ARTICLE 6 APPROACH PAPER SERIES

Corresponding Adjustment and Pricing of Mitigation Outcomes

WORLD BANK GROUP

Climate Warehouse

1818 H Street NW

Washington, DC 20433

Telephone: 202-473-1000

Internet: www.worldbank.org

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Corresponding Adjustment and Pricing of Mitigation Outcomes

Abstract

Every country has mitigation opportunities in different sectors with varying costs depending on several factors such as the maturity of technologies, access to finance, policy support, and natural resources available. A country can plan its nationally determined contribution (NDC) based on such abatement cost information and prepare its strategy to achieve the NDC most effectively.

The provision of Corresponding Adjustment under Article 6 of the Paris Agreement is an important factor to consider when the country decides to engage in international carbon markets. When the host country transfers authorized emission reduction credits[1] or internationally transferred mitigation outcomes (ITMOs), Corresponding Adjustment creates an obligation and the associated liability for the host country – i.e., the host country has to increase its NDC burden by the volume transferred. Without informed decisions, countries may oversell and end up having to implement more expensive mitigation activities to meet their NDCs. This potential liability to the host country is linked to the *marginal cost* and the associated *opportunity cost* of meeting the NDC.

The Global Change Analysis Model (GCAM)[2] suggests that many or most host countries would need to charge Corresponding Adjustment fees well above US$25/ tCO2e *in addition* to the cost of the emission reduction credits. Such Corresponding Adjustment cost is NDC-specific and varies depending on the level of NDC ambition. Each country can derive its own Corresponding Adjustment costs through modelling exercises[3], and the more ambitious the host country's NDC is, the higher the cost is.

This opportunity cost-based pricing approach is one possible way to mitigate the overselling risks (risking the NDC compliance) linked to corresponding adjustment. Alternative approaches include: earmarking mitigation activities that go beyond host country NDC compliance needs and selling them at a price that covers the costs of respective mitigation activity; setting a uniform corresponding adjustment fee in linkage to a global least-cost scenario to achieve the 2030 NDC pledges or the climate goals of the Paris Agreement; and auctioning ITMOs. Advantages and disadvantages of each approach are provided in chapter 5.

Lastly, developing suitable institutional structures is important to ensure that such pricing approaches are appropriately considered and assessed by the government and used to effectively support achieving the NDC commitments. Chapter 6 suggests establishing a sovereign climate fund as one possible institutional structure with an illustration of potential transaction flows.

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1 An emission reduction credit represents a standard unit to measure an emission reduction equivalent to one metric ton of carbon dioxide (tCO2e). A generic term for emission reduction credit is a carbon credit. https://openknowledge.worldbank.org/handle/10986/38258

2 GCAM is a dynamic-recursive model that can be used to explore climate change mitigation policies. As an open-source community model, the source code, data, and documentation are publicly available. It is also used in all IPCC assessment reports. See GCAM documentation at https://github.com/JGCRI/gcam-core/releases

3 While a country can use its own modeling tool, there are existing models such as the open-access GCAM and the World Bank/IMF Climate Policy Assessment Tool (CPAT).

1. Background – importance of the issue

Future climate markets will differ substantially from those that emerged under the Kyoto Protocol. The Paris Agreement requires all countries to voluntarily adopt individual targets, elaborated in their nationally determined contributions (NDCs). This requires increased oversight and capacity by countries ranging from setting a NDC target and developing strategy for the use of international cooperation – including carbon markets – to implementing mitigation activities to achieve the NDC.

The cost implication of performing corresponding adjustment for the transfer of credits outside the country is one of the key considerations for a host country strategy for the use of Article 6. International transfer of emission reduction credits (ERCs)[4] authorized by a host country should be correspondingly adjusted (i.e., be reflected in the host country's NDC accounting to avoid double counting), and this may[5] increase the NDC burden by the amount that was transferred. Since every country has limited mitigation opportunities available, and because those mitigation options have different costs, countries would have to implement more expensive mitigation activities to meet their NDCs as a result of corresponding adjustment.

To ensure that host countries meet their NDC cost effectively, while engaging in transfers of mitigation outcomes with corresponding adjustment for Article 6, other international uses or for the voluntary carbon markets, it is important that countries have a robust pricing strategy to better understand the opportunity cost of making corresponding adjustment, the marginal cost of meeting the NDC, and accordingly the price at which they sell their ERCs whose revenues could help countries implement additional mitigation activities as necessary to meet their NDCs.

This paper aims to develop guidance on the pricing based on opportunity cost pricing for Adjusted ERCs. Adjusted ERCs are emission reduction credits that come with corresponding adjustment. In the context of the Paris Agreement, the term Internationally Transferred Mitigation Outcome (ITMO) is often used to refer to Adjusted ERCs used in the compliance carbon market. The opportunity cost for corresponding adjustment is based on the marginal cost of the host country to achieve its NDC. The marginal cost of 2030 NDCs for regions and countries are estimated using the Global Change Analysis Model (GCAM)[6]. These results are then utilized to present the pricing implications of corresponding adjustment. The paper concludes with proposed arrangements to implement the opportunity cost-based pricing for the host country to charge a fee/levy/cess/tax (depending on the applicable regulatory framework in the host country) for ERCs accompanied by corresponding adjustment for Article 6 or other "authorized" uses of the ERCs including the voluntary carbon markets.

[4] An ERC represents a standard unit to measure an emission reduction equivalent to one metric ton of carbon dioxide (tCO2e). A generic term for ERC is a carbon credit. https://openknowledge.worldbank.org/handle/10986/38258

[5] If a host country's NDC target emissions are below a business-as-usual level, international transfer of ERCs "will always" impose a cost to the host country's economy as "additional" mitigation should happen to replace the transferred ITMOs for NDC compliance.

[6] GCAM is a dynamic-recursive model that can be used to explore climate change mitigation policies. As an open-source community model, the source code, data, and documentation are publicly available. See GCAM documentation at https://github.com/JGCRI/gcam-core/releases

2. Mitigation costs, opportunity costs and pricing of ERCs

The price of emission reduction credits varies widely and depends on many factors including the qualitative choices and preferences of market players. In addition to the cost of the mitigation action that generates ERCs, there are several additional factors such as project type, quality of units, size, location, and how buyers value the (co)benefits of the underlying project, which influence the price of ERCs. In addition to the cost-based and quality-based pricing considerations, the NDCs creates opportunity cost when corresponding adjustment is needed. This is a result of additional mitigation measure – often at a higher cost – that the host country would need to implement to meet the NDC due to corresponding adjustment.

2.1 The cost of a mitigation activity

A mitigation activity generates emission reductions relative to a counterfactual baseline. It can consist in an individual project such as windmill for power generation, a program of mitigation activities such as the distribution of clean cook stoves, a sectoral or jurisdictional program such as a REDD+ program, or a policy such as the removal of a fossil fuel subsidy.

All these mitigation activities come with a cost for their development, implementation and operation including the monitoring, reporting and verification (MRV) of the generated emission reductions. In most cases, implementation is the most important cost category, and for an individual project, implementation costs are primarily investment costs. The share of this mitigation activity cost is covered by secured financing (if any), and there can be a remaining cost gap that needs to be closed. This remaining financial gap can be used to develop pricing for the emission reduction using different approaches such as incremental cost pricing, financial gap analysis, etc. This approach applies to costing of and payments for emission reductions that ensure financing and operation of the mitigation activity and create no additional liability or obligation for the host country where the mitigation activity is located. The concept of corresponding adjustment for the transferred ERC, however, creates an obligation for the host country to invest in additional mitigation activity that is likely to be at a higher cost.

2.2. The cost of transferring ITMOs

Costing of emission reductions changes fundamentally if these emission reductions are transferred out of the host country of the underlying mitigation activity. If this is the case, they must be excluded from being accounted against the host country's NDC to avoid double counting of mitigation and undermining of environmental integrity of international carbon market transactions. Under the rules of the Paris Agreement, double counting is prevented by applying corresponding adjustments to national emissions/NDC accounts.

If a country has a NDC target to reduce emissions by 100 units and at the same time transfers 10 units of emissions reductions out of the country, its economy needs to generate 110 units of emission reductions instead of 100 units in the scenario without the transfer to meet the NDC target. These additional emission reductions come at an additional cost that accrue to the transferring country because of the transfer. This represents the ***opportunity cost*** of the transfer. If, for example, a private project entity in a host country could reduce emissions at a cost of $3/tCO2e, transferring these emission reductions out of a country with an emissions target (its NDC) might require implementing an additional mitigation activity at a cost of $20/tCO2e somewhere else in the economy so that the NDC can still be met. Whereas the private project entity could sell its emission reduction for as low as 3$/tCO2e, the host country would need to pay $20/tCO2e to meet its NDC.

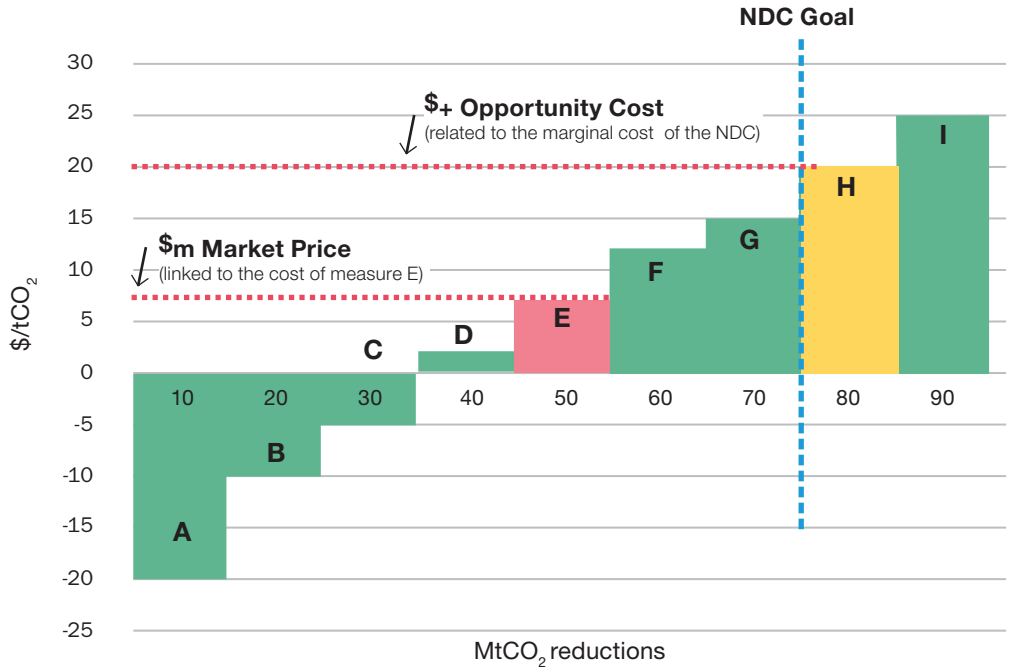
2.3 Determination of opportunity cost

A generalized (albeit somewhat idealized) approach to opportunity cost determination can be based on economic analysis using marginal abatement cost (MAC) curves. MAC curves rank mitigation activities available to a country from lowest[7] to highest cost in function of the volume of mitigation they can deliver. The NDC target can then be expressed as a point on the MAC curve indicating the pledged mitigation and its marginal cost (see figure 2 below).

If such MAC curves are available, the opportunity cost, of selling and transferring ERCs can be identified as the cost of the lowest cost mitigation activity going beyond the NDC target, e.g., activity H in figure 2 at a cost of $20/tCO2e.

It is important to note in this context that there are basically two different types of MAC curves: bottom-up rankings of technology costs at given prices and quantities in the economy, and top-down MAC curves derived from general equilibrium modelling with endogenous prices and quantities. While the bottom-up MAC-curves are suitable for assessing marginal project-type of mitigation activities, the top-down MAC-curves are required to analyze larger-scale interventions affecting key economic parameters such as policies or large-scale sectorial mitigation programs.

Figure 2: Stylized MAC curve with NDC target



[7] Some mitigation activities might come at a negative cost, e.g., some energy efficiency measures.

2.4 A heuristic approach to opportunity cost for corresponding adjustment

Host country specific MAC curves can provide opportunity costs. In the analysis here, the GCAM is used to provide comparable opportunity costs for different regions and countries following a heuristic approach which consists of determining the marginal cost of achieving a host country NDC assuming a least cost solution, i.e., a solution that would be generated by a carbon tax or a comprehensive ETS covering the whole economy. Once this NDC achievement cost is known, the opportunity cost for corresponding adjustment can be approximated through simple linear extrapolation.

Adding those opportunity costs of the corresponding adjustment to the cost of generating the underlying mitigation will then provide the cost of the Adjusted ERCs. This approach can be summarized in five steps assuming the most common case of NDC targets expressed in mitigation relative to a BAU scenario:

(1) Determine c(ERC) = unit cost of the emission reductions that underly the Adjusted ERC;

(2) Determine unconditional NDC mitigation pledge relative to BAU;[8]

(3) Estimate marginal cost of mitigation pledge = c(NDC);

(4) Estimate marginal cost of ITMO augmented pledge = c(NDC+ITMO) = Opportunity Cost (**$**+);

(5) Find ITMO cost = c(ITMO) = c(ERC) + Opportunity Cost (**$**+).

**As mentioned above, ITMO refers to Adjusted ERCs used in the compliance carbon market. One can replace ITMO with Adjusted ERCs in the steps above to find the cost of Adjusted ERCs.*

Steps 2 and 3 require economic modeling for which the GCAM is used.
Step 4 can be done through linear extrapolation.

Table 1: Hypothetical example of ITMO costing using heuristic approach

Country	c(ERC)	NDC % BAU	NDC absolute	c (NDC)	ITMO	c (NDC+ITMO) = OC	ITMO cost
A – 1,000 mt	5 $/t	5%	50 mt	10 $/t	1 mt	p (5.1%) = 10.2 $/t	15.2 $/t
B – 500 mt	5 $/t	20%	100 mt	40 $/t	1 mt	p (20.2%) = 40.4 $/t	45.4 $/t
C – 6 mt	5 $/t	33%	2 mt	66 $/t	1 mt	p (50%) = 100 $/t	105 $/t

Table 1 shows in column 1 three hypothetical countries A; B; C with their respective BAU emissions in million tones (1,000; 500; 6). These countries each implement the same type of mitigation activity at a cost of $5/t (column 2). Country A's emission target is -5% relative to BAU, translating into targeted emission reductions of 50 mt (columns 3 and 4). For country B, numbers are assumed to be -20% and 100 mt, and for country C, -33% and 2 mt. Column 5 shows the marginal cost of achieving the three countries' respective NDC targets (assumed to be respectively 10$/t; 40$/t; 66%/t in consideration of column 3, i.e., a country's emissions target compared to its BAU). These NDC costs will need to be derived through modelling. Each of the three countries aim to transfer 1 mt of emission reductions as ITMOs (column 6). To achieve this additional mitigation, country A needs to reduce its emissions relative to BAU by 5.1% to still achieve its NDC target (up from 5% without ITMO transfer). For country B it is 20.2%, and for country C, 50%. Column 7 provides the corresponding marginal cost of achieving these

[8] BAU determination will in most cases need to rely on historical trend extrapolation and/or econometric approaches. In case a host country provides a different BAU scenario, the NDC target need to be calibrated to the BAU scenario so that the cost of the pledged mitigation effort is correctly reflected in the modelling.

augmented mitigation needs. These represent the opportunity cost of transferring ITMOs. Column 8 shows the total cost of the ITMO transfers per unit (including the cost of generating the underlying emission reductions) for the three countries. These total ITMO costs per unit constitute the minimum prices the three countries would need to ask for, to be able to deliver the ITMOs without loss and regret.[9]

Three observations can be made from looking at that example: (1) Emission reductions generated at the same costs in all three countries come with different ITMO opportunity costs and therefore different total ITMO costs per unit; (2) ITMO costs are always higher than the costs of generating the underlying emissions reductions, and often they are substantially higher; and (3) ITMO costs are higher the more ambitious the host country's NDC is, and the larger the ITMO volume relative to the NDC target mitigation is.

If ITMOs were paid at just their cost, prices would increase in NDC ambition and ambition enhancement. Donor countries or providers of private philanthropic climate financing that aim to contribute to net mitigation through cancelling purchased ITMOs might follow this approach.

In case ITMOs are acquired for compliance and offsetting purposes, pricing will typically not only reflect cost but will also reflect the willingness to pay of the buyer which can exceed, potentially by a substantial margin, ITMO costs depending on the marginal cost of the buyer to achieve its own mitigation target (see section 5 below).

2.5 Opportunity costs and marginal costs for 2030 NDCs

The GCAM estimates the level of carbon price in 2030 required for each country to meet their respective unconditional NDCs, and results from the study have been used to estimate the comparable marginal cost of reaching each country's 2030 NDC. These provide estimates of the opportunity cost for providing corresponding adjustment for ERCs, which can be found in table 2.

The marginal costs of NDCs are higher, the more ambitious the host country's NDCs are. It should be noted that the data used in GCAM were sourced from the NDCs submitted without independent assessment of the NDC and BAU information (i.e., if the BAU level that the country used is credible, and if the expected emissions level with the implementation of NDC truly generates less emissions than the BAU level). If this independent assessment of the NDC and BAU is conducted, the GCAM model can produce more realistic opportunity cost for each country.

[9] A special case of ITMO costing is for a country that uses exclusively a carbon tax to achieve its NDC target and where ITMOs are generated by crediting emission reductions from such a tax. For that case, Strand has shown that the cost of generating emissions reductions through the tax (operationalized as the deadweight loss of the tax) can be approximated by half of the tax rate and the ITMO cost by the double of the tax rate, which means ITMO cost = 4 x MO cost. See: Strand, J., Supporting Carbon Tax Implementation in Developing Countries Through Results-Based Payments for Emissions Reductions, 2020, https://openknowledge.worldbank.org/handle/10986/34651

Table 2: Opportunity Costs and Marginal Costs for 2030 NDCs derived from the GCAM model

GCAM Regions/Countries		Opportunity Cost ~ Marginal cost* (cNDC) ($/tCO2)
Africa	East Africa	67
	North Africa	46
	West Africa	31
	Southern Africa	21
America	USA	155
	Northern South America	78
	Southern South America	36
	Central America and Caribbean	20
Asia	Japan	145
	South Korea	123
	Central Asia	74
	Southeast Asia	25
	South Asia	11
Europe	EU	129
	European Free Trade Association	127
	Eastern Europe	56
	Non-EU	17
Middle East	Middle East	50

*Carbon price level required to achieve 2030 NDCs in 2015 US$
Source: Ou Yang, Iyer Gokul, Clarke Leon, Edmonds Jae, Fawcett Allen A., Hultman Nathan, McFarland James R., …. Stephanie Waldhoff, Sha Yu, Haewon McJeon. 2021. "Can Updated Climate Pledges Limit Warming Well below 2°C?" Science 374, no. 6568: 693–95. https://doi.org/10.1126/science.abl8976

3. From costing to pricing

Marginal costs for NDCs, and the linked opportunity costs identified through the approach explained in chapter 2, are expected to provide guidance regarding the minimum price which host countries should consider when providing corresponding adjustment for ERCs. In other words, this opportunity cost, estimated based on the marginal cost of the host country's NDC, could form the floor price for Adjusted ERCs.

The actual price will in practice be determined based on negotiation between the seller and buyer countries in relation to many factors including the quality of the credits, underlying category of the project (e.g., sector, technology) and so on. The negotiated price of the Adjusted ERCs will also be determined by the buyer's willingness to pay which, in turn, will be influenced by the marginal costs of the buyer's NDC. This means that the price of ITMO will be determined at some level between these two as shown below through the negotiation process by two transacting countries. c(ITMO)[10] in the host country ≤ P(ITMO) ≤ c(ITMO) in the buyer country.

4. Limitations of opportunity cost-based pricing

Opportunity cost pricing approach for ITMOs has several drawbacks, but these issues mostly apply to alternatives as well.

First of all, the approach comes with assumptions on future technology costs which change over time and are difficult to predict precisely. While the approach should be built on most likely scenario of how costs might evolve, there is a possibility to overestimate or underestimate them, in which case, the host country will end up having revenues that exceed or fall short of the necessary amount to cover additional mitigation activities to meet its NDC. To minimize such discrepancy, countries would need to update the cost curve (MAC curve) periodically – at least every NDC period, although it would not solve the fundamental uncertainty issue.

Also, a host country, when implementing and fulfilling its unconditional NDC, may not always be able to use its least expensive mitigation alternatives, due to lack of full knowledge of these alternatives, and to potential constraints on what mitigation alternatives are available in practices. If so, mitigation costs could be higher than the costs assumed in our calculations, and the opportunity and ITMO costs correspondingly higher.

On the other hand, there could (and is very likely to) be positive co-benefits accruing to hosts from their mitigation activity, for example due to lower air pollution, greater energy security and lower long-run energy costs, when part of their fossil fuel consumption is phased out. These factors lower the host's real costs of implementing its mitigation activity, and at the same time reduces its opportunity and ITMO costs. It is difficult to say in general how these factors in total would impact on these costs; this must be evaluated in each individual case.

[10] c(ITMO) = c(ERC) + OC where c(ERC) is the unit cost of the emission reductions that underly the ITMO and OC: opportunity cost; marginal cost of ITMO augmented pledge = c(NDC+ITMO)

5. Alternative approaches

Opportunity cost pricing is not the only conceivable approach, and a few alternatives could be explored.

For instance, host countries could identify and earmark mitigation activities whose implementation cost is higher than the marginal cost of achieving their NDCs. Under a least-cost NDC strategy, selling ITMOs from such activities would not compete with NDC achievement, and therefore opportunity cost becomes irrelevant. In this case, pricing the ITMOs based on respective activities' implementation costs could work.

However, the earmarking approach significantly reduces transaction opportunities and flexibility for host countries in achieving their NDCs by limiting the scope of eligible activities. Also, mitigation planning happens under uncertainty on baseline emissions and actual performance of mitigation activities, which could make initially considered mitigation activities that are beyond the NDC the ones that the host country would need to meet its NDC.

Another alternative could be charging a uniform corresponding adjustment fee based on either a carbon price level needed to achieve the 2030 NDC pledges or the climate goals of the Paris Agreement. The recent studies suggest that the former would be within a range of $9/t - $73/t[11] while the latter would be around $100/t[12]. While this approach has the merit of simplicity, it could potentially generate large windfall gains in host countries that have low NDC ambition.

Finally, auctioning can be used to discover the price of ITMOs if the host country has an in-depth understanding of their NDC and its ITMO costing as well as a well-designed auction mechanism. This is, however, not the case for many host countries as they lack the required capacity. Using auctioning without a proper understanding of the ITMO costing could result in too low prices below opportunity costs.

6. Considerations for countries and practical approaches

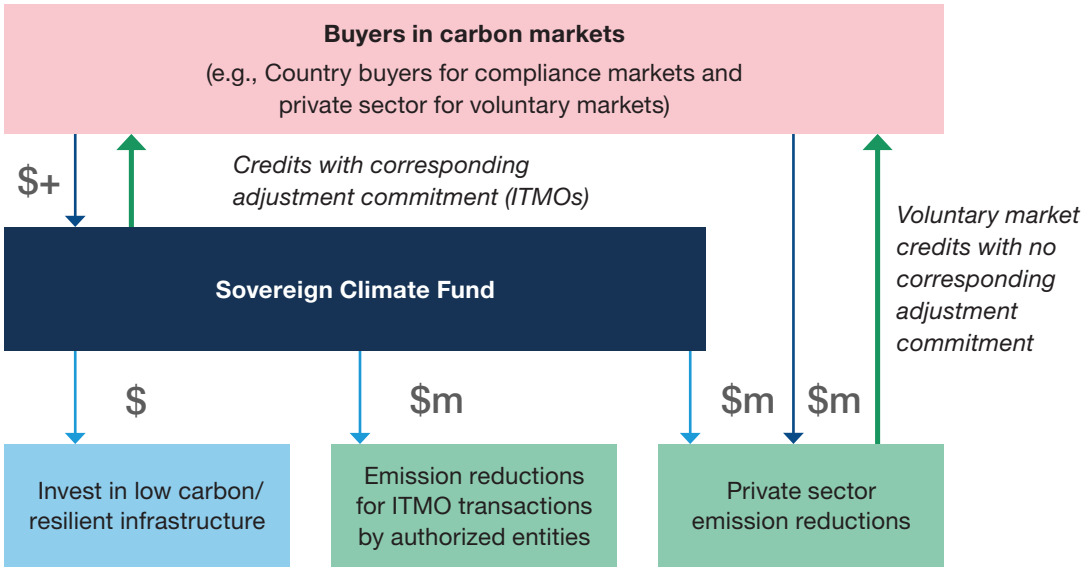
It is important to ensure that the revenues in excess of immediate mitigation costs, generated with the ITMO price derived from the above approach, do not become a windfall to project developers and are instead retained for use to implement additional mitigation activities to meet the NDC. For that purpose, it is necessary for the host government to have the ability to collect these payments, at least the portion covering opportunity cost associated with the corresponding adjustments. Such payments to the host country could be operationalized in various ways such as imposing a fee for Authorization and/or levying a tax on ERC transfer among other possible transfer schemes. One possible approach can be that the host government establishes a sovereign "climate fund" to capture the fee/levy/tax in lieu of the opportunity cost linked to the marginal cost of meeting the NDC. As illustrated in the figure below, the sovereign climate fund manages ERC transactions, pays the market price for carbon credits to the project entities, and invests part of the sale proceeds in activities which raise NDC ambition and increase climate resilience in the host country. There may be pure voluntary market and private sector transactions where the sovereign fund or the government is not at all involved. The sovereign climate fund or the government needs to be involved only when the transaction requires corresponding adjustments.

[11] Jae, E et al, How much could Article 6 enhance nationally determined contribution ambition toward Paris Agreement goals through economic efficiency, Climate Change Economics 2021, https://scholar.harvard.edu/files/jaldy/files/edmonds_et_al_2021_cce.pdf

[12] See: State and Trends of Carbon Pricing 2022, World Bank, https://openknowledge.worldbank.org/handle/10986/37455

The use of the sovereign climate fund requires the host country to set out clear country-level processes for participation in voluntary and Article 6 carbon markets. By having a centralized channel through which all ERC transactions are processed, it will enable the government to manage the NDC progress tracking more easily and use these revenues in a planned manner to effectively support the NDC commitments and overall development goals (e.g., use the revenues to increase the viability of certain mitigation projects in the country). Furthermore, this sovereign fund gives visibility to how the revenues from fee/levy/cess/tax are used, which will help in branding the country's emission reductions in international carbon market.

Figure 3: Illustration of transaction flows using the Sovereign Climate Fund



$+ is the price paid for mitigation outcomes (MOs) with corresponding adjustment (CA). This price reflects the opportunity cost to the government to generate additional MOs to meet the NDC due to CA for the sold mitigation outcomes. $m is the market price for carbon credits in the voluntary markets where the emission reduction credits are not associated with government commitment for corresponding adjustment.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