

G20 Countries Should Lead the Way in Designing a Greenhouse Gas Emissions Allowance Trading System

Christian Flachsland (Hertie School),

Noah Miller (University of Southern California)

Adam Rose (University of Southern California)

Dan Wei (University of Southern California)

March 30, 2017 | Last updated: January 23, 2020

International policy coordination, such as a system of tradable greenhouse gas (GHG) emissions allowances, can greatly lower the cost to all participants of slowing climate change. We consider strategic options on a path of international agreements that will help implement the COP 21 GHG reductions. An emissions trading system involving all G20 countries that made unconditional pledges could reduce total mitigation costs from an estimated \$1.5 trillion to \$0.24 trillion, a savings of 83%. Moreover, the ensuing allowance sales revenues would greatly enhance the capability of lower-income G20 countries to meet their pledges. We also examine analogous benefits of other configurations of participating countries and allowance trading designs, such as the transfer of auction revenues to low-income countries.

Challenge

Low- and middle-income (LMI) countries made substantial pledges at COP 21 in Paris in 2015 to mitigate and sequester GHGs. However, they have limited capacity to do so in terms of finance, technology and institutions.

One approach to remedying the situation is direct financial or technology transfers. LMI countries have extensive financial needs, estimated at \$100 billion annually (COP 21 Report). A fund established at COP 15, and reinforced at COP 21 was to provide the needed financing, but payments into this fund are currently far short of this amount.

A second approach is to design an emissions trading system to achieve the COP 21 goals. A system of tradable GHG emission allowances could be carefully structured so as to achieve the COP 21 GHG reduction goals, as well as subsequent goals to confine global average temperature increases from pre-industrial levels below 2°C, and even below 1.5°C by the end of the century. While a global system would provide the greatest cost-savings, it presents several obstacles. It may prove easier to build up to a global system through a series of incremental programs. There are a number of international climate policy coordination mechanisms that could achieve equivalent or at least part of the beneficial outcomes of a broad-based allowance trading system if they work towards achieving the least-cost combination of mitigation strategies across countries and contributing to financial transfer funds. These mechanisms include linking domestic emissions trading systems and other policy instruments (Bodansky et al 2016). Here we examine several cases: a G20 trading system that includes only sub-regions for some major countries (Canada, China, USA),^[1] a more complete G20 arrangement composed of countries in their entirety,^[2] a G20 arrangement that considers the non-involvement of key countries (China, Russia, USA), and a full global system of countries that offered unconditional NDCs.

We acknowledge several past difficulties in countries coming to agreement on a system of tradable GHG emission allowances, specifically as to the allocation of allowances, with many countries having voiced different development goals and divergent views on equitable allocation of the burden of combating climate change. However, the "bottom-up" approach of the Paris pledge has given countries the leeway to set

or the burden of combating climate change. However, the bottom-up approach of the Paris pledges has given countries the leeway to set their own emission reduction goals, based on their own development agenda and ideas of fairness, and with the implicit approval of other countries. We also acknowledge the fact that not all countries are amenable to an allowance trading system. However, we note that the results of implementing a carbon tax (a strong alternative to allowance trading) across countries would have a very similar outcome to a pure auction-based trading arrangement, but without the flexibility of a partial application such as auctioning less than all the allowances. Finally, some COP 21 pledges by LMI countries may seem very ambitious, but they can be achieved with the transfers associated with a system of emission allowance trading that includes auctioning and redistribution.

[1] We base these sub-regions on areas that have already implemented cap and trade (C&T) systems, such as Regional Greenhouse Gas Initiative (RGGI) and Western Climate Initiative (WCI) in the United States, and thus could more easily work towards international system linkages, as, for example, California and Quebec have already done.

[2] We do not include any individual European countries as sub-regions, because, although France, Germany, Italy and the UK are all individually members of the G20, they are also currently members of the EU, which holds a spot in the G20 as well, and maintains its own emissions trading system (EU ETS), which would link in entirety with other systems. We thus include the entire EU as a single entity.

Proposal

Emissions trading is a policy instrument that has great promise for implementing the mitigation and sequestration of GHGs. Successful applications have included the European Union Trading System (EU ETS), the California Cap-and-Trade System in the US, the many regional pilot programs in China, and the Kyoto flexibility mechanisms for the two compliance periods between 2008 and 2016. This approach, often known as cap and trade (C&T), has the advantage of establishing a limit on the total amount of emissions, and allowing purchases and sales between participants to attain this cap at the lowest overall cost. It represents an incentive-based system that promotes compliance. In general, lower costs will enhance political support for achieving the ambitious emission reduction goals embodied in the Paris Agreement.

Careful institutional design will be required to manage a global C&T system, as many unilateral institutional changes (e.g., adjustment of caps) will affect all other participants in the trading system (Flachsland, Marschinski, Edenhofer 2009). A stepwise approach of linking or harmonizing existing domestic C&T systems and other policies (such as carbon taxes or price floors in emissions trading systems) offers a realistic route to building a globally harmonized mitigation policy regime minimizing costs and ensuring fair burden-sharing across countries and over time (Burtraw et al 2013). Our calculations below consider several intermediate arrangements on a path to the implementation of international flexibility mechanisms in a global C&T system. The sizeable gains from trade and international financial transfers would be progressively realized in the process of international policy coordination approximating this institutional benchmark.

Design Features

This proposal explores the design of a comprehensive GHG emission allowance trading system for the Nationally Determined Contributions (NDCs), or pledges, made by 90 countries and regions^[1] at COP 21 that are *not conditional* on the fulfillment of other aspects of the Paris Agreement, such as climate financing. We examine the implications of the following design features:

- countries included
- auctioning versus free-allocation (grandfathering) of allowances
- supplementary transfers
- allocation of auction revenues

The simulations assume Year 2030 emission levels as currently projected, and consider both regular and land use, land use change and forestry (LULUCF) emissions (for countries that include them in their pledges).

Data and Models

We utilize data on the NDC's themselves (United Nations Framework Convention on Climate Change 2016), supplemented by the data from Climate Equity Reference Project (2016) and the World Resources Institute (CAIT Climate Data Explorer 2015), for the 90 countries that made unconditional pledges, but aggregate them into 15 regions in our Global Paris Agreement Trading Scenario analysis. We use *macroeconomic* marginal cost curves derived from the GEM E-3 Model (an integrated energy, environment, and economic model of the

world) (Vandyck et al 2016), and apply a cost-minimizing model developed for emissions trading analysis (Rose et al 1998) and recently refined for analyses like the ones presented below (Rose et al 2017).

Analysis

Table 1 presents the results of the simulation of GHG emissions trading in the Year 2030 among the G20 countries that made unconditional pledges at COP21. The results indicate that emissions trading can reduce the total costs of all G20 participating countries from \$1.50 trillion (in 2015 dollars) to \$0.24 trillion, or a saving of over 83%, while still achieving the pledged emission reductions as a whole. The last column of Table 1 indicates that each country gains from participating in the emissions trading; cost savings range from \$0.2 million for Argentina to \$577.9 million for the U.S.

Generally, regions with high marginal costs of mitigation (and sequestration) are allowance buyers and regions with low marginal costs are allowance sellers, but there is another important feature operative here. As one would expect, the US, EU and other high-income regions are buyers and countries like China, India and Russia are sellers. However, many LMI regions are also buyers, including more advanced ones such as Mexico, and ones with relatively much lower per capita income, such as Indonesia. One reason is that these countries have made high pledges in absolute terms and in relative terms compared to their positions on mitigation commitments prior to COP 21 (Rose et al 2017). Second, this result is driven by the vast potential of inexpensive abatement in China and India in 2030.

Table 1. Simulation of Emissions Trading Among G20 Countries/Regions in Year 2030:

Free-Allocation of Allowances

(in million 2015\$ or otherwise specified)

Trading Party	Before Trading	After Trading	Mitigation Cost	Allowances								
Traded (mtCO ₂)												
Emission Reduction (mtCO ₂)	Mitigation Cost	Trading Cost ^{a,b}	Net Cost	Cost Saving	Argentina							
663	-0.4	15	687	-24	663	0.2	Australia	46,879	216	23	1,309	13,849
15,158	31,721	Brazil	152,685	766	98	5,565	49,180	54,745	97,940	Canada		
95,500	394	56	3,073	25,300	28,373	67,127	China	8,920	-4,057	4,526		
163,562	-260,360	-96,798	105,718	EU	359,377	1,479	41	2,524	94,942	97,466		
261,910	India	0	-1,030	1,030	40,584	-66,090	-25,506	25,506	Indonesia			
17,691	129	113	5,310	8,278	13,588	4,103	Japan	66,830	282	28	1,620	
18,092	19,712	47,118	South Korea	37,500	111	5	322	7,129	7,451	30,048		
Mexico	4,113	27	43	1,896	1,716	3,612	501	Russia	0	-394	394	15,630
-25,263	-9,632	9,632	Saudi Arabia	1,899	20	0	4	1,281	1,285	614	USA	
709,844	2,056	0	0	131,970	131,970	577,874	Total	1,501,900	5,481	6,371		
242,086	0	242,086	1,259,814									

^a Allowance Price: \$64.18/tCO₂e; Average Mitigation Cost with Trading = \$38.00/tCO₂e.

^b Negative entries signify revenues from allowance sales.

The results in Table 1 indicate that, while China, India and Russia will sell allowances to more than offset their total compliance costs, LMI countries, such as Mexico and Indonesia, will incur more than \$17 billion in annual net costs. If we include Brazil, the net cost increases to \$72 billion. Note, however, that these values would be over \$21 billion and \$174 billion, respectively, without emissions trading. All regions

are better off with emissions trading, but the lower-income regions' net cost-savings is smaller in both absolute and relative terms.

We also examined the case of the establishment of an emissions trading arrangement across G20 countries, but with limits on trading to only sub- regions in countries where this is currently the case (i.e., Canada, China, USA). We note that the results presented in Table 1 represent the following improvement over this alternative case: the emission reduction is 65% higher, with mitigation costs only 23% higher, and cost savings more than 100% higher. The major reason for the difference in the two cases is the 76% lower emission reduction possibility in China from confining trading to only the current seven provinces/cities experimenting with this policy instrument (which also has the effect of raising the emissions allowance price by 38%). However, because this limited arrangement is tied to the status quo of emissions trading in key countries, we have presented the details of broader trading among G20 countries in Table 1 as an indication of the advantages of a major step Forward.

Table 2. Summary of Emissions Trading Among G20 Countries/Regions

(Excluding, individually: Russia, China, and USA) in Year 2030: Free-Allocation

(in million 2015\$ or otherwise specified)

Non- Participating Party Allowance Price (\$/tCO ₂ e)	Total Group Mitigation Cost After Trading	Total Group Cost Savings After Trading	Status Change from Allowance Buyer to Seller Status Change from Allowance Seller to Buyer Percentage of Total Group Emissions Reduced
Base-Case	64.18	242,086	1,259,814
China	199.14	583,967	909,013
Indonesia, Mexico, Saudi Arabia	-	14.3	Russia 68.33 252,527 1,249,373 - - 15.3
USA	45.05	130,035	662,021 - Argentina 11.1

Table 2 presents the results of an examination of the contributions of each of three major G20 countries/regions, or, from another

perspective, the effect of their non-participation in the trading system. The simulation indicates that China's absence would have the greatest influence. The non-availability of a large number of low-cost mitigation options in this country would result in more than a tripling of the allowance price. It also shifts Indonesia, Mexico and Saudi Arabia to the allowance seller side. China's absence would also reduce the total group emission reduction percentage from 15.3% to 14.3%. In the case of the US not participating, the allowance price would fall because of a large drop in demand. Moreover, the percentage of group GHG emissions reduction would fall significantly to 11.1%. The result of China and US not participating, individually, would decrease the total cost savings of the other G20 countries as a group by \$245.1 billion and \$19.4 billion, respectively.

Table 3 to 5 present the results of simulations of GHG emissions trading in the Year 2030 that includes all 90 countries (15 aggregated regions) that made unconditional pledges at COP 21. Table 3 illustrates the power of emissions trading to reduce the total costs of participating regions from \$1.71 trillion (in 2015 dollars) to \$0.4 trillion, a saving of 77%, while still achieving the pledged emission reductions. This cost saving compares with other estimates of the benefits of allowance trade in the context of the Kyoto Protocol and Paris Agreement, ranging from approximately 60% (Böhringer 2000), 75% (Fujimori et al 2016) to 88% (Nordhaus, Boyer 1999). Over 6 billion tons of carbon dioxide equivalent (tCO_{2e}) emission allowances would be traded at a price of \$72.97/tCO_{2e} and an average cost per tCO_{2e} reduction of \$43.50 in year 2030.

Table 3. Simulation of Emissions Trading Among Countries Making Unconditional Pledges at COP21 (aggregated into 15 Regions) in Year 2030:

Free-Allocation of Allowances

(in million 2015\$ or otherwise specified)

Trading Party	Before Trading	After Trading	Mitigation Cost	Allowances								
Traded (mtCO ₂)												
Emission Reduction (mtCO ₂)	Mitigation Cost	Trading Cost ^{a,b}	Net Cost	Cost Saving								
Australia	46,879	202	36	2,236	14,758	16,994	29,885	Brazil	152,685	715	149	9,111
Canada	52,138	61,249	91,437	Canada	95,500	371	79	4,647	27,088	31,735	63,765	
China	8,920	-4,509	4,979	194,542	-329,033	-134,491	143,411	EU 28	359,377			
India	1,395	125	8,317	101,773	110,090	249,286	India	0	-1,153	1,153	49,047	-
Japan	84,160	-35,113	35,113	Japan	66,830	265	45	2,755	19,360	22,115	44,715	
Mexico & S. America		27,155	2	565	27,011	144	27,155	0.2	North Africa & Mid. East			
Rest of Europe	20,506	180	75	5,100	13,108	18,207	2,298	Rest of Europe	7,571	44	3	228
Rest of the World	3,216	3,443	4,128	Rest of the World	124,337	621	1,388	69,894	45,340	115,234		
Russia	9,102	Russia	0	-442	442	18,921	-32,229	-13,308	13,308	Singapore & S. Korea		
Ukraine Belarus Moldova	93,959	285	30	1,913	20,793	22,706	71,253	Ukraine Belarus Moldova	0	-32	32	
United States	2,099	-2,341	-242	242	United States	709,844	2,056	0	0	150,046	150,046	
Total	559,798	Total	1,713,562	6,137	9,100	395,822	0	395,822	1,317,740			

a Allowance Price: \$72.97/tCO_{2e}; Average Mitigation Cost with Trading = \$43.50/tCO_{2e}.

b Negative entries signify revenues from allowance sales.

The results in Table 3 indicate that, while China, India and Russia will sell allowances to more than offset their total compliance costs, the lowest-income region (ROW) would still incur more than \$115 billion in annual net costs. All regions are better off with emissions trading, but the lowest-income regions' net cost-savings is smaller in both absolute and relative terms.

In effect, although emissions trading results in sizable cost-savings for high-income regions, it does so minimally for LMI regions, indicating an inequity according to principles such as Ability to Pay, Vertical, Egalitarian, and Rawlsian equity (Kverndokk, Rose 2008).

Table 4. Simulation of Emissions Trading Among Countries Making Unconditional Pledges at COP21 (aggregated into 15 Regions) in Year 2030:

15% Auctioning for USA, EU28, JPN, CAN and AUZ; 100% Free-Allocation for Other Regions

(in million 2015\$ or otherwise specified)

Trading Party	NDC Emissions (mtCO ₂)		Free-Allocation Allowances (mtCO ₂)		Emission Reduction Undertaken After Trading (mtCO ₂)		Mitigation Cost		Allowances Needed from Trading		or Auction ^a	
	1	2 ^b (= 1 x 85%)	3	4	5	6	7 (= 4 + 6)	8	9	10	11	12
Australia	408	347	36	2,236	263	19,223	21,459	Brazil	1,197	1,197	149	
9,111	715	52,138	61,249	Canada	525	446	79	4,647	450	32,835	37,482	
China	19,252	19,252	4,979	194,542	-4,509	-329,033	-134,491	EU 28	3,141			
2,670	125	8,317	1,866	136,152	144,469	India	5,695	5,695	1,153	49,047	-	
1,153	-84,160	-35,113	Japan	732	622	45	2,755	375	27,371	30,127	Mexico &	
South America	2,592	2,592	565	27,011	2	144	27,155	North Africa & Mid. East	2,491			
2,491	75	5,100	180	13,108	18,207	Rest of Europe	109	109	3	228	44	
3,216	3,443	Rest of the World	6,570	6,570	1,388	69,894	621	45,340	115,234			
Russia	1,865	1,865	442	18,921	-442	-32,229	-13,308	Singapore & South Korea				
569	569	30	1,913	285	20,793	22,706	Ukraine Belarus Moldova	532	532	32		
2,099	-32	-2,341	-242	United States	4,543	3,862	0	0	2,738	199,769		
199,769	Total	45,678	44,958	9,100	395,822	7,539 ^c	102,325 ^d	498,146				

a Negative entries signify excess allowances regions can sell in the trading market.

b Auction pertains only to USA, EU28, JPN, CAN and AUZ; 100% free allocation of allowances for all other regions.

c The column total is the sum of all the positive numbers in this column, which represents the total amount of allowances needed from trading and/or auction.

d Since allowances purchased equal allowances sold, this value represents total auction revenues.

Table 4 presents the results of a system design that would generate at least \$100 billion in auction revenue that could be transferred to LMI countries to provide critical financing and to alleviate perceived inequities. This design calls for the five highest-income regions to purchase 15% of their allowances at auction and for the remainder of the regions to receive all of their allowances freely. Consistent with economic theory, this system results in the same allowance price (both in the trading market and auction) as in the pure trading system. This results in the same cost savings for all LMI regions as in Table 3, but the five highest-income regions becoming worse off because of their need to purchase an additional 15% of allowances from auction. The lowest-income region would still incur \$115.2 billion of total costs, but this could be largely offset by the \$102.3 billion of auction revenues.

On the other hand, a lack of enforcement mechanisms raises concerns that some countries may drop out of the Paris Accord (Auerbach)

On the other hand, a lack of enforcement mechanisms raises concerns that some countries may drop out of the Paris Accord (Averchenkova, Bassi 2016), while others have made unambitious pledges that allow for emissions growth that may question long-term commitment. Still other countries, especially LMI countries, have offered pledges that are much higher than their previous positions relating to equitable burden-sharing. To assess the potential impacts of these uncertainties, we have performed additional simulations. This highlights the need for additional carbon finance for LMI countries, which can be forthcoming through several alternative policy devices, including, of course, the transfer of auction allowance revenues.

Table 5. Summary of Emissions Trading Among Countries Making Unconditional Pledges at COP21

(Excluding, individually: India, Russia, China, USA, and the EU) in Year 2030: Free-Allocation

(in million 2015\$ or otherwise specified)

Non-Participating Party	Allowance Price (\$/tCO ₂ e)	Total Group Mitigation Cost After Trading from Allowance Buyer to Seller	Total Group Cost Savings After Trading	Status Change
China	149.52	688,143	1,016,499	Base-Case 72.97 395,822 1,317,740 - 15.3
USA	58.37	260,973	742,745	NAM, MSA, ROW 14.6 EU 28 62.26 293,317
India	83.44	436,838	1,276,723	MSA 15.3 Russia 76.56
EU 28	62.26	293,317	1,060,868	MSA 15.3
MSA	15.3	409,917	1,303,645	USA 58.37 260,973 742,745 - 11.9

Table 5 presents the results of an examination of the contributions of each of five major regions, or, from another perspective, the effect of their non-participation in the trading system. The simulation again indicates that China's absence would have the greatest influence: the allowance price would more than double; NAM, MSA, and ROW would become allowance sellers and see a reduction in net costs of nearly \$30 billion as a group. China's absence would also reduce the total group emission reduction from 15.3% to 14.6%. In the cases of either the US or EU not participating, the allowance price would fall because of a large drop in demand. Moreover, the percentage of group GHG emissions reduction would fall significantly, to 11.9% or 12.8%, respectively. The result of the US and EU not participating would decrease the total cost of the lowest-income region by \$11.8 billion and \$8.1 billion, respectively, because this region is an allowance buyer and the allowance price is lowered when either the US or EU do not participate.^[2]

Table 6. Summary of Mitigation Costs and Expected Savings from GHG Emissions Allowance Trading

Country	Partial G20 Scenario	Full G20 Scenario	Global Paris Agreement Scenario	Mitigation Costs
---------	----------------------	-------------------	---------------------------------	------------------

Allowance Purchases / Sales			Cost Savings		Mitigation Costs			Allowance Purchases / Sales			Cost		
Savings	Mitigation Costs		Allowance Purchases / Sales		Cost Savings		Argentina [MSA] ^a			1,164	-		
590	89.7	687	-24	0.2	[27,011]	[144]	[0.2]	Australia			3,869	16,092	26,918
1,309	13,849	31,721	2,236	14,758	29,885	Brazil			15,352	56,330	81,003	5,565	
49,180	97,940	9,111	52,138	91,437	Canada			1,917	7,699	15,067	3,073	25,300	
67,127	4,647	27,088	63,765	China			48,068	-88,531	42,184	163,562	-260,360		
105,718	194,542	-329,033	143,411	EU	18,513	112,142	228,722	2,524	94,942				
261,910	8,317	101,773	249,286	India	63,938	-118,370	54,432	40,584	-66,090				
25,506	49,047	-84,160	35,113	Indonesia [ROW]			9,440	6,579	1,672	5,310	8,278		
4,103	[69,894]	[45,340]	[9,102]	Japan			4,754	21,267	40,809	1,620	18,092		
47,118	2,755	19,360	44,715	South Korea [SSK]			1,313	8,666	27,521	322	7,129		
30,048	[1,913]	[20,793]	[71,253]	Mexico [MSA]			3,214	824	75	1,896	1,716	501	
[27,011]	[144]	[0.2]	Russia	24,712	-45,427	20,715	15,630	-25,263	9,632	18,921			
-32,229	13,308	Saudi Arabia [NAM]			659	999	241	4	1,281	614	[5,100]	[13,108]	
[2,298]	USA	0	22,320	64,804	0	131,970	577,874	0	150,046	559,798	Total		
[Paris Total]	196,912	0	604,253	242,086	0	1,259,814	[395,822]	[0]	[1,317,740]				
Allowance Price	\$88.43/tCO ₂ e		\$64.18/tCO ₂ e		\$72.97/tCO ₂ e		Percent of World						

Emissions Covered

40.37% 73.67% 88.07% Percent of World

Emissions Reduced

7.39% 11.23% 13.51%

^a For the Global Paris Agreement Scenario analysis, some G20 countries were combined with aggregated regions, such as the case of Argentina and Mexico being a part of the Mexico and South America (MSA) region. Thus, for the third set of columns, values in brackets reflect the region indicated rather than the G20 country's specific values.

Table 6 summarizes the gains to G20 countries from adopting a C&T system under the various country coverage scenarios described above. Across the scenarios, all G20 countries are better off, and non-G20 countries included (i.e., those that made unconditional pledges under the Paris Agreement) are also better off in the case of the Full Global scenario. Additionally, under a partial auction, the promised \$100 billion climate financing fund could be easily raised without severely impacting the savings to G20 countries. More specifically, the first set of columns reflects that simply by linking the existing G20 national and sub-national C&T systems,^[3] over 40% of the world's emissions would be included, and over 7% of the world's emissions would be reduced, while saving over \$600 billion compared to a no-trading scenario. The second set of columns expands this system to cover all G20 countries in their entirety. Doing so increases the coverage of world emissions to almost 74% and their reduction to over 11%, while more than doubling the savings to over \$1.25 trillion. Finally, the third set of columns expands the system to cover all countries that submitted unconditional NDCs.. We note that global savings further increase to over \$1.3 trillion.

The G20 countries can lead the way on a path to establishing a global emissions trading system to meet Paris Agreement pledges in a cost-effective way by both focusing on expanding regional C&T systems to nation-wide systems, and by linking their respective systems with those of other G20 members. Once the linking of existing and expanded systems achieves a critical scale, introducing non-G20 countries could add even more global cost savings in achieving GHG emission reductions to meet critical atmospheric concentration targets.

Recommendations

Recommendations

Recommendation 1: G20 countries should show leadership in developing a GHG emissions allowance trading system. This will significantly lower the cost of implementing the COP21 pledges for all participants through ordinary trading and will provide opportunities to provide additional funding to low- and middle- income countries through the redistribution of auction revenues. Progress by G20 countries in this direction has the potential to illuminate the path forward toward a truly global system of emissions trading that will result in a win-win outcome on both the benefit and cost sides for all countries.

Recommendation 2: Under an emissions allowance grandfathering and trading arrangement, require supplemental direct cash transfers from either, or both, high-income countries and the middle-income countries/regions for whom allowance sales revenue more than offsets mitigation costs, to fund the \$100 billion needed by low-income countries to meet their COP21 pledges.

Recommendation 3: Design an auction-based trading arrangement that provides the \$100 billion to LMI countries through the redistribution of auction revenues. This could take either the form of auctioning some or all allowances only to high-income countries or auctioning a proportion of the allowances to all countries to obtain the necessary revenues.

Recommendation 4: Gradually establish international policy linkages, such as via linked C&T systems, harmonized carbon prices (e.g., coordinated GHG taxes or price floors in C&T systems), or linked regulatory policies, to realize efficiency gains from achieving the least-cost combination of mitigation strategies across countries and from implementing international climate finance transfers. The Paris Agreement recognizes these options under the title “internationally transferred mitigation outcomes.”

Recommendation 5: The design and implementation of an allowance trading system should be considered in a broader policy context, including accompanying measures. A Monitoring, Reporting and Verification framework is needed to guarantee the additionality of emission reductions under the trading system. Moreover, capacity building to improve institutional frameworks in LMI countries, as well as a technology transfers to LMI countries, can help fulfill the COP21 Accord.

[1] The European Union elected to submit a single comprehensive pledge. In the analysis below, we group many other countries into regions as well. For brevity and consistency, we simply use the term “region” to cover both individual countries and regional groupings.

[2] Note that the column labeled “Total Group Mitigation Cost” in Table 5 needs to be interpreted carefully. The total cost when either the USA or EU do not participate is lower than the Base Case. However, this is only because the total GHG emissions reduction is lower than in the Base Case when either of these two regions does not participate.

[3] In this scenario, we include national systems for all countries except Canada, China, and USA as all either have a national system in place, are in the process of implementing a national system, or could realistically be expected to implement a national system in the near-term future.

References

1. United Nations Framework Convention on Climate Change. 2015. COP 21 Report.
[More Information](#)
2. Bodansky, D.M., S.A. Hoedl, G.E. Metcalf, R.N. Stavins. 2016. Climate Policy.
[More Information](#)
3. Flachsland, C., R. Marschinski, O. Edenhofer. 2009. Climate Policy.
[More Information](#)
4. Burtraw, D., K.L. Palmer, C. Munnings, P. Weber, M. Woerman. 2013. Resources for the Future.
[More Information](#)
5. United Nations Framework Convention on Climate Change. 2016. NDC Registry.

[More Information](#)

6. Climate Equity Reference Project. 2016. Stockholm Environment Institute & Eco-Equity.
[More Information](#)
 7. CAIT Climate Data Explorer. 2015. World Resources Institute, Washington, DC.
[More Information](#)
 8. Vandyck, T., K. Keramidas, B. Saveyn, A. Kitous, Z. Vrontisi. 2016. Global Environmental Change.
[More Information](#)
 9. Rose, A., B. Stevens, J. Edmonds, M. Wise. 1998. Environmental and Resource Economics.
[More Information](#)
 10. Rose, A., D. Wei, T. Vandyck, N. Miller. 2017. Economics of Natural Disasters and Climate Change. Equity implications of COP 21 greenhouse gas emission reduction pledges (forthcoming).
 11. Böhringer, C. 2000. Energy Policy.
[More Information](#)
 12. Fujimori, S., I. Kubota, H. Dai, K. Takahashi, T. Hasegawa, J.Y. Liu, Y. Hijoka, T. Masui, M. Takimi. 2016. Environmental Research Letters.
[More Information](#)
 13. Nordhaus, W.D. and Boyer, J.G. 1999. The Energy Journal.
[More Information](#)
 14. Kverndokk, S. and Rose, A. 2008. International Review of Environmental and Resource Economics.
[More Information](#)
 15. Averchenkova, A. and Bassi, S. 2016. Grantham Research Institute on Climate Change and the Environment, London, UK.
[More Information](#)
-

Existing Initiatives & Analysis

Implementation Overview (1)

Global agreements to combat climate change gained traction with the Kyoto Protocol in 1998, but progress was slow until the Paris Accord in 2015. Many economists and policy makers agree that a global cap and trade approach would provide a least-cost way of achieving desired levels of GHG mitigation. In the absence of a global system, some countries and regions established their own systems. Others worked to overhaul the thinking behind a global system, from a top-down approach to determining country/region mitigation targets, as presented at Kyoto, to a bottom-up approach, as formalized in Paris. The latter approach allows each country to decide for itself, given its own national and global context, how much it is willing to contribute to mitigation efforts. Some analyses (<https://ec.europa.eu/jrc/en/geco>) have been done with respect to the expected energy and economic impacts of the Paris pledges, with and without globally coordinated action. Additionally, the World Bank has begun an initiative (<http://www.worldbank.org/en/topic/climatechange/brief/globally-networked-carbon-markets>) to link existing regional cap and trade systems as a way of building global mitigation capacity to working towards a globally comprehensive system. At the same time, the International Carbon Action Partnership (<https://icapcarbonaction.com/en/partnership/about>) has been formed to provide working knowledge to governments that now have, or plan to implement, a cap and trade system.

Existing Agreements (2)

Paris Agreement (COP 21)

Taking place at the end of 2015, the Paris Agreement formalized the bottom-up approach to climate mitigation efforts. [More Information](#)

Marrakech Climate Change Conference (COP 22)

Taking place at the end of 2016, the Marrakech Conference focused on practicality and implementation of the Paris Agreement. [More Information](#)

Existing Policies and Monitoring (5)

Kyoto Mechanisms

Initiated with the Kyoto Protocol, and put into force in 2008, covers all industrialized nations that ratified the treaty. [More Information](#)

European Union Emissions Trading System

Started in 2005; includes every EU country in a comprehensive cap and trade system. [More Information](#)

Regional Greenhouse Gas Initiative

Started in 2009; includes nine North-East US states in a cap and trade system. [More Information](#)

California/Quebec/Ontario Cap-and-Trade Programs and Linkages

California and Quebec's programs were started in 2012, with Ontario's started in 2017, each individually covering the respective state or province.

California and Quebec's programs were officially linked at the end of 2013, and there is an agreement to link in Ontario as well. [More Information](#)

Chinese Pilot Programs

All started in 2013; seven separate cap and trade pilot programs cover 2 provinces, 4 municipalities, and 1 special economic zone. [More Information](#)