated with the emergence of new areas of development in the world. The geopolitical picture is now changing rapidly, making increasingly necessary the coordination of climate policies to prevent the emissions reductions of some zones being eroded by increases in others. The inclusion of CO2 emissions resulting from changes in land use and emissions of other greenhouse gases would only marginally alter the relative weights of different countries/regions represented.

The world's top twenty energy CO_2 emitters

The table below shows the energy CO_2 emissions (combustion of oil, gas and coal) of the twenty highest emitting countries in 1990 and 2012. The last column shows the cumulative share of the highest emitters in the world's total emissions. For example, emissions from China, the United States and the European Union account for 53% of the global total in 2012. The top ten global emitters account for 75% of global emissions.

Rank	Country	Emissions in 1990 ($MtCO_2$)	Emissions in 2012 ($MtCO_2$)	Cumulative share of the main emitters in the global total
1	China	2,278	8,251	26%
2	USA	4,869	5,074	42%
3	UE 28	4,068	3,505	53%
4	India	581	1,954	59%
5	Russia	2,179	1,659	64%
6	Japan	1,057	1,223	68%
7	South Korea	229	593	70%
8	Canada	428	534	72%
9	Iran	179	532	74%
10	Saudi Arabia	151	459	75%
11	Brazil	192	440	76%
12	Mexico	265	436	78%
13	Indonesia	146	436	79%
14	Australia	261	386	80%
15	South Africa	254	376	81%
16	Turkey	127	302	82%
17	Ukraine	688	281	83%
18	Thailand	80	257	84%
19	Taiwan	115	257	85%
20	Kazakhstan	236	226	86%
	World	20,974	31,734	

Source : Christian de Perthuis & Raphaël Trotignon, *Le climat à quel prix? La négociation climatique,* Odile Jacob, 2015.

Note. These figures do not take into account non-CO_2 greenhouse gas emissions or CO_2 emissions from industrial processes, deforestation and changes in land use. Taking these emissions into account would bring the total to about 50 billion tonnes of CO_2e in 2012.

Bibliography

Aglietta, M., & E. Espagne (2015), "Financing energy and low carbon investment: public guarantees and the ECB", *CEPII Policy Brief,* N°6.

Aykut, S., & A. Dayan (2015), *Gouverner le climat ? Vingt ans de négociations internatio-nales*, Presses universitaires de Science Po.

Belis, D., P. Joffe, B. Kerremans, & Y. Qi (2015), "China, the United States and the European Union: Multiple Bilateralism and Prospects for a New Climate Change Diplomacy", *Carbon & Climate Law Review,* Volume 9, Issue 3.

Bretschger, L. (2013), "Climate policy and equity principles: fair burden sharing in a dynamic world", *Environment and Development Economics, Vol18-05.*

CITEPA, *De la COP21 à la COP22 et au-delà*, Special report, March 2016.

Courchene, T. & J.R. Allen (2008), "Climate Change: The Case for a Carbon Tariff/Tax" *Policy Options/Options politiques*, Institute for Research on Public Policy.

Crampton, P., A. Ockenfels & S. Stoft (2015), "An International Carbon-Price Commitment Promotes Cooperation", *Economics of Energy and Environmental Policy* 4.

Dasgupta, D., R. Ray & S. Shyamsunder Singh (2015), "Climate Change Finance, Analysis of a Recent OECD Report: Some Credible Facts Needed", *Discussion Paper, Ministry of Finance, Government of India.*

De Perthuis, C., & P.A. Jouvet, (2015), *Green Capital, a new Perspective on Growth*, Columbia University Press.

De Perthuis, C. & R. Trotignon (2015), *Le climat à quel prix? La négociation climatique*, Odile Jacob.

Dequidt (2016), "Coût et Instruments économiques pour la réduction des émissions de gaz à effet de serre liées à la gestion des sols agricoles", Doctoral thesis, AgroParisTech.

Duprez, A. & T. Spencer (2016), Judging the Paris Agreement: A Comparision with IDDRI's 10 Criteria for Success", *IDDRI Issue Brief N°3*.

Espagne, E. (2016), "Climate Finance at COP21 and After: Lessons Learnt", *CEPII, Policy Brief* N°9.

Godard, O., (2015) *La justice climatique mondiale*, La Découverte, collection Repères.

Gollier, C., & J. Tirole (2015), "Negotiating effective institutions against climate change", *Economics of Energy and Environmental Policy* 4.

Goulder, L.H. (2013), "Markets for tradable pollution allowances: what are the (new) lessons?", *Journal of Economic Perspectives*, 27(1).

Guesnerie, R. (2003), *Kyoto et l'économie de l'effet de serre*, Report N°39 to the Conseil d'Analyse Economique.

Guesnerie, R. & H. Tulkens (Editors), (2008), *The Design of Climate policy*, CESifo Seminar Series, MIT Press.

Hagem, C. & B. Holtsmark (2009), "Does the Clean Development Mechanism have a viable future?", *Statistics Norway, Research Department, Discussion Papers No. 577*.

Hourcade, J.C., & P.R. Shukla (2013), "Triggering the low-carbon transition in the aftermath of the global financial crisis", *Climate Policy*, Volume 13, Supplement 1.

Institute for Climate Economics, (2015), "COP21: un succès qui marque la fin du commencement", *Point Climat* N°38.

Jaffe, J. & R.N. Stavins (2010), Linkage of tradable permit systems in international climate policy architecture, in Aldy, E. & R.N. Stavins (editors), *Post-Kyoto International Climate Policy, Implementing Architectures for Agreement*, Cambridge University Press.

Jouvet, P.A., & C. de Perthuis (2015), "Routes to an Ambitious Climate Agreement in 2015", *Discussion Paper 75, Harvard Project on Climate Agreements, Harvard Kennedy School*.

Maljean-Dubois, S., & M. Wemaëre (2015), *La diplomatie climatique de Rio 1992 à Paris 2015*, A. Pédone.

Nordhaus, W.D., (2013), *The Climate Casino, Risk, Uncertainty and Economics for a Warming World*, Yale University Press.

Nordhaus, W.D., (2015), "Climate Clubs: Overcoming Free-Riding in International Climate Policy", *American Economic Review*, 105 (04).

OECD, (2015), *Effective Carbon Rates on Energy in OECD & Selected Partner Economies,* Tax Policy Analysis.

Olsom M. (1965), *The Logic of Collective Action*, Harvard University Press

Ostrom, E. (1990), *Governing the commons: the evolution of institutions for collective action*, Cambridge University Press.

Simonet, G. (2016), *La gestion des forêts tropicales comme levier d'atténuation du changement climatique : l'expérience des 'projets REDD+'*, Doctoral thesis, Abiès-AgroParisTech.

Sinn, H.W. (2012), *The Green Paradox, A Supply-Side Approach to Global Warming*, MIT Press.

Stiglitz, R. (2015), "Overcoming the Copenhagen Failure with Flexible Commitments", *Economics of Energy and Environmental Policy* 4.

Tirole, J. (2009), *Politique climatique: une nouvelle architecture internationale*, Rapport N°87 au Conseil d'Analyse Economique.

Trotignon, R., Jouvet, P-A., Solier, B., Quemin, S. & J. Elbeze (2015), "European carbon market: lessons on the impact of a market stability reserve using the Zephyr model", *Working Paper N°2015-11, Climate Economics Chair*.

Wei, J., M. Hennlock, D. Johansson & T. Sterner (2011) "The fossil endgame: strategic oil price discrimination and carbon taxation", *Journal of Environmental Economics and Policy*.

Weitzman, M.L. (2015), "Internalizing the Climate Externality: Can a Uniform Price Commitment Help?", *Economics of Energy and Environmental Policy* 4.

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