Less than 2^{o}C? An economic-environmental evaluation of the Paris Agreement

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Abstract

The literature dedicated to the analysis of the different climate agreements has usually focused on the effectiveness of the aims for emissions in the light of the advance in climate change. This article quantifies the variation in emissions that the Intended Nationally Determined Contributions (INDCs) will entail and their financial allocation and policies country-by-country and regionally. The objective is evaluating the Paris Agreement feasibility regarding the INDCs and, economic and environmental constraints. The criteria through which the 161 INDCs are analysed are as follows: i/ socio-economic impact of the transition; ii/ focus on energy management; iii/ substitution of non-renewable sources; iv/ the role of technology; v/ equality of the transition; vi/ compliance with emission reductions. The results obtained show that the Paris Agreement excessively relies on external financial support (41.4%). Moreover, its unilateralist approach, the socio-economic and biophysical constraints could be the underlying cause of the ineffectiveness of the 2ºC objective. This way, each country would emit an average of 37.8% more than in the years 2005-2015. When this is weighted, the figure would be a 19.3% increase, due mainly to the increases in China and India. These figures would lead the temperatures up to 3º-4ºC.

Keywords: Climate change, INDCs, Climate policy, Climate finance.

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1. Introduction.

The consequences of climate change induced by human activity are a growing concern for the international community (IPCC, 2014; UNEP, 2011; Melillo et al., 2014). Evident effects such as extreme meteorological phenomena, rising temperatures and rising sea levels show the rapid climatic adaptation of natural ecosystems. The rapid increase in these impacts and the fact that abrupt changes could arise leads to the conclusion that the cost of transferring the responsibility for putting it right to the coming generations becomes ever higher. In this sense, the IPCC (2014) has warned that if, by 2050, we have not managed to reduce the level of emissions with respect to 2010 by between 25% and 72%, then maintaining the rise in world temperatures to below 2^{o}C with respect to preindustrial levels will be "more improbable than probable". Besides the most visible consequences today, if the temperatures rose by more than 3^{o}C-4^{o}C, humanity would face a scenario of massive extinction of species, entailing risks for human health and severe restrictions on access to food and water, so vital for survival (IPCC, 2014). Achieving this goal involves phasing out fossil fuels whereby around 82% of the current reserves of coal, 49% of natural gas reserves and 33% of the oil reserves should remain underground in order to avoid an increase in temperatures of more than 2^{o}C (McGlade & Ekins, 2015).

Regarding these concerns, in December 2015, the 21st Conference of Parties (COP21) was celebrated, made up of 188 countries, and whose most important result was the Paris Agreement (UN, 2015) and the collection of Intended Nationally Determined Contributions (INDCs) submitted by each of the participating countries. After de burial of the Kyoto Protocol, the current agreement is an unilateral vision in which the players establish their own voluntary objectives (Spash, 2015) through the INDCs. Although the agreement indicates that the main priority is to "hold the increase in the global average temperature *to well below 2*^{o}C above pre-industrial levels", during the COP21, the participants were sufficiently optimistic as to speak openly of 1.5^{o}C. Not only this, but in spite of the fact that they incorporated such equality criteria as the obligation of the Developed Countries (DC) to a greater reduction in emissions and the channelling of financial resources to the Least Developed Countries (LDC), the COP21 succeeded in involving some countries with medium incomes in these differentiated efforts (Viola, 2016).

In response to global concerns of these issues, a widening literature on sustainability transitions has emerged in recent years (Markaard, Raven, and Truffer 2012). Literature on climate summits mostly evaluates whether they comply with emissions limits or not (den Elzen et al., 2011; UNEP, 2010; Kartha & Eriksson, 2011; Höhne et al., 2012). Considering COP21 and the Paris Agreement (2015), main contributions are related to its impacts in energy technologies evolution (Peters 2017; Lacal Arantegui and Jäger-Waldau 2017) or evaluate possible transition pathways under its contexts in different regions (Liobikienė and Butkus 2017; Van de Graaf 2017; Gao 2016). Some works, conversely, points out difficulties to accomplish the COP21 objectives according to geopolitical and governance limits from a general perspective of the Paris Agreement (Spash, 2015; Viola, 2016). Moreover, an increasing number of governments, municipalities and NGOs are creating its own low carbon transitions plans plans according to their own criteria, or those established in the aforementioned climate summits. Thus, on the basis of Wiseman et al. (2013), Nieto & Carpintero (2016) deal with a more in-depth analysis of 19 low-carbon transition plans from government sources and other dependent agencies, NGOs and research centres.

In this article, Paris Agreement is evaluated on the light of biophysical, technological and economic limits, throughout a systematic analysis of each of the 161 INDCs submitted by the 188 countries in COP21.

Thus, the aim of this article is to put these INDCs under the same microscope that analyzed some previous plans (Nieto & Carpintero, 2016), situating the focus on the socio-economic impacts, international equality, technology, energy and emissions. This analysis will allow us to evaluate the feasability of the Paris Agreement policies in complying with its own objectives through the national commitments (INDCs). In the same way, we will evaluate the main limitations of the imposed governance and finance framework. In order to achieve these aims, a systematic analysis of the policies, the emission reduction commitments and the funding needs for implanting INDCs has been carried out.

The article is structured as follows: Section two describes the methodological process used to give homogeneity to the data offered by the INDCs. Section three sets out the main results of the exhaustive analysis of these INDCs. Section four confronts the results extracted from INDCs with the biophysical restrictions and the literature. Finally, Section five summarizes the article's main conclusions.

2. Methodology.

The flexibility of the Paris Agreement has led to a lack of systematic presentation of the INDCs. Therefore, this paper proposes a methology to homogenize data and categorize the information. For more detailed information, consult Annex A, as well as the repository of INDCs[1]. We have examined a total of 161 INDCs representing 188 countries that account for 97.8% of the world's emissions.

In order to achieve the aims of this article, we have paid special attention to the policies of mitigation as opposed to those of adaptation because of their economic (Buchner et al., 2015) and environmental importance. We have noted (as far as possible) the data concerning the objectives for reducing sectoral and global emissions, the policies for achieving the said objectives and their funding, with the greatest possible breakdown. We have also studied the proposed financial mechanisms and the nature of the agents who would lead the transition. We have grouped the different countries with respect to their level of income in accordance with the World Bank's (WB) classification, establishing a distinct group for the 12 most contaminating countries on the planet (Top 12) in 2014 (72.2% of the total emissions) because of their relevance for climate policies.

With reference to emissions, the INDCs have both unconditional and conditional objectives. The former would be carried out exclusively with domestic resources, while the latter would be conditional on receiving outside assistance. In general, the INDCs presented some problems that made the analysis more difficult; such as the discrepancies between the year of reference and that of the horizon. To resolve this issue, we have discarded those INDCs that do not have the year 2030 as their time horizon or the reference year outside the range 2005-2015. This reference year has been chosen because of two reasons. Firstly, EU used 2005 as one of the reference years (along with 1990 and 2030) in its Communication titled *"A roadmap for moving to a competitive low carbon economy in 2050"*. Secondly, most of the INDCs are within this time range, so it was reasonable to use it. Besides, a differential analysis has been carried out of the 12 most contaminating countries (Top12), for which we were able to establish a common reference year of 2005.

On the other hand, the reduction objectives are presented in different ways:

i/ As a partial and/or sectoral objective: for instance, a proportion of renewable sources in the energy mix or objectives that are merely relative to one sector of the economy. These have not been considered in the calculation of emissions reductions.

[1] http://www4.unfccc.int/submissions/INDC/Submission%20Pages/submissions.aspx

ii/ In GHG emissions intensity (CO2eq/GDP). To calculate the net variation in emissions, we proceed as set out in the methodological annex.

iii/ As emissions reductions with respect to a base year. The only countries obliged to do so are those in Annex I[2] and, with some exceptions, the only ones who do so in this way. No additional calculation is needed beyond establishing the base range and/or horizon year.

iv/ As emissions reductions with respect to a trend scenario (business as usual). This is the most common, used by all the countries not in Annex 1, except Brazil[3]. To calculate the variation in absolute terms with respect to the base range, we proceed as detailed in the methodological annex.

Taking a conservative stance, we have considered that the trend and the real variation in emissions is the same for the Annex I countries, assuming that they will carry out all the promised policies and that they will, indeed, reach the appointed goals. In addition, we have calculated the weighted emissions with respect to each country's contribution to global emissions in 2013, the last year for which reliable, homogeneous data exist through the Emission Database for Global Atmospheric Research (EDGAR) of the European Commission.

On the other hand, the necessary funding for each plan has been broken down into mitigation, adaptation and other expenses. The INDCs provide figures in dollars (without specifying any basis) to be expended from 2020 to 2030. Financial effort is measured as the share of financial funding allocated by the INDC over GDP (2010 constant dollars at market prices). External funding and its proportion over total funding has been evaluated as well. Similarly, we have obtained the amount of funding required per unit percent of emissions reduction. This information has been obtained directly from the data facilitated by the INDCs. When not provided, it has been made the assumption that the share of external funding equals the proportion of conditional emissions reduction over total emissions reduction.

Finally, it has been summarized the main policies with respect to the different sectors of each country, as well as a summary table of the main policies to which each country is committed. The policies are broken down according to the Directives of the IPCC for the national inventories of greenhouse gases (1996). However, the breakdown of the energy sector has been used due to its strategic nature for some INDCs.

[2] Industrialized countries that were members of the OECD (Organisation for Economic Co-operation and Development) in 1992, plus countries with economies in transition (the EIT Parties), including the Russian Federation, the Baltic States, and several Central and Eastern European States.

[3] Unless explicitly mentioned alternatively, when a particular country is mentioned, the reference is its INDC, which can be consulted in the UNFCC repository, as explained in footnote 1.

3. Towards a new landscape: the INDCs in detail.

An exhaustive analysis of all the INDCs has been carried out with respect to four criteria: i/ the quality of the information provided; ii/ the proposed policies; iii/ the funding needed to carry them out and, finally; iv/ the estimated reduction in emissions.

3.1. Quality of information

The greatest difficulties involved in carrying out this research concerned the lack of homogeneity in the data. The INDCs come from different sources, the quantity and quality of the information is highly variable and even contains errors. The INDCs have been divided with respect to the quality of the general and funding information offered, according to the criteria of Table 1.

Table 1. Information criteria

	General information	Financial information
Low Quality	Low or none emissions information and/or low or none policies	No financial information.
Medium Quality	Sufficient emissions information and/or sectoral disaggregated policies information.	Financial information in total amounts.
High Quality	Good emissions information and highly deep disaggregated policies information.	Financial information disaggregated by area (mitigation/adaptation) and/or by policies/sectors.

Source: Own compilation on the basis of the INDCs submitted to COP21.

According to what can be seen in Table 7, the quality of the information follows a trajectory which is inversely proportional to the level of income of the country collecting the said information. Only 18.5% of the plans can be considered as offering general information of high quality, and only 12.7% as far as finance is concerned. In addition, only the plans from countries with medium-low and low incomes offer a higher than average quality in both categories.

These correspond mostly to small island states and African countries. For the former, climate change supposes the greatest possible threat (being submerged under the sea), while the latter see in the Paris Agreement an opportunity for sustainable development aided externally. The low quality of financial information provided by the OECD countries does not provide any data at all about the funding of their policies (two thirds of the plans have been classified as of “low quality”). The lack of any common standards or adequate auditing of the information received means that the objectives are difficult to compare or measure, which in turn makes any effective control over compliance almost impossible.

3.2. Mitigation policies: energy, industry, agriculture, waste and LULUCF.

The different policies under review in the INDCs respond to the following sectoral structure: i/ energy - electricity generation, transport and housing -; ii/ industrial processes; iii/ use of solvents and other products, iv/ agriculture, v/ change in land use and forestry (LULUCF) and, vi/ waste. Table 2 summarizes the principal policies by sectors and each one is assigned a code to facilitate understanding and clarity in the other summary tables.

Table 2. Overview of main policies in the INDCs

SECTOR	SUBSECTOR	POLICY	ACTION	CODE
ENERGY	ELECTRICITY GENERATION	Transition to renwable and cleaner technologies.	Renewable deployment: solar, wind, hydro.	G1
			Combined cycle power stations. Switch to natural gas.	G2
		Decentralization of energy	Off and on-grid roof solar panels, solar thermal and	G3
		Rural electrification.	Substitute charcoal by electricity/Electrification	G4
		Process efficiency.	Best thermoelectric generation (coal and gas).	G5
			Reconstruction, construction or improvement of	G6
			Efficient technologies.	G7
		Reduction	Absolute reduction in energy consumption	G8
	RESIDENTIAL	Consumption efficiency.	Enhanced technologies for heating and cooking	R1
			Best lighting technologies.	R2
			Enhance buildings efficiency/solar thermal installation.	R3
			Social awarness.	R4
	TRANSPORT	Transport efficiency	Encouraging acquisition of hybrid and efficient vehicles.	T1
			Discourage acquisition of inefficient vehicles.	T2
		Fuels substitution.	Carbon tax (emissions).	T3
			Promotion and research on biofuels.	T4
			Promotion of electric and hybrid vehicle.	T5
		Structural change.	Mass public transport.	T6
			Intermodality and switch to an efficient transport	T7
			Spatial and urban planning.	T8
			Improvement of road system.	T9
			Non motorized transport.	T10

SECTOR	POLICY	ACTION	CODE
INDUSTRY	Process efficiency.	Improve the overall efficiency of industry.	I1
		Energy cogeneration.	I2
		Measures oriented to industrial ecology.	I3
	Sectoral.	Reduce emissions in cement industry.	I4
	Structural change.	Modernization and switch to an enhanced value added	I5
		Tertiarisation (China).	I6
	Emissions reduction.	Carbon capture and storage and Carbon capture and use.	I7
	Extractive industry.	Reduce flaring and venting.	I8
		Improvements in processes, efficiency and distribution.	I9
WASTE	Circular economy and reduction.	Reduce, Reuse, Recycle.	W1
		Transform waste to energy.	W2
		Social awarness (minor support).	W3
	Management.	Improve landfill management,consctruct new ones and promotion of compost.	W4
	Sanitation.	Sanitation improvement in residential sector.	W5
AGRICULTURE	Structural change.	Modernization and intensification of agriculture.	A1
		Climate Smart Agriculture.	A2
	Sectoral.	Reduce emissions of rice fields.	A3
	Others.	Control of fertilizers and pesticides.	A4
		Methan capture.	A5
LULUCF	Extend vegetation cover.	Avoid defforestation.	L1
		Afforestation and refforestation.	L2

Source: Own compilation based on the INDCs reported to COP21.

This analysis is dealt with from the sectoral point of view by policies and, secondly, from the regional point of view by country and income group. In order to evaluate most common policies at world level, it has been calculated the number of countries choosing each policy over total countries. Then to address the regional analysis, the same process has been made in each income group region. Further information on the method is in the methological annex.

3.2.1. Analysis by sector and policy

As can be seen in Table 3, the policies that stand out most of all are those aiming for an electric mix based on renewable energies (95.2% of the INDCs). This policy is followed by transversal efficiency measures for all sectors and the increase in green cover through LULUCF. Some of these measures, such as the electrification of the economy and decentralized electricity generation (23% and 31% respectively), take on even greater importance on a regional scale. With respect to the decentralization of energy, oil rich countries stand out; countries such as Nigeria, which aims to install off-grid photovoltaic panels, or Equatorial Guinea , with its "home energy" programme. In addition to those already mentioned, an important role will be played in the future of energy by natural gas and the combined cycle power stations, according to what can be seen from the INDCs.

Table 3. Top 15 policies.

Code	Policies	Proportion
G1	Renewable deployment: solar, wind, hydro.	95.2%
G7	Efficient technologies.	44.4%
L1	Avoid deforestation	43.7%
L2	Afforestation and refforestation.	41.3%
G3	Off and on-grid roof solar panels, solar thermal and small hydro.	31.0%
T6	Mass public transport.	29.4%
T1	Encouraging acquisition of hybrid and efficient vehicles.	27.0%
W4	Improve landfill management,consctruct new ones and promotion of compost.	26.2%
G4	Substitute charcoal by electricity/Electrification	23.0%
W2	Transform waste to energy.	23.0%
G2	Combined cycle power stations. Switch to natural gas.	20.6%
R1	Enhanced technologies for heating and cooking (substitution of charcoal).	20.6%
W1	Reduce, Reuse, Recycle.	19.8%
T4	Promotion and research on biofuels.	18.3%
I1	Improve the overall efficiency of industry.	15.1%

Source: Own compilation on the basis of INDCs submitted to the COP21. Information provided by total parties with policies.

As for the transport subsector, there is a great bid to foster public transport and efficiency policies for private vehicles (29.4% and 27.0% of countries, respectively). The latter goal the countries hope to achieve through incentive-disincentive tax policies, in particular through the promotion of imports (important in the small island states), or the establishment of a carbon tax on inefficient vehicles. Although the commitment to biofuels is not at all generalized (18.3% of the plans), it is important demographically and/or economically for some countries that are committed to it, such as Argentina , and especially India. Far less important is the promotion of the electric or hybrid vehicle (13.5% of countries), although, once more, we find a relevant exception in India , which refers to its National Electric Mobility Mission Plan 2020 (NEMMP) detailing its action plan (Government of India, 2012).

In the industrial sector, what stand out are the measures to improve efficiency related with better technologies and the cogeneration of energy. In addition to reduction measures in sectors with especially high emissions, such as that of cement, structural measures are also envisaged, such as modernization and increasing the value added of industry and boosting the service sector of the economy (China). The use of carbon capture and storage (CCS) and carbon capture and utilization (CCU) (Saudi Arabia, Bosnia-Herzegovina, Malawi, Norway, Qatar, Saint Vincent & the Grenadines, Venezuela), as well as the use of clean technologies, are other measures aimed at reducing emissions. Furthermore, countries with an extractive industry do not provide for leaving their resources underground. They concern only an improvement in the extraction, processing and distribution processes, as well as a reduction in emissions due to gas flaring.

As for the waste sector, classic measures are considered, such as reduction (with a smaller presence), recycling and reuse, as well as what is usually called “recovery”. They also consider the transformation of waste into energy through biogas or biomass, and the improvement of rubbish tips or their construction in countries that lack an adequate waste management (26.2% of the INDCs). For its part, India, with an important public health problem related with the management of human waste in the cities, aims to promote an ambitious sewage network, beginning with the most basic aspect: the installation of lavatories in homes. In the agricultural sector, especially in low income countries, the aims of “modernization” abound, although they do not specify how this should be done. Some countries, such as Afghanistan and Nigeria among others mention to apply for the so-called Climate Smart Agriculture (CSA), even though it is more an adaptation program instead of mitigation. On the other hand, measures are also planned to reduce methane emissions in the rice fields, to control the increased use of fertilizers and pesticides and, finally, to capture methane from the enteric fermentation of cattle and manure.

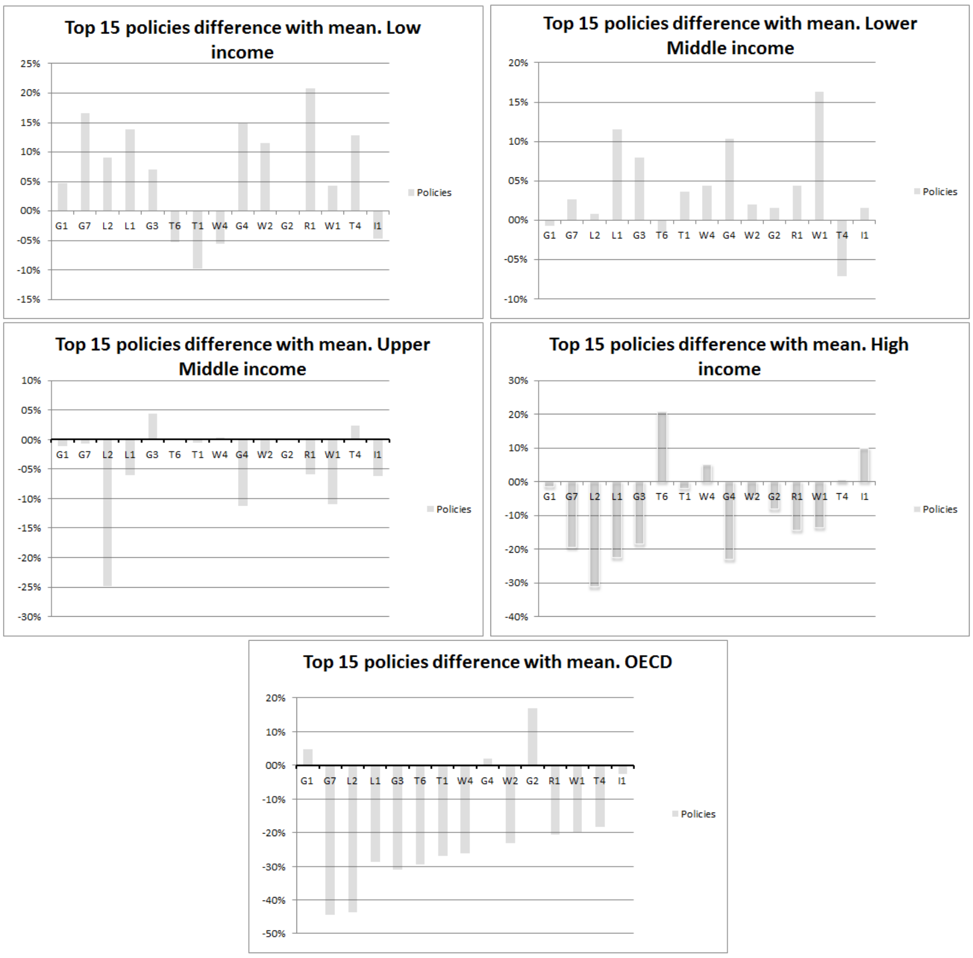
Finally, LULUCF sector is one of those that are becoming more important, particularly for those countries that already have a large surface area of forest. Of greatest importance in this sphere are: the fight against deforestation, the reforestation of deforested areas, and the afforestation of areas previously dedicated to other uses. Outstanding in this respect are such countries as Brazil (as a carbon sink) , or others with such large populations as Bangladesh , and even those with such enormous economic and environmental importance as China .

3.2.2. Regional analysis

This sectoral policy view would be incomplete without a regional insight, which has a key relevance in the feasibility of accomplishing the Agreement. Figure 1 shows the deviation of each top15 policy share by income group from the world average.

It can be seen, for instance, that the electrification of the economy and its decentralized generation take on greater importance in the Less Developed Countries (LDCs). Charcoal is used abundantly in these countries as a source of primary energy for heating and cooking (see Figure 1).

Figure 1. Top 15 policies. Differences of each policy with respect to the global mean by income groups.



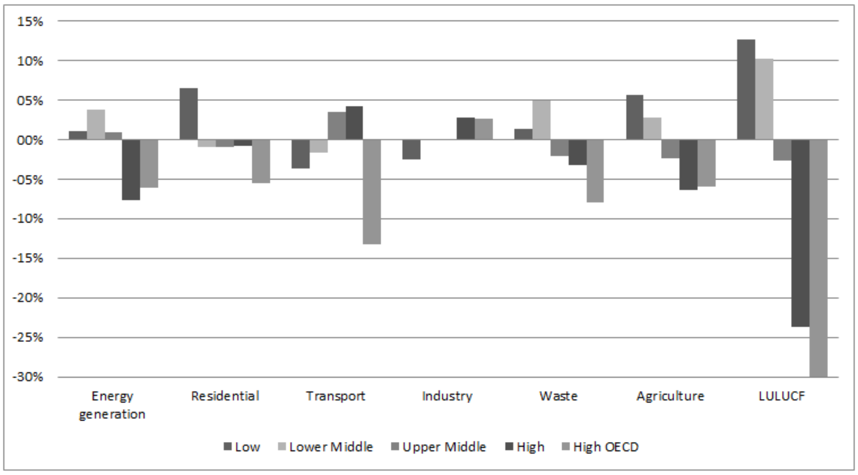
Source: Own elaboration on the basis of INDCs submitted to the COP21.

This is why low income countries also stand out with respect to improvements in cooking and heating efficiency. In the same way, the lower middle income countries are comparatively more committed to the reduction, recycling and reuse of waste than the rest, as well as to the fight against deforestation. The upper middle income countries are committed above the average to promoting biofuels and decentralizing the generation of electricity. On the other hand, the high income countries champion the improvement of their public transport systems and the efficiency of their industries. Finally, the countries of the OECD, in spite of the bias caused by the lack of data, seem to be more committed to natural gas and combined cycle power stations. In general terms, it can be seen that low income countries make above average use of the Top

15 policies and that this use begins to fall the higher the country's income. Also evident is a dynamic towards abandoning the LULUCF policies as the countries' incomes get higher.

These tendencies are confirmed when we analyze the relative weight of each set of sectoral policies over the total number of countries. Figure 2 shows the deviation of sectoral relevance (measured as the number of countries taking policies from each sector, see methological Annex A) of each region from world average. Thus, the LDCs have an above average impact on the policies concerning the generation of electricity, housing, waste management, agriculture and LULUCF; while the developed countries (DC) do so in transport and the industrial sector.

Figure 2. Sectoral relevance by income groups. Differences with respect to global sectoral mean.



Source: own elaboration on the basis of INDCs submitted to COP21.

The importance of the abovementioned sectors, in the former case, follows an inverse relation to income, while in the second case, the relation is positive. This regional distribution of the policies will have important consequences for the efficacy of the Paris Agreement in reaching its goals.

Table 2. Overview of policies by country (1-72).

	Country	Energy	Resid.	Transport	Industry	Waste	Agric.	LULUCF
1	Afganisthan	G1 G3 G4	R1		I9	W4	A2	
2	Albania	G			I			
3	Andorra	G				W		
4	Angola	G1 G3		T4			A4	L1 L2
5	Antigua y Barbuda	G1		T1		W2		
6	Algeria	G1 G2 G8		T1	I8			L1 L2
7	Argentina	G1 G7		T4 T6 T7				L1
8	Armenia	G1 G7		T3 T5				L1 L2
9	Australia	G1 G7		T1				
10	Azerbaijan	G1 G2 G3 G5 G6	R2 R4	T5 T6 T9	I8 I9	W4	A1 A5	L2
11	Bahamas	G1 G2	R2 R3	T1 T2 [illegible]				
12	Bahrain							
13	Bangladesh	G1 G2 G4 G5 G7	R1	T1 T6 T7	I1	W2 W4	A1 A3	L2
14	Barbados	G1 G7				W2		
15	Belize	G1 G7	R	T1 T4 T6				L1 L2
16	Benin	G1 G2 G3	R	T6		W	A1	L1 L2
17	Bhutan	G1 G7		T1 T6 T7 [illegible]	I1 I5	W1 W4	A2 A5	L1 L2
18	Belarus							L2
19	Bolivia	G1 G4						L1 L2
20	Bosnia-Herzegovina	G1 G3 G4	R1 R4		I7			
21	Botswana							
22	Brazil	G1 G7		T1 T6	I1			L1 L2
23	Brunei	G1 G8				W2		
24	Burkina Faso	G1 G3 G6	R1 R2	T1 T4		W2	A5	L1 L2
25	Burundi	G1 G3 G7	R1			W2 W4		
26	Cabo Verde	G1 G3 G7	R1	T1 T5		W1 W2 W3		L2
27	Cambodia	G1 G3	R	T1 T5 T6	I1		A5	L1 L2
28	Cameroon	G1 G7				W1 W4	A1	L1
29	Canada	G1 G2		T1 T2	I8			
30	Chad	G1 G5				W4		L2
31	Chile	G1 G4		T2	I1			
32	China	G1 G2 G5		T1 T6 T8 T9 [illegible]	I3 I5 I6 I7	W1 W3	A4 A5	L1 L2
33	Colombia							
34	Comores	G1 G2 G6				W2 W4		L1 L2
35	Congo	G1 G4					A1	L1 L2
36	Cook Islands	G1 G6 G7						
37	Ivory Coast	G1 G2 G7		T1 T8	I1 I2	W1 W2 W4	A1	L1
38	Costa Rica	G1 G4 G7 G8	R		I1			L1 L2
39	Cuba	G1 G3	R1 R2				A5	
40	Djibouti	G1 G6	R	T2 T6				
41	Dominica	G1 G3 G7		T5		W4		
42	Ecuador	G1 G2	R1	T7				L1 L2
43	Egypt	G1 G7	R3	T1 T6 T7	I1 I2 I3 I8	W1 W4	A3 A5	
44	El Salvador	G1 G7	R3	T8			A1	
45	Eritrea	G1 G4	R1 R2	T2 T4	I2	W1 W2	A5	L2
46	Ethiopia	G1	R	T1	I1		A1	L1
47	Fiji	G1 G7		T4 T5				
48	Phillipines							
49	Gabon	G1 G2 G7		T2 T6 T9	I8			L1
50	Gambia	G1 G6 G7	R1 R3	T1		W1	A3 A4	L2
51	Georgia							L1 L2
52	Ghana	G1 G7	R1 R2	T6	I1 I2	W1		L1
53	Grenada	G1 G7		T2 T3 T4		W2 W4		L1 L2
54	Guatemala							
55	Guinea	G1 G4 G7						L1 L2
56	Guinea Bissau	G1						L1 L2
57	Equatorial Guinea	G1		T1 T6 T8	I1	W1	A2	L1 L2
58	Guyana	G1 G3 G7	R1 R2 R4		I2		A5	L1 L2
59	Haithi							
60	Iraq							
61	Honduras							
62	India	G1 G3 G4 G5 G6	R2 R3	T1 T4 T5 T6 T7		W1 W2 W5		L2
63	Indonesia	G1 G7				W1 W4	A1	L1 L2
64	Iran							
65	Iceland	G1 G2	R		I8			
66	Marshall Islands	G1 G3 G7	R1	T1 T4 T5		W4		
67	Israel	G1 G2 G7		T6				
68	Jamaica	G1 G7		T1 T3				
69	Japan	G1 G4	R	T1 T5 T6 T7	I1 I2	W1 W4	A4	L1 L2
70	Jordan	G1 G2 G3 G7	R3	T1 T5 T6 T7	I2	W4		L2
71	Kazakhstan	G1 G7				W4		L2
72	Kenya	G1 G7	R1	T1		W4	A2	L2

Source: Own compilation on the basis of INDCs submitted to the COP21.

Table 4 (continuation). Overview of policies by country (73-144).

	Country	Energy	Resid.	Transport	Industry	Waste	Agric.	LULUCF
73	Kiribati	G1 G3		T4				L1 L2
74	Kuwait							
75	Kyrgizistan							
76	Lao	G1 G4		T4 T6 T9				
77	Lesotho	G1 G4 G6	R1 R2	T1 T6	I1	W1 W4		L1 L2
78	Lebanon	G1 G7						
79	Liberia	G1 G4 G7	R1					
80	Liechtenstein							
81	Macedonia							
82	Madagascar	G1 G4 G7	R1			W1 W2	A2 A3	L1 L2
83	Malaysia							
84	Malawi	G1 G3	R1 R3	T4 T6	I4 I7	W1 W2	A1 A4	L1 L2
85	Maldives							
86	Mali	G1 G4					A2 A3 A4	
87	Morocco	G1 G2 G7				W1 W4	A1	L2
88	Mauritius	G1 G2 G4		T5		W2	A2	L2
89	Mauritania	G1 G4 G7		T1 T2				
90	Mexico							
91	Micronesia							
92	Moldova							
93	Monaco			T5 T6 T10				
94	Mongolia	G1 G5 G6	R1 R3	T2 T5 T6 T9	I1 I2 I4	W1 W2 W4	A4 A5	
95	Montenegro							
96	Mozambique	G1 G2		T4		W1 W4		L1 L2
97	Myanmar	G1 G3 G4 G7	R1					L1 L2
98	Namibia	G1	R	T2 T6				L1
99	Nauru							
100	Nepal	G1	R1	T6 T10		W2		L1 L2
101	Niger	G1 G2 G4	R			W2		L2
102	Nigeria	G1 G2 G3 G7		T2 T6 T7 T9	I1 I8 I9		A2	L1
103	Niue	G1 G7		T1 T5				L1
104	Norway	G1			I1 I7			
105	New Zealand							
106	Oman	G1 G7			I1 I8			
107	Pakistan							
108	Palau	G1 G3 G4	R	T2 T4 T6		W2		
109	Papua New Guinea	G1 G7	T1 T6 T7					L1 L2
110	Paraguay	G1 G7		T7				L2
111	Peru							
112	Qatar	G1 G7			I1 I7			
113	DR Congo	G1 G3					A1	
114	Central African Republic	G1 G4	R1 R2	T4		W1		L1 L2
115	Republic of Korea							
116	Dominican Republic							
117	Rwanda	G1 G2 G3 G6	R1	T2 T4 T6 T7	I1 I3	W2		L1
118	Russia							
119	Solomon	G1 G3						
120	Samoa	G1 G3						
121	San Marino	G1 G8	R3	T8		W4		
122	St Kitts	G1 G6 G7 G8		T1 T2 T7 T8 T9				
123	St Lucia	G1	R3	T1 T2		W4		L1
124	Santo Tomé	G1 G3						
125	Saudi Arabia	G1 G7			I7 I8			
126	Senegal	G1 G3 G4 G7 G2	R1	T6	I4	W2	A3 A5	L1 L2
127	Serbia							
128	Seychelles	G1	R	T2 T4 T5 T6		W4		
129	Sierra Leone	G1 G3	R4	T1 T6 T4		W1 W2	A2 A5	
130	Singapur							
131	Somalia	G1						L1
132	Sri Lanka			T1		W1 W2 W4		
133	St Vincent and the Grenadines	G1 G3 G7	R3	T2 T6				L1 L2
134	South Africa	G1		T5	I7			
135	Sudan	G1 G2 G3 G7				W1 W2 W4		L1 L2
136	South Sudan	G1 G7	R	T2				
137	Switzerland							
138	Surinam	G1 G3	R	T4		W2		L1
139	Swazilandia							
140	Thailand	G1 G6 G7						
141	Tajikistan	G1 G6			I5			
142	Tanzania	G1 G2 G4 G6	R	T6 T7				
143	Togo	G1	R	T4			A3	L1
144	Tonga	G1 G3 G6	R					

Source: Own compilation on the basis of INDCs submitted to the COP21.

Table 4 (continuation). Overview of policies by country (145-161).

	Country	Energy	Resid.	Transport	Industry	Waste	Agric.	LULUCF
145	Trinidad and Tobago							
146	Tunez	G1	R		I4	W2 W5		L2
147	Turkmenistan							
148	Turkey	G1 G3 G6	R3	T6 T7 T8	I1	W1 W2 W4	A1 A4	L2
149	Tuvalu	G1 G3 G7						
150	UAE	G1 G2	R3	T1 T6 T7	I1	W4		
151	Ukraine							
152	EU28							
153	Uganda	G1 G3 G4	R1	T1			A2 A5	L1 L2
154	Uruguay	G1		T1 T4 T5 T6 T7	I4	W4	A3 A4 A5	L2
155	USA	G1	R3	T1	I8	W4		
156	Vanuatu	G1 G3 G4 G7						L1
157	Venezuela	G1 G3 G7	R2 R3 R4	T6	I4 I7 I8	W4		
158	Vietnam	G1 G2 G7	R	T1		W1 W2	A5	L1 L2
159	Yemen	G1 G2 G3 G4 G7	R3 R4	T1	I2	W2	A5	
160	Zambia	G1 G3 G4	R1	T4			A2 A5	L1
161	Zimbabue	G1 G3 G4 G5 G7	R3	T4		W4		

Source: Own compilation on the basis of INDCs submitted to the COP21.

3.3. Finance, equity and leadership of the transition

Means of implementation are needed to set these policies in motion. Article 9.1 of the Paris Agreement establishes that the DCs (Annex I countries, i.e. OECD) should provide the LDCs with financial resources. In addition, there should be reports every two years on the resources mobilized. In this sense, the great majority of the INDCs of the LDCs incorporate a series of unconditional objectives, assumed by the country itself, and other objectives conditioned by the reception of external support. Besides financial resources, other external support contemplated in the Agreement includes capacity-building and technology transfer.

All the figures set out in this section must be considered with caution, due to the lack of homogeneity and clarity of the INDCs. Thus, the proportions destined to mitigation policies (83.2%), as opposed to those of adaptation, are often biased due to the high figures given by India (2500MM$), Iran (927.5MM$) and South Africa (898.79MM$) that account for 79.8% of the total funding. The group of countries that make the greatest effort in terms of finance with respect to their GDP are the low income countries, due both to their reduced level of GDP and the great quantity of external finance they have to account for. Specifically, 87.1%of all the financing required by the INDCs over the low income countries which has been evaluated corresponds to external resources. The choice, in Table 5, of the last indicator instead of the first is due to the fact that it is excessively biased because of the lack of data. It can be observed that the majority of countries requiring external financing do so in a relatively high proportion. This is such that a conservative estimate (only including the external financing explicitly mentioned) shows that almost half (41.4%) of the funding needed to completely implement the INDCs depends on international cooperation. Of course, this is a challenge in the design of climate funding which we shall deal with below.

Table 5. Financial allocation by income group (billions $). Total and effort related to GDP

	Mitigation (bs $)	% over Total	Adaptation (bs $)	% over Total	Other (bs $)	Total (bs $)*	% GDP	% external support**
Low	387.0	61.8%	156.4	25.0%	82.5	625.8	204.6%	87.1%
Lower Middle	1016.3	35.9%	323.3	11.4%	1492.3	2831.8	99.1%	73.2%
Upper Middle	1793.3	91.5%	167.4	8.5%	0.0	1960.7	69.4%	92.7%
High	6.2	78.6%	1.5	19.4%	0.2	7.9	22.7%	77.8%
High OECD	ND	ND	ND	ND	ND	ND	ND	ND
Top 12 polluters	846.5	33.6%	222.8	8.8%	1452.3	2521.6	89.2%	-
TOTAL	**3202.7**	**83.2%**	**648.5**	**16.8%**	**1574.9**	**5426.2**	**7.3%**	**41.4%**

Source: own compilation on the basis of INDCs submitted to COP21. GDP in 2005 constant dollars at market prices.* The totals in bs $ are not always the sum of Mitigation+Adaptation+Other because some INDCs offer totals with differences whose origin is not explained.** The percentage represents the proportion of external resources required by those INDCs that do offer data. However, the total percentage is the total amount of external resources required by all the plans over the total financing of the all the INDCs, including those that have no breakdowns.

In order to channel the public and private resources that finance the mitigation and adaptation policies of the DCs to the LDCs, the UNFCCC has developed a complex system of climate funding (Buchner et al., 2015; Román, 2013). The ones most cited by the INDCs are the Green Climate Fund (GCF), the Green Environment Facility (GEF) and the Clean Development Mechanism (CDM) for compensation. The CDM should be a zero sum game (Erickson et al., 2014) in which investment in mitigation projects in the LDCs generates 'Certified Emission Reductions' (CER) that can be used to increase emissions by the same amount that the investment reduced them, or alternatively can be sold on the carbon markets. In total, 42 countries want to gain access or have already gained access and want to continue with the CDM, not counting those who have expressed a desire to use unspecified market mechanisms.

The funding sources proposed by countries say a lot about the agents who will guide the practical set up of the INDCs. Depending on whether the conditional part of the external support for the LDCs is larger or smaller, the transition will be influenced by the criteria established by the international institutions or by the particular interests of the countries with which they reach bilateral agreements. In addition, naturally, the degree of importance given to the public or private sector will have consequences in the transition's directive criteria, its effectiveness, and the coordination between policies and how fast the changes are implemented.

Based on the finance sections of INDCs, it can be seen that in low income countries, more importance is given to external support (in particular the GCF), donations, carbon markets and the CDM. The weakness of these States means that, in addition, the private sector plays an important role. Those outstanding for their confidence in the private sector are Burkina Faso , Liberia and Sierra Leone . For its heterogeneity of agents, Uganda is also worthy of note, with a transition led by the public sector, but with the participation of the local communities, public-private partnerships (PPP) and the international community.

In the medium-low income countries, public participation and multilateral finance institutions have greater weight. The external support continues to be the principal driving force of the transition, although bilateral agreements are gaining weight, while the participation in such control mechanisms as CDMs are falling slightly (this is a constant as income rises). While Indonesia mainly has confidence in the private sector, Bolivia does so in the public sector and demands that the external support should be totally non-returnable. As the countries' level of income rises, the financial autonomy to put the transition into practice also rises.

In the medium-high income countries, Colombia mainly has confidence in the private sector and tries to involve the university system in the transition; while Cuba, on the other hand, continues to have confidence in a transition through the public sector, with such measures as the distribution of clean technologies for the residential sector (lighting and cooking). China , however, deploys some very diverse means led by the state, such as the PPP, favourable taxation, public contracts, green credit and financial guidance through the public bank, disaster insurance, etc. As we analyze the INDCs of the countries with higher incomes, the information becomes scarcer, but it continues with the dynamic of increasing the internal autonomy and government leadership.

3.4. Reducing emissions?

Since one of the objectives of this article is the evaluation of the efficacy of the INDCs to comply with the Paris Agreement, the calculation of the variation in absolute emissions for each one is fundamental. The said calculations have had to be done because of the disparity in the forms of presentation of the contributions and have been carried out according to what is set out in the section and annex on methodology. Table 7 shows these results. As explained in section 2, there has been needed to estimate emissions reductions from the INDC's data for those not giving the information as a reduction from a base year. Taking the simple arithmetic means, and if the mitigation policies (BAU) are not carried out, then each country would double (an increase of 95.7%) their emissions of GHGs in 2030 as compared to their defined level between 2005-2015. In order to get a better adjusted calculation, if we take the weighted mean as each country's contribution to world emissions (in 2014), the result would be an increase in world emissions of 31.5%. This result can basically be explained by the top 12 polluters, which will be analysed separately below. .

The setting in which mitigation policies are carried out is not much rosier. In the best of cases (conditional on the reception of external support from countries not included in Annex I), each country would emit an average of 37.8% more than in the years 2005-2015. When this is weighted, the figure would be a 19.3% increase, due to the contribution of some Top 12 polluters, as we discussed in the next subsection. . In the least optimistic case, in which none of the conditional policies are put into practice, each country would modify their emissions on average with respect to the base interval by 75.0%. If this is weighted, emissions would increase on a global level around 25.8%.

Although the INDCs always talk about reductions, they are seen in GHG emissions intensity (CO2eq/GDP) or over a BAU setting. Predicting the countries where the GDP will grow much more than their emissions and the BAU settings being on the increase, the final result is that of a net increase in GHG emissions, which cancels out the reductions in the Annex I countries and Brazil. India, for instance, aims to more than quadruple their emissions, China aims to increase by 39.8%, while other countries such as Burundi , Papua New Guinea , Liberia , Bangladesh or Congo oscillate around a growth factor of between 3 and 4. The trend scenarios of Congo and Burundi stand out especially, as they plan to multiply their emissions by more than 6 and 5 times, respectively.

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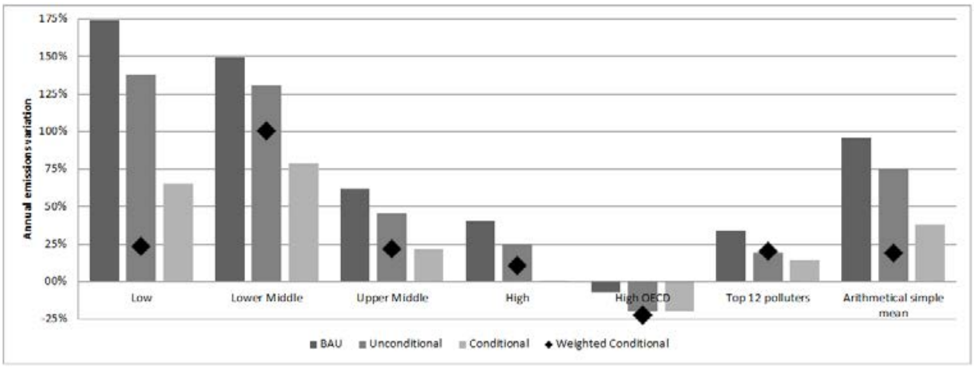
Figure 3. Emissions variations by income level and different scenarios from baseline 2005-2015 to 2030



Own elaboration on the basis of the INDCs submitted to COP21.

In effect, Figure 3 reflects a decreasing tendency in mean emissions as income rises. However, the weighted mean shows an initially upward trajectory which then decreases as the income level increases. This is so because the low income countries currently represent a very small fraction of the emissions, while India (lower middle) would explain the highest point. On the other hand, the upper middle countries see China's increase compensated for by the absolute reduction in emissions proposed by Brazil. As can be seen, the OECD countries (all of those in Annex I) are the only ones that plan to make an absolute reduction in emissions.

Finally, as can be seen in Table 7, the countries that use their resources less efficiently (measured in dollars by percent unit of absolute reduction or over the BAU scenario) are the LDCs[4]. This is due to two reasons. The first one is beacuse they are the countries that plan to depend on greater external funding. The second one is because their mitigation policies would be more than compensated for by economic growth.

3.5. The Top 12 polluters pathway

Top 12 polluters encompasses 60% of world population and 72.2% of GHG emissions. Policies and objectives established by this groups will affect 6 out of 10 world inhabitants (and probably increasing as population in China, India and others do not stop rising). Regarding the information provided by Top 12 polluters can be seen (Table 6) that policies information varies amongst them, but financial information is of low quality in general. In the first place of policies these countries choose a transition towards a renewable electricity mix. In the second place in most used policies by, Top 12 polluters arethe improvement in the efficiency of private vehicles (77%).

As a result of the Top 12 policies and emissions reduction objectives, the whole Paris Agreement expected outcomes vary. In fact, when the average emissions reduction objectives are weighted by the countries contribution to GHG world emissions, the result is lower. This is because the increases in China and India (39.8% and 232.78%) respectively) are offseted by the reduction compulsorily proposed by Annex I countries plus Brazil. Nevertheless, if just China and India are taken apart, Paris Agreement expected outcomes would be rather differents. For instance, without their contribution, the emissions would decrease by 4.0% in the Conditional

4- The high index shown by the upper middle countries is due to the high inefficiency in reducing emissions of the funding used by Iran (77.3MM$ per percent unit of reduction over the BAU scenario).

scenario, while they would slighlt rise by 2.5% unconditionally. In other words, given the past behaviour of DCs economies, the incorporation of China and India to their consumption and production patterns would be the main reason why the Paris Agreement objectives are so difficult to achieve. Paradoxically, without the economic contribution of India (as China does not provide finance information) the allocation or resources destined to mitigation would be almost halved in terms of world GDP, droping to 3.9%.

Table 6. Overview of Top12 polluters. Information, emissions and financial resources.

	General Information quality	Financial Information quality	Absolute emissions variation respect 2005 (%)			Main policies*	Share of total emissions
			BAU	Unc	Cond		
China	High	Low	-	39.8%	-	G1, G2, G5, T1, T6, T8, T10, I3, I5, I6, I7, W1, W3, A4, A5, L1, L2	23.9%
U.S.A.	Low	Low	-	-28.0%	-	G1, R3, T1, I8, W4	12.1%
EU-28	Low	Low	-	-34.8%	-	No information.	9.0%
India	Medium	Medium	-	232.8%	-	G1, G3, G5, G6, R2, R3, T1, T4, T5, T6, T7, W1, W2, W5, L2	5.7%
Brazil	Medium	Low	-	-43.0%	-	G1, G7, T1, T6, I1, L1, L2	5.7%
Russian Fed.	Low	Low	-	10.3%	-	No information.	5.3%
Japan	High	Low	-	-22.7%	-	G1, G4, R, T1, T5, T6, T7, I1, I2, W1, W4, A4, L1, L2	2.8%
Canada	Low	Low	35.0%	-30.0%		No information.	2.0%
Congo, DR	Medium	Medium	74.0%	74.0%	44.4%	G1, G3, A1	1.5%
Indonesia	Medium	Low	123.7%	65.6%	32.0%	G1, G7, W1, W4, A1, L1, L2	1.5%
Australia	Low	Low	-	-28.0%	-	G1, G7, T1	1.5%
Korean Rep.	Medium	Low	51.9%	-4.3%	-	No information.	1.3%
Total			**71.2%**	**26.3%**	**10.5%**		**72.2%**
Weighted			**24.5%**	**20.5%**	**19.2%**		

Own elaboration on the basis of the INDCs analyzed (INDCs,2016). *According to the code stated in Table 2.

4. Economic and environmental features of INDCs

In order to globally evaluate the INDCs, we follow the definition of Fischer-Kowalski (2011) of a socio-metabolic transition towards sustainability as that in which society does not pass the limits imposed by the biophysical system upon which it depends. To do this, it is not enough to analyze the sufficiency or insufficiency of the reduction in GHG emissions to the atmosphere. It is also necessary to evaluate the energy and material sustainability of the suggested policies to promote a socio-economic structure. Section 4.1, 4.2, 4.3 and 4.4 contrasts policies collected in the INDCs (see section 3.2) with the literature. Supported in this literature, we discuss the feasibility of INDCs proposed policies and its capability to jointly achieve the 2ºC objective. Section 4.5 and 4.6 follow the same rationale but referring to finance (see section 3.3) and emissions reduction (see section 3.4) respectively rather than policies. The variables through which the INDCs are classified are as follows: i/ socio-economic impact of the transition; ii/ focus on energy management; iii/ substitution of non-renewable sources; iv/ the role of technology; v/ equality of the transition; vi/ degree of compliance with emission reductions.

4.1. Socio-economic impact

Although the Director of Strategies of the UNFCCC has admitted that the fight against climate change requires a "fundamental transformation in the way we use and produce energy" (Thorgeirsson, 2015), there is a generalized belief that this is consistent with maintaining the current socio-economic system (Spash, 2016).

Although numerous INDCs, such as China, appeal to economic growth and the modernization of their productive structure as a mitigation strategy, there is abundant empirical evidence of the string correlation between growth and environmental impact (de Bruyn et al., 1998; Stern, 2004; Tapia-Granados & Carpintero, 2013; Tapia-Granados, et al., 2012; Wagner, 2008; Carpintero, 2005). Far from there being a process of dematerialization associated with economic growth (Shafik, 1994)[5], what has been observed is a process of environmental load displacement (Peng et al., 2016; Muradian et al., 2002; Cole, 2004). The transfer of "dirty" production to the poor regions has been facilitated by productive specialization, commerce and international finance (Batra et al., 1998; Andersson & Lindroth, 2001; Steen-Olsen, et al., 2012). In addition, we know that both technological industry (Sun-Hee, 2002) and, in general, industrial modernization and the switch to a tertiary economy (Carpintero, 2003) are great consumers of both energy and materials.

On the other hand, numerous INDCs, of note among them being Bangladesh, Cameroon, Turkey or Morocco, express their interest in modernizing their agricultural systems, although they do not explain how this might mitigate the emissions of GHG. However, history tells us that agricultural modernization turns into a process of subordination to industry, making the former dependent on the latter and closely linked to oil products[6]. Thus, agriculture modernization would only result in an increase in both direct and indirect emissions. The indirect emissions are not usually assigned to agriculture, which are normally reduced to

5- As established by the Environmental Kuznets Curve.

6 - Related with its use in making pesticides and herbicides, fuel for machines and that associated with the transport needed to carry the food from where it is produced to where it is consumed (a distance that this process increases).

methane from livestock and the directly emitted waste. This way, the contribution of modern agriculture to climate change is often undervalued.

For all the above reasons, the link between economic growth and wellbeingandalso between growth and environmental sustainability is weakening, as an abundant literature on ecological economics has long been stressing (Víctor, 2015; Jackson, 2011). Measures from industrial ecology approach, followed by Rwanda among others, would contribute in a more effective way to reduce environmental impacts (Ivner et al., 2015; Wen and Meng, 2015; Yu et al., 2015; Côte and Liu, 2016). Given the environmental costs of modern agriculture, it would be much more interesting to transit towards agroecology, with a similar performance for modern agriculture but with less dependence on petroleum and environmental impacts (Altieri, 1995; Gliessman, 2006; Badgley, 2007; Pretty et al., 2003; Seufert, 2012). This model would be based on a proximity system of agricultural foodstuffs that would reduce the need for transport as well as a less meat intensive diet. Bhutan, for instance, advocates encouraging organic farming. China, on the other hand, advocates measures aimed at encouraging an agricultural system that adequately closes the ecological cycles, as well as reaching “zero growth” in pesticides and herbicides (intensive in petroleum use).

4.2. Demand side management policies

With the exception of a few countries, such as Algeria, Barbados, Bhutan or Costa Rica , the majority of the INDCs assume there will be a growing demand for energy, i.e, energy demand is considered as an exogenous variable. Instead of proposing ways to reduce energy demand, beyond the general compromise with efficiency gains, the INDCs focus on changing the energy mix. -However, this view would seem to ignore the energy resources we have counted on in the past and which can be counted on in the future. The development and growth of industrial society cannot be understood without the concurrence of fossil fuels and their enormous energy potential(Hall 2011; Fouquet 2016). There are, therefore, at least two factors that seriously compromise this basic assumption of the great majority of INDCs and government sources studied.

First of all, the arrival of the conventional peak oil (Hubbert, 1956; ASPO, 2008, IEA, 2010) has opened the door for non-conventional oil with a much lower energy performance (EROEI[7]) (Hall & Klitgaard, 2012), which are also more expensive and contaminating to extract

7 - Energy returned on energy invested (EROEI) is the mean energy performance as the relation between the amount of energy obtained by each unit of energy invested in a process.

(Heinberg, 2013). This, together with the foreseeable arrival of extraction peaks in other vitally important energy sources (Heinberg, 2007), leads us to anticipate risks for the future energy supply. Moreover, the International Energy Agency (IEA) (2016) recognized that it is not assured that investments in new oil explorations will be enough to meet demand due to high decline in output from existing fields. Secondly, if the transitions towards low-carbon economies of the INDCs are to be taken seriously, leaving a high proportion of fossil fuels underground should be mandatory (McGlade & Perkins, 2015). The substitution of the energy they provide (to say nothing of whether such provision will get larger or not) by other sources free from GHGs would seem to be complicated, if not accompanied by a reduction in energy consumption, as we shall see below.

The main hurdle to follow this path is that it implies changing consumption and production patterns by means of demand side management policies (Creutzig et al. 2016), especially in DCs and emergent countries. Nevertheless, these policies applied to agriculture, transport, buildings and other sectors show interesting results for climate change mitigation (Creutzig et al. 2016). For instance, households' food consumption has high impacts on energy consumption and direct and indirect emissions (Di Donato, Lomas, and Carpintero 2015). Therefore, changes in diets would be able to reduce by 35% GHG emissions (Stehfest et al. 2009), but it would require a huge conversion in agro-alimentary sector. In addition, reduction of transport needs would require re-organizing the cities design once all of their infrastructures are yet installed. Finally, this reduction in transport needs could need shorter commercialization channels and reducing the volume of international trade.

Comentario [O1]: Añadir breve mención a gestión demanda yu refeeremncia Creutzig 2016.

4.3. Substitution of non-renewable energies

On applying a management approach to the energy supply, the INDCs only consider a substitution of the current energy mix by another one with a greater renewable and/or nuclear proportion. Nevertheless, the ability to substitute one technology for another is far from being perfect.

The support or maintenance of nuclear energy is subject to limitations as far as resources goes, and this should be taken into account. If the forecast of the IEA turns out to be true, the extraction peak of uranium may well be reached in the next few decades (Zittel & Schindler, 2006). On the other hand, the substitution by biomass (in particular biofuels) is also subject to strong limitations (de Castro et al., 2014; Pimentel et al., 2007; Patzek, 2004). Due to the strong dependence of modern agriculture on fossil fuels, agrofuels present a very poor

EROEI (de Castro et al., 2014). Furthermore, their cultivation enters into competition with land dedicated to food production, upon which it would exercise such pressure as to possibly result in price rises.

In addition, the electrification of the economy, even if it could be done totally through renewable sources, would not be simple at all. In this sense, there are sound arguments to sustain that renewable sources do not have sufficient capacity to replace the energy potential of fossil fuels (Moriarty and Honnery, 2016; Capellán-Pérez et al., 2014; 2015; de Castro et al., 2011; 2013; Hoogwijk et al., 2004). There are also rigidities in the substitution of sources due to the different uses they have. For instance, the fuel used in planes, transport and heavy industry cannot simply be substituted by electric energy. In spite of some meritorious efforts in this sense, it would seem clear that it is very difficult to consider a simple technological exchange in the energy mix if it is not accompanied by a reduction in energy consumption.

Finally, it is worth to mention that in absence of a clear policy of leaving fossil fuels underground (McGlade & Ekins, 2015), the international community could face the green paradox. As the market penetration of non-fossil sources increases, their demand would fall, leading to decrease of prices. If there is no political decision to leave fossil fuels underground, their consumption will probably be rebooted via prices incentives. So, if these circumstances are to be avoided, changing the energy mix through is not enough to address decarbonisation.

4.4. The role of technology

The transition towards a hypocarbon model is already possible today, but it would involve a great socio-economic transformation, as stated before. Therefore, technological solutions are proposed, prominently, those referred to efficiency. These policies are the ones that have captured the most funding in recent years[8] (Buchner et al., 2015) and are the preferred policies of the INDCs. Although they are destined to reducing energy consumption, the rebound effect (Polimeni et al., 2008; Blake, 2005; Carpintero, 2003; Duarte et al., 2013) may paradoxically cause the opposite effect, since the most efficient technology reduces the price and increases consumption beyond the initial reduction.

8- In its less conservative range (HSBC, 2014).

A reflection of this point of view would be carbon capture and storage (CCS) or afforestation, which would allow the economy system to keep emitting GHGs into the atmosphere. For instance, Saudi Arabia, one of the main world oil producers, focus on capturing CO_2 from their fields rather than leaving the fossil fuel underground and diversify its economy. The first of them has shown it can face up to obstacles that are difficult to overcome in order to be economically viable (Raveendran, 2013; Leung et al., 2014). On the other hand, afforestation is another of the most widely used measures among the INDCs, especially in LDCs. However, as the forestry land competes with agriculture land, a strong increase in forested areas could push up the prices of prime materials for food and biofuels. In the best of cases, the afforestation of the most ambitious countries could offset deforestation to other countries in order to meet the farmland global requirements (Nilsson et al., 1995; Alig et al., 1997; Murray et al., 2004; Ewers and Rodrigues, 2008; González-Eguino et al., 2016). It is, therefore, a policy that could be incompatible with the current agro-alimentary model and the promotion of biofuels, or maybe subject to filtrations that would convert afforestation into a neutral climate policy.

Although it is a critical sector, the transition towards sustainable transport is of secondary importance in the INDCs (Capellán-Pérez et al., 2014) and there are serious difficulties when attempting to carry it out. As mentioned above, it would be extremely difficult to supply a growing fleet of private vehicles by substituting fossil fuels for electricity or biofuels. In addition, their deployment would enter into conflict with the availability of such materials as lithium (Ortego et al., 2016) and require strong institutional support for the creation of niches in the market and infrastructures. This means that the process could take decades to complete (Kemp et al., 1998; Fouquet, 2010). In any case, transport electrification is not even a very demanded policy in INDCs, as just 13.5% chooses it. Rather, hybrid and more efficient vehicles is the most demanded transport policy amongst the INDCs.

4.5. Transition equity

Emergent medium income countries, such as China or India, interpret equity in the transition as an excuse to maintain the growth of their emissions. The return to individual, voluntary contributions agreed on in the Paris Agreement has only further contributed to sustaining this point of view. However, the obligatory nature of the transfer of resources from the DCs to the LDCs has led to the consideration of the INDCs of the DCs as adequate in terms of equity on an individual level. Nevertheless, the global view indicates a different reality, since the lack of a globally integrated agreement makes it ineffective. The measures that delve into the need to redistribute the effort are reduced to the international climate funding institutions that work through individual projects and to bilateral agreements between DCs and the rest.

The commitment achieved in the Copenhagen Agreement (renewed in Paris) to mobilize 100MM $ annually from the DCs to the LDCs has not only not been kept until now, but falls far short of the needs detected in the INDCs by the LDCs. The total external support distributed between 2020 and 2030 results in the need of 160 MM$ annually. Conversely, the IEA (2014) estimates that achieving a low-carbon energy sector will require an average of 1.2 trillion $ in additional investments every year until 2050. However, the INDCs just compromise 286.45MM $ annually from the total accredited investment. The comparison highlights the fact that, in the best of cases, the financial information of the INDCs is extremely deficient and that, if taken as an approximation, the Paris Agreement would be inefficient in achieving its means of implementation.

According to the *Landscape of Climate Change* (Buchner, 2015), the climate and development institutions only provided 26% of the funding, of which half was national, so only 13% came from bilateral and multilateral institutions. Furthermore, 74% of all climate investment (both public and private) remained in the country of origin, reaching 94% in the case of private funding. This shows that private funding tends not to have an important role in the equity of the transit. Similarly, by its very nature, and in the absence of adequate incentives, private funding is subject to the rhythms and needs of the enterprises, which has proven to be ineffective in the fight against climate change (Atteridge, 2011). However, the weight of private funding in climate policies has been constantly increasing, from 56% of the total in 2011 to 62% in 2015 (Buchner et al., 2011; Buchner et al., 2015). In the light of all this, it would not seem to be a good trend for promoting equity, efficiency and multilateralism.

The most important incentives instrument in climate funding is the Clean Development Mechanism (CDM), which is widely incorporated into the INDCs. The CDM, as described previously, which is theoretically neutral in so far as emissions reductions is concerned, could be contributing to their increase. This would be because of problems in determining additionality or the incorrect limitation in the number of years projects can last (Erickson et al., 2014). Funding through projects is, indeed, one of the main lagoons in a global climate policy, since the climate finance institutions (GCF, GEF, etc.) finance projects and do not obey an equitable global transit strategy that can effectively reduce emissions.

4.6. Compliance with the objectives of emissions reductions

As the Non-Annex 1 countries are allowed to present their mitigation objectives on a trend scenario, the Paris Agreement ends up causing substantial increases, on a global scale, of GHG emissions. In addition, these figures are obtained on the basis of several conservative suppositions. Thus, it is considered that the reductions of the Annex 1 countries will be complied with and are also accounted for as BAU scenarios. In those INDCs that offer a reduction interval, they have opted for the upper bound; while, in the “Conditional” scenario, they assume that all the external funding is received. These increases in annual emissions, much higher than the planet’s impact absorption capacity, would go against the principal objective of the Paris Agreement: not surpassing the $2^{o}C$ above preindustrial levels.

Supposing that the proportion each country contributes to world emissions does not vary too much, if we take the weighted mean in each scenario, while maintaining the level reached between 2030 and 2050 constant, then the world temperature would increase by at least $3^{o}C$ (IPCC, 2014). Even the IEA (2016) assumes increasing emissions in all their scenarios. Should annual emissions continue to increase in the same proportion, a rise of $4^{o}C$ would be practically guaranteed. This increase would endanger humanity’s essential food production and would irreversibly worsen the problems related to extreme meteorological phenomena (IPCC, 2014). Thus, we will probably see a transfer of resources from mitigation and the regular economic activities to the defensive efforts of adaptation.

Table 7. Overview of main results (excluding policies).

	General information quality		Financial information quality		Finance (bs $)	Financial effort (% over GDP)	External financial support (%)*	BaU	Conditional variation (respect 2005-2015)	Unconditional Variation (respect 2005-2015)	Financial effectiveness ($/Reduction over BAU)	Financial effectiveness ($/Absolute reduction)	Emissions share**
Income level	**High**	**Low**	**High**	**Low**	**FINANCE**			**EMISSIONS**					
Low	30.0%	6.7%	26.7%	16.7%	625.8	204.6%	87.1%	174.3%	65.2%	137.9%	0.9	15.9	5.2%
Lower Middle	22.2%	22.2%	20.0%	53.3%	2831.8	99.1%	73.2%	149.2%	78.7%	130.5%	1.1	1.2	16.5%
Upper Middle	14.9%	34.0%	4.3%	61.7%	1960.7	69.4%	92.7%	61.7%	21.8%	45.4%	8.9	0.7	37.9%
High	9.1%	45.5%	4.5%	77.3%	7.9	22.7%	77.8%	40.0%	0.2%	24.2%	0.1	-0.1	8.8%
High OECD	8.3%	66.7%	n.d.	100.0%	ND	ND	ND	-7.0%	-19.6%	-19.6%	ND	ND	29.4%
Top 12 ***	16.7%	41.7%	0.0%	83.3%	2521.6	89.2%	-	34.2%	14.0%	19.3%	1.3	ND	72.2%
Global simple arithmetic mean and totals	**18.5%**	**29.9%**	**12.7%**	**31.2%**	**5426.2**	**7.3%**	**41.4%**	**95.7%**	**37.8%**	**75.0%**	**2.6**	**-6.8**	**97.8%**
Weighted mean								**31.5%**	**19.3%**	**25.8%**			

Own elaboration.

* The percentage represents the proportion of external resources required by those INDCs that do offer data. However, the total percentage is the total amount of external resources required by all the plans over the total financing of the all the INDCs, including those that have no breakdowns
** Share of global emissions (2012) according to EDGAR. The sum of all country groups does not account for 100% because of discarded INDCs and non-participant countries in COP.
*** Top 12 polluter emissions variation are for base year 2005.

5. Conclusions

The Paris Agreement sets up a landscape in which the interventions of the agents that bring about the transition will be carried out. In spite of the heterogeneity in the documentation of the INDCs, this paper proposes a classification of the characteristics of the commitments of each country. This classification and its results (summarised in Table 7) allows analyzing the different patterns of national proposals and analyzing the real effectiveness of the proposed measures.

Although policies at global level show certain patterns (renewable electricity mix, efficiency, afforestation, etc.) regional distribution matters. The non-integrated, individual, voluntary approach of the Paris Agreement, under a free trade and capital flows framework, could lead policies in one region to be offset by the dynamic response in other regions. Responsibility of climate change falls on Developed Countries (DCs) and their consumption and production patterns. However, the incorporation of China and India to these patterns, sometimes in order to satisfy DCs demand through environmental load displacement, hinders the accomplishment of Paris Agreement even more. As long as the socioeconomic system remains unchanged, the objective of the Paris Agreement would have to face numerous challenges like these.

Another difficulty facing the full compliance of the INDCs is the voluntary nature of their commitment and the non-existence of any control, monitoring and penalization system. In addition, the low quality and scarce clarity of information provided concerning these individual commitments (only 18.5% provide good information on policies and emissions and 12.7% on finance) contributes to worsening difficulties for any kind of follow-up. What is more, the "Conditional" compliance of the INDCs is subject to the receipt, on the part of the LDCs, of external funding that represents 41.4% of the total funding. Not only this, but the channelling of this funding (external and internal) through a model based on individual projects, carbon markets (through the CDM) and their growing dependence on private initiative, make for an uncertain future panorama. Ultimately, after burying the Kyoto Protocol and the questionable results from the Copenhagen Agreement (2009), the renunciation of an integrated, global model in the Paris Agreement seems to lead to expected results that will be weak. In addition, geographical, instutional and biophysical constraints matter, dynamically adjusting the consequences of policies submitted. Further climate agreements should take this into consideration in order to achieve effective results.

Thus, from the detailed review of the INDCs, it can be concluded that, in the best of cases, annual world emissions would increase by around 19.3% in 2030 with respect to the base interval (2005-2015). Even so, this supposes a reduction in comparison with the 31.5% increase projected by the BAU scenario in which no measures are taken. Should this level remain constant between 2030 and 2050, the world temperature would increase by at least 3ºC (IPCC, 2014). Should annual emissions continue to increase in the same proportion, an increase of 4ºC would practically be assured. Adaptation of natural and economic systems to climate change will thus have to be addressed in the near future.

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Annex A. Methodological annex.

The heterogeneity of the data in the INDCs has forced us to make a series of hypotheses which are summarized in the Methodology section and are set out in detail here.

The policies, classified using codes, have been recorded country by country, grouped in the sectors described above. To carry out the analysis, and to establish comparisons, the proportion of countries adopting each policy over the total number of countries providing information has been calculated. This reduces the analysis to 126 of the 161 INDCs submitted (representing 188 countries). In order to estimate the interest of each group of countries by income, we have calculated the mean of these proportions in each sector.

As for funding, we have collected the data offered in the INDCs in dollars. Although the base varies in some of them, in most of them there is no mention of this aspect, so the quantities expressed in dollars are subject to this limitation. To calculate the percentage of external support required by the INDCs that do not explicitly provide this information, we have assumed that it would be distributed uniformly, the proportion being that which represents the conditional reduction in emissions over the total reduction in emissions (conditional + unconditional).

We have calculated the variation in emissions of the INDCs in relation to the intensity of emissions in the following manner: having defined the intensity of emissions as

A.1. $$I = \frac{E}{GDP}$$

the following equation is solved:

A.2. $$\frac{((I_{2030} * GDP_{2030}) - (I_{BY} * GDP_{BY}))}{(I_{BY} * GDP_{BY})} - 100 = \Delta E.$$

Where $I_{2030/BY}$ is the intensity of emissions in 2030 and the base year respectively; $GDP_{2030/BY}$ is the GDP in 2030 and the base year respectively; and ΔE is the percentage variation of the emissions. Both China and India present their data in this way and require additional hypotheses. They have had to use the projections of the GDP for the year 2030 of the OECD.

In the case of the INDCs that apply a reduction on a BAU scenario, the procedure was as follows: applying arbitrary emissions of 100, the problem was solved using the following equation:

A.3 $$\frac{((100 * (1 + \Delta BAU) * (1 - \Delta PROP)) - 100)}{100} = \Delta E.$$

Where ΔBAU is the percentage variation of emissions in the BAU scenario; $\Delta PROP$ is the proposed percentage reduction in emissions on the BAU scenario (conditional and unconditional, depending on the case); and ΔE is the percentage variation in the emissions.

BAU scenario refers to the emissions in the horizon year if policies were not applied, usually based on historical emissions trends.

With a conservative assumption, we have considered that the INDCs which propose a reduction range will finally achieve the upper bound.

Regarding the policies analysis, we have to differentiate three analyses: policies at world level, policies at regional level, and sectoral-regional analysis.

Policies at world level are assessed throughout the number of countries using each policy over total countries, according to eq. A4:

A4. $$\alpha_W = \frac{\sum P_i}{N}$$

Being subscript i each policy, regardless the sector and $\sum P_i$ the number of countries using each policy (P_{ij}) considered and N the total number of countries. Top 15 policies are shown in Table 4. For the regional level, an analogous calculation is made:

A5. $$\alpha_r = \frac{\sum P_{i,r}}{N_r}$$

Where the numerator represents the same as in A4 but for region (income group) r. The denominator is the number of countries in region r. Figure 1 shows the deviation from each top 15 policy share by income group to the world average, namely: $\alpha_r - \alpha_W$. Finally, we take the arithmetical mean of α_r and α_W by sector:

A6. $$\alpha_{j,W} = \frac{\sum \alpha_W}{N_j}\ ;\quad \alpha_{j,r} = \frac{\sum \alpha_r}{N_j}$$

With N_j being the number of policies in each sector j. By proceeding this way, we obtain an approximation to the relative importance of each sector in the different regions and in the world. Finally, analogously to Figure 1, Figure 2 shows the deviation from each region to world: $\alpha_{j,r} - \alpha_{j,W}$.

Annex B. Countries by income group

Income group	Contries
Low income	Afganisthan, Benin, Burkina Faso, Burundi, Cambodia, Central African Rep., Chad, Comores, DR of Congo, Eritrea, Ethiopia, Gambia, Guinea, Guinea Bissau, Liberia, Madagascar, Malawi, Mali, Mozambique, Nepal, Niger, Rwanda, Sierra Leone, Somalia, South Sudan, Tanzania, Togo, Uganda, Zimbabue.
Lower-Middle	Armenia, Bangladesh, Bhutan, Bolivia, Cameroon, Cape Verde, Congo, Djibouti, Egypt, El Salvador, Georgia, Ghana, Guayana, India, Indonesia, Ivory Coast, Kenya, Kiribati, Lao, Lesotho, Mauritania, Morocco, Myanmar, Nigeria, Papua New Guinea, Samoa, Senegal, Solomon Islands, Sri Lanka, St. Tome, Sudan, Tajikistan, Vanuatu, Vietnam, Yemen, Zambia.
Upper-Middle	Algeria, Angola, Azerbaijan, Belarus, Belize, Bosnia-Herzegovina, Brazil, China, Costa Rica, Cuba, Dominica, Ecuador, Fiji, Gabon, Grenada, Jamaica, Jordan, Kazajstan, Lebanon, Marshall Islands, Mauritius, Mongolia, Namibia, Palau, Paraguay, South Africa, St Kitts, St Lucia, Surinam, Thailand, Tonga, Tunez, Turkey, Tuvalu.
High	Antigua and Barbuda, Argentina, Bahamas, Barbados, Brunei, Equatorial Guinea, Monaco, Oman, Qatar, San Marino, Saudi Arabia, Seychelles, St.Vincent&Grenadines, U.A.E., Uruguay, Venezuela.
OECD	Australia, Canada, Chile, EU28, Iceland, Israel, Japan, Korean Rep., New Zealand, Norway, Switzerland, USA.

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