Financial additionality tests for cooperation under Article 6 of the Paris Agreement: case study Peru

Axel Michaelowa, Sandra Dalfiume, Jorge Estremadoyro

Final Report

Freiburg, Germany, 11.10.2021

Acknowledgements

The authors would like to thank Rosa Morales (Ministry of Environment of Peru), Hugh Salway (Gold Standard Foundation) and Milagros Sandoval (Ministry of Environment of Peru) for the comments provided to the report. However, this does not imply that they endorse the analysis or recommendations included in this study.

This report forms part of a programme led by the Gold Standard Foundation with support from the Government of Switzerland's Federal Office for the Environment, focused on Additionality under Article 6 of the Paris Agreement. Please note that the views expressed in this report are those of the authors and do not represent any official position of the Gold Standard Foundation, the Swiss Federal Office for the Environment nor the Ministry of Environment of Peru.

Contents

1. Introduction 6
2. Background on the energy sector in Peru 8
3. Energy-related GHG emissions and mitigation potential 9
4. Financial additionality testing in CDM projects in Peru 10
5. Peruvian participation in Article 6 14
6. National legislation and framework for climate change mitigation 15
7. Methodological approach to Article 6 in Peru and positive lists 16
8. When and at what level should additionality testing be undertaken? 17
9. Differentiation of generic additionality testing for inclusion in positive list according to characteristics of activities 19
10. Conclusions 26
11. Summary 26
References 27
Annex 1: CDM projects vs. RE auction awarded projects 30
Annex 2: GHG emissions of the energy sector as per the IPCC 2006 guidance 35
Annex 3: Energy mitigation measures 36
Annex 4: CDM energy projects in Peru and IRR 39

Figures

Figure 1: Focus of this report based on the eligibility criteria developed under World Bank consultancy for positive list determination 7

Figure 2: Solar and wind energy dispatch in Peru 8

Figure 3: Hydropower dispatch in Peru 9

Figure 3: Ideal scenario for the use of Article 6 in Peru 15

Figure 5: Additionality tests and positive lists 18

Figure 6 How to establish a benchmark percentile level 21

Tables

Table 1: Aggregation levels for additionality testing 17

Table 2: Highly mature technologies 24

Table 3: Mature technologies 24

Table 4: Low penetration technologies 24

Table 5 Mitigation measures proposed for the stationary combustion sector 36

Table 6 14 Mitigation measures proposed for the mobile combustion sector 37

Abbreviations

AFOLU	Agriculture, forestry and land use
BAU	Business as usual
CDM	Clean Development Mechanism
CER	Certified Emissions Reduction
EAF	Electric arc furnace
GHG	Greenhouse gas
IPCC	Intergovernmental Panel on Climate Change
IRR	Internal rate of return
ITMO	Internationally transferred mitigation outcome
MINAM	Ministry of Environment of Peru
NAMA	Nationally appropriate mitigation action
NDC	Nationally Determined Contribution
NGO	Non-governmental organization
NPV	Net present value
OCGT	Open cycle gas turbine
PA	Paris Agreement
PDD	Project design document
PMR	Partnership for Market Readiness
RE	Renewable energy
REDD+	Reduction of emissions from deforestation and forest degradation
RENAMI	Registro Nacional de Medidas de Mitigación
SME	Small and medium enterprise
UNFCCC	United Nations Framework Convention on Climate Change
WACC	Weighted average cost of capital

1. Introduction

When engaging in international carbon markets under Article 6 of the Paris Agreement (PA), governments hosting activities need to undertake a set of assessments to identify which activities should be eligible for sale of internationally transferred mitigation outcomes (ITMOs). From a host country perspective, it is crucial to analyze if activities generating ITMOs are, inter alia, covered by the NDC scope, aligned with national development priorities, and additional. Due to the need to embark on corresponding adjustments of the host country's emission balance, activities that do not fulfil these criteria will generate a burden for the host country as the government will have to identify alternative mitigation options to achieve its NDC. The primary purpose of Article 6 is not to help Peru achieve its NDC mitigation targets. Through the corresponding adjustments to be made, ITMOs will be used towards buyer country NDCs. Hence, it is important that the country does not sell the mitigation actions to be achieved most easily (low-hanging fruits). In this sense, Peru should not sell mitigation actions that it could have undertaken with its own resources. Additionality requires that activities eligible for Article 6 are different from the business as usual (BAU) scenario, meaning Article 6 activities should not have happened in the absence of the incentive generated by the revenue from ITMO sales. An activity financed from the government budget, or using a technology with high penetration in the market is usually non-additional.

Thus, additionality testing is crucial for Article 6 activity host country governments to ensure that they only authorize only real mitigation outcomes that require carbon market support for international transfers (Michaelowa et al. 2019). Additionality tests developed and used by the Kyoto Mechanisms, primarily the Clean Development Mechanism (CDM), can inform the design of additionality tests under Article 6 of the PA. On the one hand, regulatory and policy additionality requires activities to not be mandated by a regulation or triggered by a policy instrument[1]. On the other hand, financial additionality requires activities to not be attractive without the revenue from the credits. Under the CDM, financial additionality testing has been applied and continuously been refined after it became clear that the previously used barrier test led to the registration of many non-additional projects.

Drawing on the COP 21 mandate that Article 6 should be developed taking into consideration lessons learned and experiences of the Kyoto Mechanisms, this study develops the theoretical concepts on how to undertake financial additionality tests for energy-related activities to be eligible for Article 6, focusing on the specific situation in Peru, applying approaches that do not generate high transaction costs and operationalizing financial additionality assessment through easy-to-understand parameters.

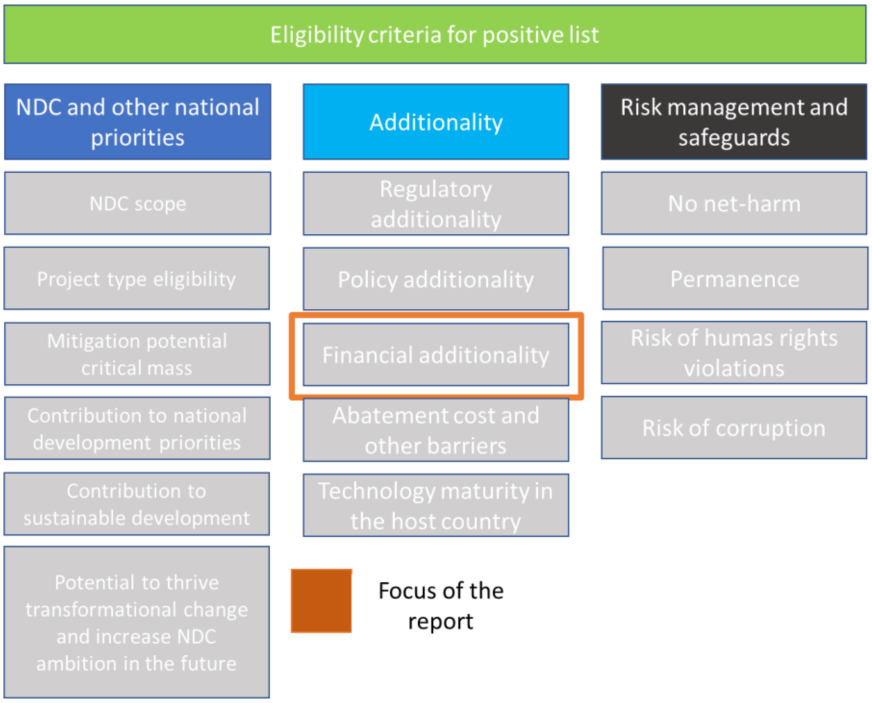
[1] It should be noted that the introduction of a policy instrument credibly triggering mitigation, e.g. through a substantial carbon price, could be deemed an additional Article 6 activity. We do not discuss this here further, as we focus on crediting of specific activities in this study.

It does not look at specific activities, but higher levels of aggregation (e.g. technology, subsector and sector.

In this light, activities that do not generate revenues and can show regulatory and policy additionality, are deemed automatically additional. Conversely, when an activity is likely to create revenues or savings, the suggestion is to either rely on performance benchmarks or payback period thresholds testing. The former is targeted to industrial sectors with homogeneous technologies and to activities that involve small-scale appliances. The latter is suggested to be applied to commercial activities that require investments.

The results of this study can be used by host country institutions authorizing Article 6 activities for several purposes. They can inform decisions on which activities should be included in an Article 6 positive list (see Figure 1 below) and, thus, be potentially covered by bilateral agreements (e.g. Swiss bilateral agreements). The information could also be used as a guidance for the private sector when aiming to submit proposals under bilateral agreements or to international Article 6 tenders. In addition, the report could be used to enhance internal capacities of host country institutions as well as relevant stakeholders on the key attributes of financial additionality and how to apply additionality testing to assess eligibility of Article 6 activities.

Figure 1: Focus of this report based on the eligibility criteria developed under World Bank consultancy for positive list determination



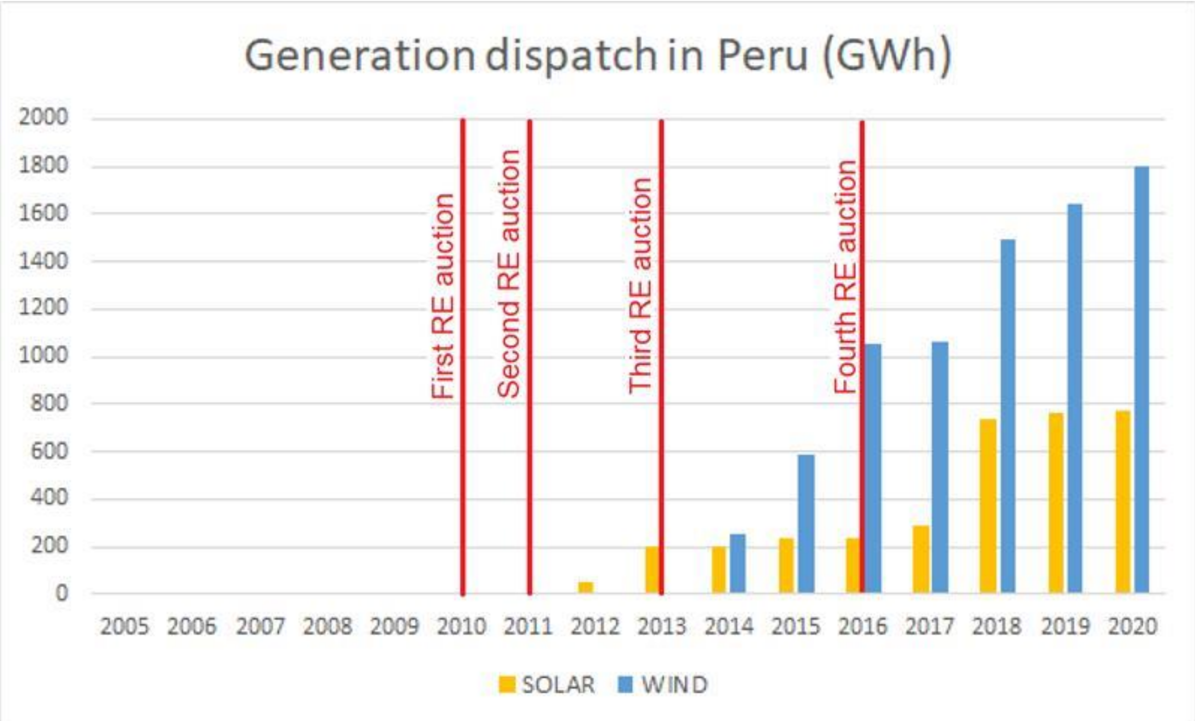
Source: South Pole and Perspectives 2021

The study focuses on the energy sector, taking into consideration that it is the largest emitter after the forestry sector with almost 30% of emissions as per the emissions inventory for 2016 (Government of Peru 2021). It will particularly address rural energy access through decentralized system including improved cookstoves, solar home systems etc., due to their high co-benefits, and renewable energy and energy efficiency interventions in small and medium enterprises (SME), as per its relevance for the government as can be seen in the measures prioritized in the final technical report of Peru's multisectoral NDC working group (see Annex 3).

2. Background on the energy sector in Peru

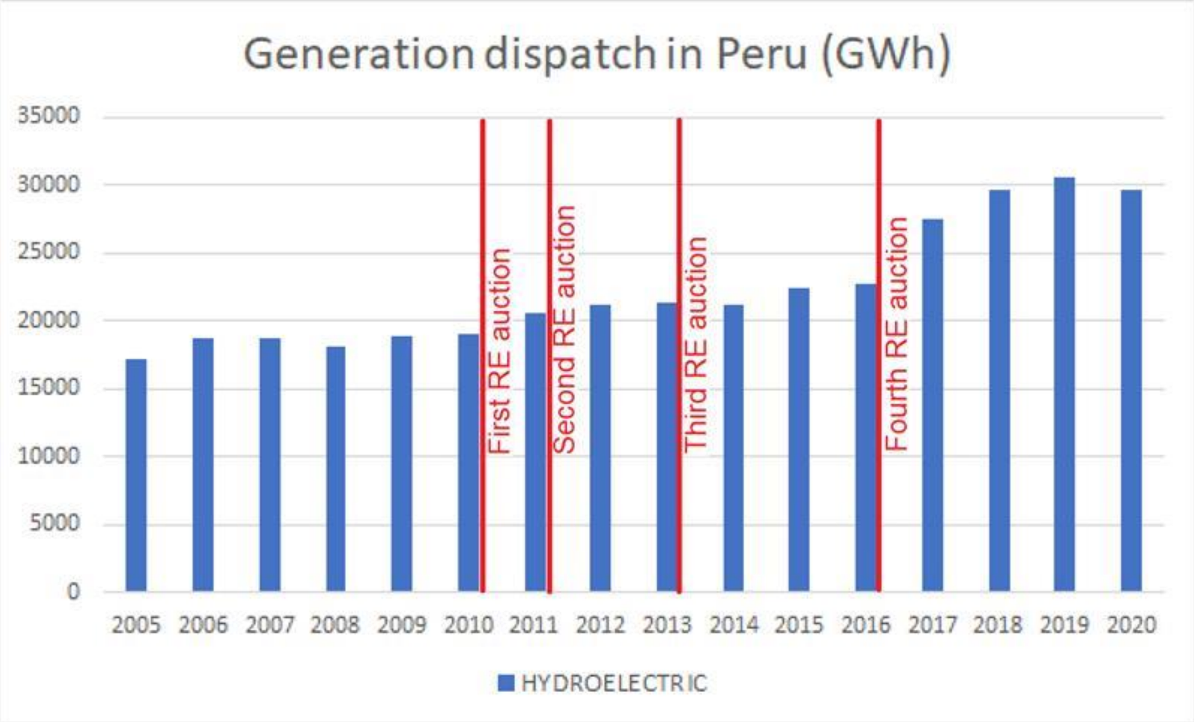
In terms of power generation, Peru's main source of energy has traditionally been hydropower. In 2004, due the exploitation of the Camisea gas block in the Amazonas region, gas started to also become a key source of power generation for the country. In 2008 a law was introduced (Decreto Legislativo N°1002) to foster investments in renewable energy (RE) resources such as wind energy, solar, geothermal, tidal, biomass and small hydropower plants with an installed capacity of up to 20 MW (non-conventional hydropower) (Osinergmin n.d.). Within the scope of this law, four renewable energy supply auctions were carried out in 2010, 2011, 2013 and 2016. Figures 2 and 3 below show the dispatch of solar, wind and hydropower until 2020 and how the supply changed after the auctions.

Figure 2: Solar and wind energy dispatch in Peru



Source: authors based on COES 2021

Figure 3: Hydropower dispatch in Peru



Source: authors based on COES 2021

On a different note, it is relevant to pinpoint that out of the 61 CDM projects registered in Peru, 39 of them were hydropower ones, registered mainly between 2008 and 2012. The capacity of these hydropower plants ranged between 0.8 MW and 507 MW (see detailed information in Annex 1) (UNEP DTU 2021). Moreover, it is worth highlighting that from the 39 CDM registered projects, at least 19 of them were also RE auction awarded projects, and at least 3 CDM registered projects were rejected in one of the four auctions (see Annex 1 for more detailed information).

3. Energy-related GHG emissions and mitigation potential

According to the 2016 Greenhouse gas (GHG) Inventory approved by the Peruvian government in May 2021, the total net emissions of the country were 205.3 $MtCO_2eq$ (Government of Peru 2021). The main source of GHG is the Agriculture, forestry and land use (AFOLU) sector with 134.9 Mt CO_2eq, accounting for 61% of all net emissions. Energy is the second largest source of emissions in Peru with 58.1 Mt CO_2eq, which represent 28.3% of all net emissions. Annex 2 expands on the different GHG emissions of the energy sector as per the Intergovernmental Panel on Climate Change (IPCC) 2006 Guidance for national GHG inventories.

According to its updated Nationally Determined Contribution (NDC) under the PA, submitted in December 2021 to the United Nations Framework Convention on Climate Change (UNFCCC), Peru's unconditional target aims at not exceeding 208.8 $MtCO_2eq$ by 2030, and its conditional target at not exceeding 179.0 $MtCO_2eq$ (Government of Peru 2020). The NDC does not specify how the country aims to achieve its target. The prioritization of mitigation activities will most likely be defined in the context of elaboration of domestic policies. In this line, in 2018 the government adopted 62 measures aimed at guiding the mitigation efforts of the country to achieve its NDC. It is not clear yet whether these measures will suffice to achieve its more ambitious updated NDC target, or if they are upscaled/complemented by further measures.

Out of the 62 measures, 38 measures were proposed for the energy sector with a total emission reduction potential of 16.9 $MtCO_2eq$ (Government of Peru 2018, p.496). Annex 3 expands on the different energy-related mitigation measures proposed by the government.

4. Financial additionality testing in CDM projects in Peru

Peru has been very active in the CDM, with 61 registered GHG reduction projects that have issued 5.6 million Certified Emissions Reductions (CERs) to date (UNEP DTU 2021). Regarding the energy sector, out of these 61 projects, 2 focused on biomass energy, 3 on the energy efficiency supply side, two on fossil fuel switch, 39 on hydropower, 5 on solar energy and 3 on wind power (UNEP DTU 2021). These projects underwent additionality tests, as required by the CDM methodologies and the underlying additionality tool. Typically, after the first years of the CDM in which a stand-alone barrier test was possible, project proposals needed to demonstrate additionality by following a four-step process: step 1- identification of project alternatives, step 2- investment analysis, step 3- barrier analysis, step 4- common practice analysis. A short description on how financial additionality tests (investment analysis) were applied to three projects in the energy sector and how validators assessed these tests follows below. The selected cases reflect how financial additionally was undertaken under the CDM by using the internal rate of return (IRR) benchmark and the unit cost of energy analysis, as well as reflecting cases where the CDM's financial additionality process was not robust enough, leading to non-additional projects.

1. Cerro del Aguila Hydroelectric Project

The project, registered in December 2012, is a 507 MW hydropower plant on the Mantaro River in the Region of Huancavelica, applying the consolidated baseline methodology for grid-connected electricity generation from renewable sources ACM0002 (version 12.3.0). Additionality was demonstrated by following the four-step process included in the version 7.00 of the tool for demonstration and assessment of additionality.

The additionality of the project was assessed only against one alternative to the project (project without CER revenues). Hence, the project was considered financially additional because it was demonstrated, first, that the project was not financial attractive, and second, that the project became more attractive with the revenues from CERs. To reach this conclusion a benchmark analysis was applied. The IRR benchmark used was 12% as per established in the Electric Concession Law. The assessment undertaken demonstrated that without the CERs the IRR of the project was 8.26% and with the CERs it increased to 10.17%. In both cases the IRR was below the benchmark, but the inclusion of CERs revenues made the project more financially attractive. The calculated IRR was a post-tax one and the CER market price chosen was obtained from the carbon market data provider Point Carbon (8.3 €). As part of the investment analysis- and as required by the tool- a sensitivity analysis was carried out. The sensitivity analysis identified how certain variables needed to evolve to potentially reach the benchmark. As per the assessment made, either the tariff on the spot market needed to increase by more than 47.6%, or the power purchase agreement power tariff would have to increase by more than 99.5%, the plant load factor would have to reach at least 66.2% or the initial investment costs would have to fall by over 31.0%. A description on why it was impossible to reach those values was included, demonstrating the project was financially additional. To validate the information provided for the investment analysis, validators relied mainly in information included in independent engineering and technical reports elaborated by external consultancy firms as per request of the project developer. Validators analyzed assumptions included in the reports, confirmed calculations were done correctly, and cross-checked data from reports with info included in the PDDs. They did however not assess independent documentation.

In hindsight, the additionality of the project is highly questionable. The project, which is the second largest hydropower plant in Peru, became operational in 2016 but has not issued any CERs yet. It also has not undertaken a request for renewal of its crediting period. The irrelevance of the CDM for the project operators is confirmed by their bond offering (Cerro del Aguila 2017) that discusses the revenues and risks of the project in extreme detail without mentioning CDM or carbon credits at all. This indicates that the plant was fully commercially viable without revenues from CER sales.

2. Conversion of open cycle gas turbines to combined cycle at Kallpa Power Plan

The aim of this CDM project registered in December 2012 was to convert three open cycle turbines (OCGT) of the Kallpa Power Plant located in Chilca, Cañete into a combined cycle facility to add a nominal 292.9 MW gross generation provided by the steam turbine at full load. The project proponents used the methodology ACM0007 version 06.1 to get the CDM registration and demonstrated additionality by following the four-step process included in the version 4 of the “combined tool to identify the baseline scenario and demonstrate additionality”.

The financial indicator selected to assess the financial additionality of the project was also the IRR. The project proponent identified two possible alternatives to the project: i) carry out the project without the CER revenues (alternative a), and ii) continuation of the current practice (alternative b). Therefore, in this case, two approaches were used to demonstrate the financial additionality of the project. First, the benchmark analysis approach was undertaken considering only alternative a. As in the previous case study, the benchmark of 12% included in the Electric Concession Law was used as a reference. The IRR of the project without CER revenue was calculated to be 10.46% which proved to be below the benchmark level. The sensitivity analysis proved that with variations of -/+10% of selected parameters (electricity tariff, guaranteed power tariff, initial investment, gas supply, operation and maintenance costs, load factor) the project still would not reach the benchmark. Hence, according to this first approach the project was proved to be additional.

In addition, an investment comparison approach was used to compare the two possible alternatives to the project. Under this assessment the IRR for the alternative a was calculated to be 12.34%. The IRR of the alternative b was calculated to be 15.38%, representing a more attractive investment than alternative a, and therefore, used as the baseline. The IRR of the project with CER revenues was calculated to be 15.61%, showing a more attractive financial alternative with a better environmental performance. In addition, the sensitivity analysis undertaken showed that i) the levels of variation for the second activity to be less attractive than the first alternative were highly improbable; ii) the levels of variation required for the first alternative to be more attractive than the second alternative were also highly unlikely. So, the investment comparison approach demonstrated that the project was additional because it was proven that the baseline scenario was not alternative a (activity without CER revenues). As in the previous case study, validators relied mainly on information included in reports provided by the project developer. Validators analyzed assumptions included in the reports, confirmed calculations were correct, and cross-checked data from reports with info included in the PDDs, confirming the project was additional. They did however not assess independent documentation.

In hindsight, additionality is questionable for this project as well. While the plant became operational in August 2012 and had a CER issuance of 0.27 million for the period between December 2012 and August 2013, no further issuance was undertaken since then. The irrelevance of the CDM for the project operators is confirmed by their bond offering (Cerro del Aguila 2017) that discusses the revenues and risks of the Kallpa project in extreme detail without mentioning CDM or carbon credits at all. This indicates that the plant has been able to operate commercially without any revenue from CER sales.

3. Fuel switching at Atocongo Cement plant and natural gas pipeline extension

The project registered in 2007 introduces natural gas as a substitute for fossil fuels (mainly coal, pet coke and furnace oil) for clinker production at the Atocongo cement plant in Lima, by installing natural gas burners and constructing a 3.5 km natural gas pipeline. It applies the baseline and monitoring methodology ACM0003, version 5 and version 2 of the "combined tool to identify the baseline scenario and demonstrate additionality".

In contrast to the previous two projects, for this case a unit cost of energy analysis was applied. This project was considered financially additional because it was demonstrated that the unit cost of energy from natural gas (2.74 US$/MMBTU) was higher than the unit cost of energy from coal (2.53 US$/MMBTU), while revenues from CER sales were calculated to be 0.25 USD/MMBTU, making the CDM project attractive. A sensitivity analysis for the robustness of the financial analysis was also undertaken. According to it, the price of natural gas needed to fall by 7.86% for the unit cost to be equal to that of coal. Evidence was provided that historical variation cost of natural gas between 2004 and 2007 reached only -3.17%. The validation report showed several requests for additional information made to the project developers with regard to the additionality analysis but eventually accepted the argument.

In this case, the additionality assessment was less robust than in the previous two cases. And a simple web search of the validator would have led it to the 2005 annual report of UNACEM, the operator of the Atocongo cement plant, which states bluntly several times that using natural gas reduces costs (emphasis by the authors of this study), e.g. "During 2005, the Board of Directors and General Management have put in place a strategic policy of cost reduction and control, destined to counter the increase of international energy costs which came into effect from the end of 2004. In the case of coal, our principal fuel, the average price increase in 2005 was of the order of 69% over the 2004 price. A number of different initiatives have been embarked upon within this policy, with the purpose of minimizing the effect of increased costs. Among these, we can point to […] ***the hook-up of our plant to the Camisea natural gas grid***." (UNACEM 2006, p. 16), and again "a number of projects that are currently being executed will also ***allow us to reduce and/or control our costs***. Prominent among these are: the interconnection of our manufacturing plant to the Camisea natural gas grid (as an alternative fuel), programmed to go on line in April 2006" (ibid, p. 23), and lastly "During the course of 2005, the project of interconnecting the Atocongo production plant to the Camisea natural gas grid was set in motion. The intention is to substitute the solid fuel currently fed to the kilns ***with this more economical alternative***" (ibid., p. 31). So, the company itself officially stated in an unequivocal way that the project was not additional.

The project had a first crediting period from November 2008 to November 2015 and was commissioned in 2008. It had three CER issuances totalling 0.31 million CERs for monitoring periods until August 2011 and then stopped issuances, apparently due to the fall in CER prices after 2012. It also did not renew its crediting period after 2015. Currently (Anonymous 2021), the plant is operating with a mix of natural gas (70%) and coal (30%) as fuel, apparently shifting fuels as per their commercial attractiveness. Even a new 136 MW gas power plant in Atocongo was approved in 2017 taking its gas supply from the Atocongo cement plant's gas pipeline (Anonymous 2017). All this clearly shows that the project was not additional.

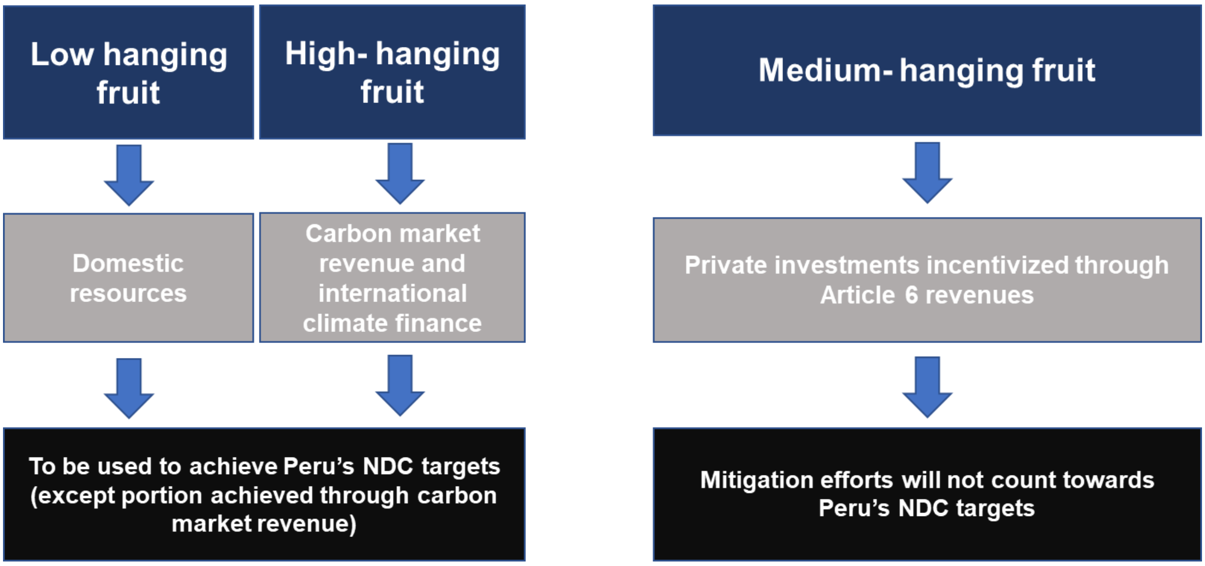
5. Peruvian participation in Article 6

Since the submission of its first NDC, Peru indicated its intention of participating in Article 6 cooperative approaches of the PA. In the last 5 years, the willingness of the country was reconfirmed through several acts undertaken at an international and national level. Peru joined the World Bank's Climate Market Club in 2020. In October 2020, it signed the world's first bilateral agreement on Article 6.2. with Switzerland specifying conditions and processes for generating and authorizing sales of ITMOs. The Peruvian interest in high-integrity Article 6 action is shown by Peru's participation in the development of the San Jose Principles for High Ambition and Integrity in International Carbon Markets in 2019, and their signature.

Through its latest NDC submission (Government of Peru 2020) the country reconfirmed the intention of using Article 6 to increase the ambition of its NDC and foster sustainable development. As mentioned in the previous section, the Peruvian NDC distinguishes between unconditional and conditional targets. However, Peru does not preclude the use of external funding to only the conditional targets[2]. By doing so, Peru is leaving a door open for NDC unconditional activities to also be eligible for Article 6. This is not ideal, because activities to be used under Article 6 will most likely be used by buyer countries for achievement of its own NDCs, undermining Peru's efforts to achieve its own NDC. In this sense, it is of utmost importance for the country to identify its 'low, medium and high' hanging fruit. 'Low-hanging fruits' should remain achievable with domestic resources to be counted towards Peru's NDC. 'Middle-hanging fruits' should be the target of mitigation investments of private entities and should be the ones eligible for ITMOs generation. 'High-hanging fruits' should be addressed through international cooperation which could include revenues from carbon markets, receipt of international climate finance and blending of the two (Michaelowa et al. 2019). In this regard, the ideal scenario on the use of Article 6 in light of Peru's NDC should be as follows:

[2] As stated in the NDC "The unconditional goal refers to the Commitment not to exceed a maximum number of GHG emissions in 2030 achieved with mitigation efforts promoted by the Peruvian government based on investments and expenses with internal, **external**, public and private resources" (Government of Peru 2020, p.9).

Figure 4: Ideal scenario for the use of Article 6 in Peru



Source: authors

In addition, due to Peru's definition of conditional and unconditional targets, looking into only the conditional part of the NDC would be insufficient to determine activities eligible for Article 6. Appropriately set activity level baselines, additionality testing and the willingness of Peru to undertake corresponding adjustments for sold ITMOs, will play a fundamental role in helping the country identify its Article 6 activities (Greiner et al. 2021).

6. National legislation and framework for climate change mitigation

In 2018, Peru enacted a Climate Change Law and in 2019 adopted the regulation elaborating the law. This regulatory framework gives the mandate to the Ministry of Environment (MINAM) to be responsible for the implementation of the PA, but also establishes the importance of the sectors involved in this process, and specifically states that sub national governments should engage in this process, as well as non-state actors.

Particularly, with regard to Article 6, Peru has taken several steps to build the appropriate institutional arrangements: i) the development of the MRV infrastructure at the national level, as well as for selected nationally appropriate mitigation actions (NAMAs) with GHG crediting potential, ii) the development of the Mitigation Action Management System, which includes the National Registry of Mitigation Actions (Registro Nacional de Medidas de Mitigación –RENAMI), the National GHG Inventory, and a National Carbon Footprint Program; and iii) GHG crediting-related technical activities in three sectors: the cement industry, solid waste management, and small-scale renewable energy systems (SP/WB report).

RENAMI is a key instrument to track the mitigation progress towards the NDC, as well as to record the units used under the different market-based approaches (PA, CORSIA) as well as ITMO transfers.

7. Methodological approach to Article 6 in Peru and positive lists

Peru is still working on the different processes and legal arrangements needed to identify which activities could fall under Article 6 and how to authorize/approve these activities. In the first half of 2021, the country received support from the World Bank through the Partnership for Market Readiness (PMR) to develop a methodological approach on how to assess project eligibility to participate under Article 6.2 in a fast-track manner. Through the support provided, a first draft of a positive list of sectors, technologies, or project types that could fast-track the approval activities under Article 6 was also developed. As part of the methodological approach a set of different criteria to assess the eligibility of activities were listed, including additionality. Financial additionality means that the activity would need to show that it is not attractive without revenue from the credits. Regulatory additionality means that the activity is not mandated by a regulation that is actually enforced. Policy additionality means that the activity is not triggered by a policy instrument. The report provided general guidance regarding the characteristics of additionality assessment and suggested that financial, regulatory and policy additionality should be tested. Also, the consultancy report outlined that the positive list would not work like the positive list under the CDM which assumes automatic additionality, but more like a preferential list, where activity developers still need to provide evidence that their activity has certain characteristics.

As discussed in the introduction, activities included in Peru's government budget and activities that are already planned to be achieved through different strategies at different levels should not be taken into consideration for Article 6. For example, the Massive Photovoltaic Programme (el Programa Masivo Fotovoltaico[3]) implemented by the Ministry of Energy and Mines in Peru since 2017 could not be considered additional as being executed with public funds.

Also, as mentioned above, in the case Peru would have set its unconditional target according to domestic resources already allocated, the additionality assessment could be limited to actions listed in internal policy instruments as contributing to the conditional target. However, this is not the case, given that the NDC states that external resources are also needed for unconditional activities (see Footnote 1 above). To safeguard the environmental integrity of the Article 6 transactions, Peru will thus have to

[3] The Massive Photovoltaic Programme aims to mitigate the lack of electricity in rural areas trough the distribution of photovoltaic panels in off-grid areas. The first phase of the programme allowed to install solar panels in 205,138 homes; 2,368 schools and 639 hospitals. The second phase of the programme to be implemented as per 2021 aims at providing solar panels to 100 000 households (MINEM 2021a).

undertake additionality testing to the activities it aims to sell from the unconditional and conditional targets.

8. When and at what level should additionality testing be undertaken?

Additionality testing can be done at different levels of aggregation.

Table 1: Aggregation levels for additionality testing

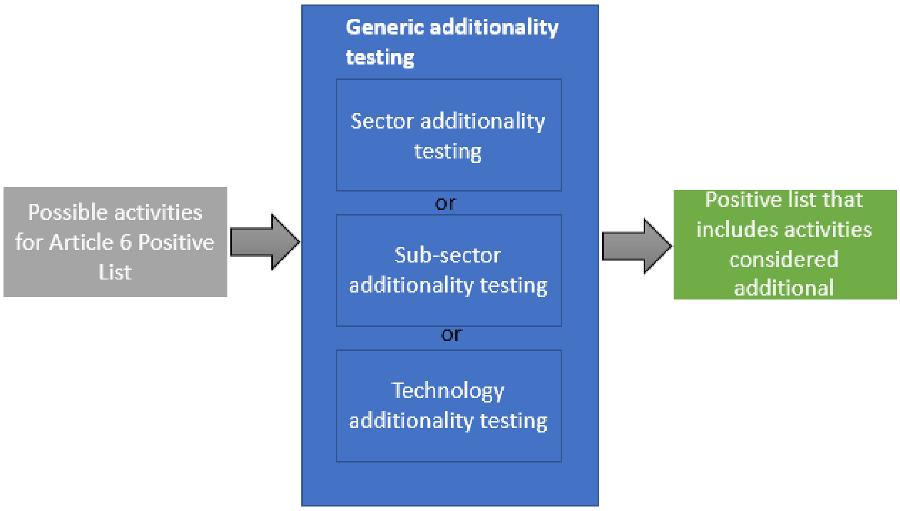
Aggregation level	Example
Sector	Energy
Subsector	Renewable energy
Technology	Solar PV
Program	Dissemination of solar PV for rural health clinics
Project	1 MW solar PV plant for Cuzco city

Note: The examples are fictitious and illustrative

In the context of the positive list, generic additionality testing should be taken before including activities on the positive list. Generic additionality testing would be limited to higher levels of aggregation above programs and projects. The approaches to such additionality testing will be developed in this report. Only activities and programs that are consistent with the criteria derived through generic additionality testing should be included in the list. They subsequently would no longer have to do an activity-specific additionality test but would have to report on parameters that show that they fulfil the criteria.

In the case of Peru, generic additionality testing should be carried out at a national level. Institutionally, both performance benchmarks and payback period thresholds should be elaborated through sectoral experts convened by relevant institutions such as Osinergmin or the Environmental Evaluation and Enforcement Agency of Peru (OEFA), with subsequent vetting by MINAM. For a detailed approach and roadmap, a separate study would be required.

Figure 5: Additionality tests and positive lists



Source: authors

Under the PA no clear guidance exists regarding the level (international or national) at which positive lists should be developed, nor the role of international oversight and standardization. Cooperative approaches will likely rely mostly on positive list processes led by host countries, as is currently happening in Peru (Ahonen et al. 2021). This allows better engagement with the private sector and other relevant stakeholders, better alignment with host countries´ NDCs and national priorities, and more flexibility in updating the positive lists (Ahonen et al. 2021). The level of international oversight and adoption of standardized guidance would most likely depend on the activities (6.2 or 6.4) the positive lists aim to address. The nature of 6.4 activities and the role the Supervisory Body plays in Article 6.4 would likely imply more dependence on criteria or even positive lists adopted at the international level. The additionality tests presented in this report aim to inform development of national, country-led positive list processes.

Below, we develop approaches for how to specify characteristics of activities eligible for the positive list, trying to simplify financial additionality testing as far as credibly possible. While there will be some activity types that are universally eligible, for other activity types the eligibility is only given if an activity exceeds pre-defined thresholds, e.g. a certain level of payback period or a performance benchmark. For those activities/sectors that are not included in the positive list, an activity-specific additionality test should be carried out before their approval. This test should be based on the combined additionality tool of the CDM[4].

9. Differentiation of generic additionality testing for inclusion in positive list according to characteristics of activities

Below, we discuss various forms that generic additionality testing with regard to inclusion of activities in the positive list can take, and for which types of activities and aggregation levels these forms are appropriate. Please note that these tests presume that there is no mandatory and enforced regulation in place for the underlying activities; as described above, regulatory and policy additionality must also be tested in addition to financial additionality.

1. Absence of revenues from the sale of goods or services

If an activity type has no revenues whatsoever, it can be immediately put on the positive list. Activity types that have revenues from the sale of goods and services need to be subject to another type of generic additionality tests.

Activities that generate no revenues include conversion from logged to protected forest without revenues from (wood and non-wood) forest products or tourism, certain REDD+ activities such as land titling, destruction of industrial gases, methane flaring at landfills as well as wastewater treatment plants and landfills with aeration techniques.

2. Performance benchmarks

Performance benchmarks look at the distribution of GHG emissions intensity for activities in a sector, sub-sector or regarding a specific technology. The activities are ordered according to the emissions intensity starting from the best and ending with the worst. The benchmark is then determined as a percentile. For example, approach c) for CDM baselines in the Marrakech Accords specified a benchmark at the 20th percentile, which means that the baseline would be set at the emissions intensity of the activity which is better than 80% of all activities.

The key challenge for using a benchmark as a proxy for financial additionality determination is to set the benchmark at a level that is in line with the performance level achieved by projects that would just

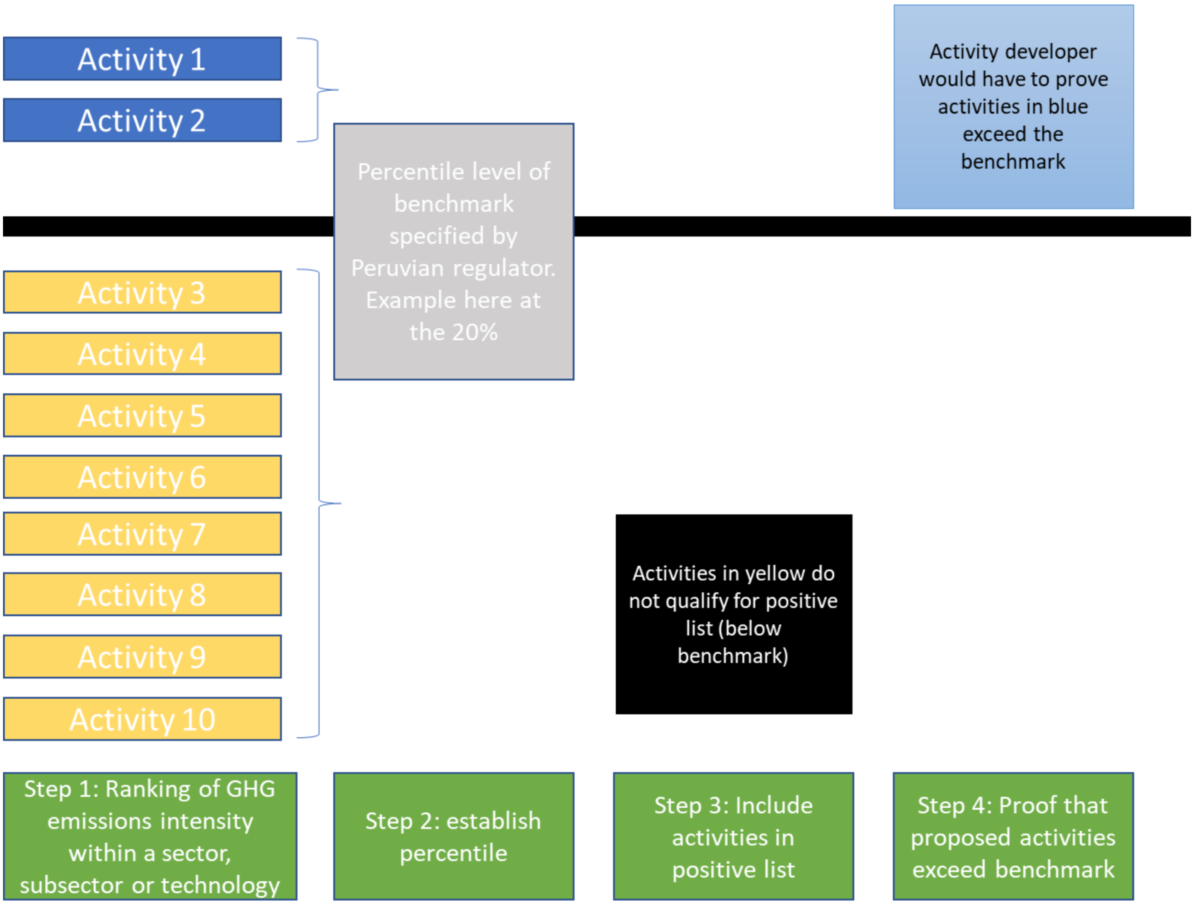
[4] This tool provides a step-wise approach to identify the baseline scenario and simultaneously demonstrate additionality for all types of proposes project activities. The tool can be accessed through the following link: https://cdm.unfccc.int/methodologies/PAmethodologies/tools/am-tool-02-v7.0.pdf

not be financially attractive without the revenue from ITMO sales. For example, a benchmark for the cement sector would have to be set at the level which can be achieved with a three-stage preheater, if it is clear that a four-stage preheater would make a cement plant not economically viable. If no project in the country has introduced a four-stage preheater yet, the benchmark would have to be put at a level of the best current performance, i.e. that with a three-stage preheater.

There may also be a situation where some companies are more risk-averse than others and therefore require higher internal rates of return for their investment. In such a situation, the benchmark would have to be situated at the performance of the company with an average level of risk aversion. Again applying a cement sector example, where three companies with different risk aversion constitute the sector – if the company with highest risk aversion operates a two-stage preheater, that with average risk aversion a three-stage preheater, and the company with lowest risk aversion a four-stage preheater, the benchmark would be set at the performance level of the company operating the three-stage preheater. In this case, any projects with four-stage preheaters would beat the benchmark and be eligible for the positive list. The challenge to operationalize such an approach is to understand the differences in risk aversion.

Translated into a generic additionality test, a benchmark approach would mean that the activities below the benchmark would not qualify for the positive list. The regulator would have to specify which activities would be included in the benchmark calculation and the percentile level of the benchmark; which is challenging as described above. The activity developer would have to calculate the activity's emissions intensity and report to the authorization authority that the activity exceeds the benchmark.

Figure 6 How to establish a benchmark percentile level



Source: authors

Whether performance benchmarks capture additionality strongly depends on the characteristics of a sector and the technologies used in the sector, as discussed above in the cement sector examples. If there is a clear correlation between the levelized unit costs of production of a good and service and the emissions intensity, a benchmark is a good proxy for additionality if it is put at the level where the revenues exceed costs by a sufficient level to mobilize entrepreneurs. The situation is problematic if there are discrete 'jumps' of the emissions intensity that are not linked to the costs. Such jumps occur if there are highly different ways of producing the same good or service at costs that are comparable, but with strongly differing emissions intensity. This is the case in the electricity generation sector where technologies with highly different emissions intensity compete on a pure cost basis. The development of the last years has shown that zero emissions intensity renewable electricity technologies now increasingly have lower costs than fossil-fuel based technologies. As long as fossil fuel-based technologies were the cheapest technologies, one could have applied a performance benchmark approach for off-grid electrification replacing diesel generation.

In the industrial sector, similar considerations apply in many sub-sectors as for the electricity generation sector. For example, for steelmaking electric arc furnaces (EAF) and blast furnaces are competing with each other due to an overlap of the costs per tonne of steel, while the emissions intensity differs by a factor of 4-5 depending on the emissions intensity of the electricity grid. So if a 20^{th} percentile benchmark would be used for additionality determination of a steel sector consisting of an equal share of blast furnaces and EAF, all EAF plants would be deemed additional. A similar situation would occur in a country that has a significant share of wet cement kilns – here all dry kilns that have a much lower emissions intensity would be deemed additional.

In the household and SME energy demand sector, which is characterized by a strong convergence of performance characteristics of appliances, performance benchmarks can become a powerful tool for generic additionality determination. For the SME industry sector this would relate to **electric motors**, **boilers** and **cooling** appliances, for the household sector to **cooking**, **heating** and **cooling** devices, the latter becoming relevant with rising incomes. The specification of the benchmark should be linked to the determination of the payback period for the technology type, see discussion of payback period criterion below. This means that the emissions intensity of the best appliance satisfying the payback period criterion would become the benchmark. If the payback period required to trigger an industrial investment would reach four years, and such payback period would be achieved for industrial boilers of 85%-90% efficiency, while the average of existing boilers would have an efficiency of 70%, the benchmark would be set at 90% efficiency, given that emissions intensity of appliances is often linked to appliance size/power, the benchmarks need to be sufficiently disaggregated. The criterion for disaggregation should be an average change in emissions intensity of 25% between the median of each size class.

In the Peruvian context, performance benchmarks should be further explored for the following sectors:

- Cement production
- Electric motors, boilers and cooling appliances for industry, disaggregated to size classes of ±25% median emissions intensity
- Cooking, heating and cooling devices for households, disaggregated to size classes of ±25% median emissions intensity

In order to determine benchmark levels, risk aversion of cement producers and payback period requirements for SMEs and households needs to be understood better.

3. Payback period thresholds

Payback period refer to the length of time required to recover the investment costs. Shorter payback periods reflect more attractive investments. Payback periods are calculated by dividing the total amount of investments by the annual cash flow and are expressed in the form of a time period (e.g. months, years). Payback period thresholds are a simplification of thresholds for the internal rate of return (IRR). IRR refers to the expected annual rate of growth of an investment. It is expressed as a percentage. The higher the percentage the better. IRR thresholds have commonly been used in the investment test under the CDM, and been derived from bank lending rates or typical capital cost (weighted average cost of capital, WACC). The vast majority of the CDM projects registered in Peru used the IRR thresholds (See Annex 4) (UNDP). IRR calculations have also been used recently by the MINAM to assess the social and private return of some its 62 mitigation activity measures (Government of Peru 2018b).

However, payback period thresholds are easier to link to industry practice than IRR thresholds as they implicitly take into account the risk aversion of companies and are widely used in Peru. Esan (2017) states for Peruvian private sector planning "contrary to what one might think, the most widely used indicator is the payback period". A 2005 Peruvian research demonstrated that in the most used investment techniques by 74 companies in Peru were net present value (NPV), payback period and IRR, in that order (Mongrut and Wong 2005). A more recent research done in 2019 in Piura, targeted to medium companies showed that 67% of the companies use payback periods, 64.7% NPV, 64.7% IRR and 62% use cost/benefit analysis (Tresierra-Tanaka and Acuña 2019). In most countries, payback period thresholds are situated around three to four years, implying an IRR threshold of 25-30%. This is definitely higher than bank lending rates of 10-15% due to the fact that banks do not lend to all companies. There is evidence that banks especially shun SMEs. A 2017 study showed that the micro, small, and medium enterprises in Peru received only between 29% and 33% of all the loans allocated by the financial system (León 2017). Obviously, due to the higher risk profile, equity, which is the key source of financing for SMEs needs to have higher rates of return than interests for bank loans. So, the “high risk” tail of company behavior and the availability of third-party funding to SMEs is not captured by the bank lending rates.

Usually, risky behavior of companies relates to areas where technologies are not mature. There, the payback period will be short, and the implied IRR the technology needs to generate will be high. Sectors with mature technologies will be able to have longer payback periods.

Payback period thresholds can be used for **all activities driven by commercial considerations**, i.e. that generate revenues from the sale of goods and services. They can also be used to inform setting of performance benchmarks for activities that lead to the reduction of outlays for energy, as discussed in the preceding section.

In the Peruvian context, payback period thresholds should be applied to the **energy production sector**, **activities in the industrial sector that cannot be covered by performance benchmarks** set in a top-down fashion and the **entire SME sector**.

We propose the following payback period threshold of 8 years for large companies and 6 years for SMEs investing in highly mature technologies, including those listed in Table 2 below.

Table 2: Highly mature technologies

Technology	Size	Payback period	Source
Hydropower	Small hydro	8-10 years	ESMAP (2011)
Cogeneration	SME	Less than 4 years to less than 10 years	Papadimitriou et al. (2020)

Table 3: Mature technologies

Technology	Size	Payback period	Source
Solar photovoltaic technologies	SME	5.5 – 7 years	Humpire (2018) Gutiérrez (2016)
On-shore wind technologies	Large	2.4-3 years	Ramos (2019) Del Carpio et al. (2018)
Biomass power technologies	SME	1.4- 4 years	Gonzales et al. (2017); Marcelo-Aldana and Viera-Sernaqué (2017)
Composting for solid waste	SME	7	PWC (2019)

Source: authors based on literature review listed in the table

Table 4: Low penetration technologies

Technology	Size	Payback period	Source
Electric vehicles (buses)	Large firms	4 years	MINEM (2018)
Liquid biofuels	SME	15 years	Deng and Parajuli (2016)

Source: authors based on literature review listed in the table

The payback period and the crediting period can be proportional, but not equal because at the payback period, there is no net profit of an activity. So, the crediting period needs to be longer than the payback period.

4. Common practice test as indicator for prohibitive barriers

Barrier testing was generally undertaken in the early years of the CDM but was essentially discontinued due to the difficulty of determining when a barrier is prohibitive. Project proponents were providing 'flowery' narratives about why the barriers were prohibitive, which led to severe criticism from non-governmental organizations (NGOs). Validators were unable or at least unwilling to properly check the argumentation.

Therefore, the barrier test was de facto replaced by the "common practice test" which tried to provide quantitative information about the penetration of the technology prior to project validation. This text either required to show that the activity was 'first of its kind' or that its penetration did not exceed a certain percentage of the total installed capacity. Here, the challenge relates to the level of disaggregation of the assessment. If the disaggregation is sufficiently deep, any technology will satisfy the common practice test. A fictitious example: if the penetration threshold is applied for solar PV plants with a capacity of 5 to 5.1 MW located in areas with annual insolation of 2500 to 2501 hours, it is relatively likely that the project plant is the only plant in its category, and thus shifts penetration from 0% to 100%. The choice of the level of disaggregation is arbitrary; it is not possible to derive commonly applicable criteria for this.

Another reason for not applying penetration thresholds is that rapid penetration will always take place once a technology gets commercially attractive. However, it cannot be stated with certainty at what level of penetration the commercial attractiveness is established, especially if concessional finance has been available for demonstration plants. Research papers discuss about the inflection point of an "S curve" of technology penetration being the point where the activity becomes universally commercially attractive, but this inflection point cannot be determined credibly ex ante.

In our view, aspects of barrier testing should inform the choice of performance benchmarks and payback period thresholds. But there is no generally applicable indicator for prohibitive barriers, the penetration rate is not satisfactory.

5. Sectors not appropriate for standardized approaches

For those sectors not listed in the preceding sub-sections, a continuation of additionality assessment approaches undertaken today would be recommended.

10. Conclusions

We propose generic additionality tests for choosing activities for the positive list of Peru regarding eligibility for Article 6 ITMO transfer abroad. Activities without revenues should be directly put on the positive list. Activities with revenues from the sale of goods or services need to show their consistency with a quantitative parameter defining additionality. Depending on the sector, we propose to either apply performance benchmarks or payback period thresholds as parameters. We would like to stress that the use of benchmarks may be limited to a small number of sectors given the difficulty to translate financial attractiveness of activities into a generic performance threshold. Activities then have to show that their performance is higher than the benchmark or that their payback period is longer than the threshold in order to be deemed additional and authorized for ITMO transfers. Performance benchmarks are particularly appropriate for industrial sectors with homogeneous technologies, and for demand side activities for small-scale appliances in households and SMEs, where they can be derived from payback period considerations. Payback period thresholds should be applied for all activities involving investments with commercial considerations. They should be shorter for SMEs and for technologies with a low level of maturity. We do not see a quantitative parameter being able to reflect non-monetary barriers; penetration thresholds are essentially arbitrary regarding their degree of disaggregation and the choice of their level.

11. Summary

Type of activity	Additionality tests	Sectors covered
Activities with revenues	Performance benchmarks	-Industrial sectors with homogeneous technologies -Demand side activities for small-scale appliances in households and SMEs
	Payback period thresholds	All activities involving investments with commercial considerations
Activities with no revenues	Automatic additionality, to be directly included in the positive list	-
	Policy or regulatory additionality tests	Sectors not covered by the financial additionality tests

References

Ahonen, Hanna-Mari; Michaelowa, Axel; Espelage, Aglaja; Kessler, Juliana; Christensen, Johanna; Dalfiume, Sandra; Danford, Erin (2021): Safeguarding integrity of market-based cooperation under Article 6, additionality determination and baseline setting, background paper, Perspectives Climate Research, Freiburg

Anonymous (2021): Peruvian cement prospects, https://www.cemnet.com/Articles/story/171256/peruvian-cement-prospects.html (accessed September 26, 2021)

Anonymous (2017): Thermo door opens for Peru hydropower operator, https://www.bnamericas.com/en/news/electricpower/thermo-door-opens-for-peru-hydropower-operator (accessed September 26, 2021)

Cerro del Aguila (2017): U.S.$650,000,000 4.125% Senior Notes due 2027 Unconditionally guaranteed by Kallpa Generación S.A, Offering Memorandum, August 9, 2017, https://inkiaenergy.com/wp-content/uploads/2019/09/CDA-OM-US%EF%BF%BD650MM.pdf (accessed September 26, 2021)

COES (2021): Portal información generación, https://www.coes.org.pe/Portal/portalinformacion/generacion (accessed July 2, 2021)

ESMAP (2011): 2011 Annual report, https://www.esmap.org/sites/default/files/esmap-files/FINAL_ESMAP-AR2011-1_FINAL.pdf (accessed September 26, 2021)

Del Carpio Casani, Eduardo; Kuwae Goto, Jaime; Maquén Fayó, Jorge (2018): Estudio de factibilidad de planta de energía eólica de 233MW para la generación de energía eléctica con la finalidad de abastecer a clientes libres ubicados en Lima, Tesis para obtener el título profesional de ingeniero industrial, http://repositorio.uarm.edu.pe/handle/20.500.12833/1927 (accessed July, 2021)

Deng, Yangyang; Parajuli, Prem (2016): Return of investment and profitability analysis of bio-fuels production using a modeling approach, Information Processing in Agriculture, p. 92-98

ESAN (2017): El PRI: uno de los indicatores que mas llama la atencion de los inversionistas, https://www.esan.edu.pe/apuntes-empresariales/2017/01/el-pri-uno-de-los-indicadores-que-mas-llama-la-atencion-de-los-inversionistas/ (accessed July 2, 2021)

Gonzales, Exequiel; Castillo, Fiorella; del Socorro Correa, Stefany; Retto, Claudio (2017): Sistema de aprovechamiento de residuos orgánicos de ganado vacuno y su aplicaicón en la agorepecuaria campos del Chira E.I.R.L., Facultad de Ingeniería Universidad de Piura https://pirhua.udep.edu.pe/bitstream/handle/11042/3223/PYT_Informe_Final_Proyecto_Biogas.pdf (accessed August 2, 2021)

Government of Peru (2018): Catálogo de medidas de mitigación, Ministerio del Ambiente de Perú, https://sinia.minam.gob.pe/documentos/catalogo-medidas-mitigacion (accessed June 24, 2021)

Government of Peru (2018b): Grupo de Trabajo Multisectorial de naturaleza temporal encargado de generar información técnica para orientar la implementación de las Contribuciones Nacionalmente Determinadas (GTM-NDC), Informe Final, https://www.minam.gob.pe/cambioclimatico/wp-content/uploads/sites/127/2019/01/190107_Informe-final-GTM-NDC_v17dic18.pdfPA%c3%91OL.pdf (accessed June 24, 2021)

Government of Peru (2019): Segundo informe bienal de actualización del Perú a la Convención Marco de las Naciones Unidas sobre el Cambio Climático, https://unfccc.int/sites/default/files/resource/Segundo%20BUR-PERU.pdf (accessed June 24, 2021)

Government of Peru (2020): Contribuciones determinadas a nivel nacional del Perú, reporte de actualización 2021-2030,https://www4.unfccc.int/sites/ndcstaging/PublishedDocuments/Peru%20First/Reporte%20de%20Actualizacio%CC%81n%20de%20las%20NDC%20del%20Peru%CC%81.pdf (accessed June 24, 2021)

Government of Peru (2021) : Inventario nacional de gases de efecto invernadero del año 2016 y actualización de las estimaciones de los años 2000,2005,2010,2012 y 2014, Ministerio del Ambiente Perú, https://infocarbono.minam.gob.pe/wp-content/uploads/2021/06/INGEI_2016_Junio-2021_Final.pdf (accessed July 2,2021)

Greiner, Sandra; Hoch, Stephan; Krämer, Nicole; Dalfiume, Sandra; De Lorenzo, Federico; Michaelowa, Axel (2021): NDC conditionality and Article 6, an analysis of updated NDCs of African countries, Short study, Climate Finance Innovators, https://www.carbon-mechanisms.de/fileadmin/media/dokumente/Publikationen/Studie/NDC-conditionality-and-Article-6-short-study-1.pdf (accessed June 24, 2021)

Gutiérrez, Abel (2016): Viabilidad técnica, económica y regulatoria para la implementación de sistemas fotovoltaicos conectados a la ren en el Perú, Mecanismos Net Metering, http://xxiiispes.perusolar.org/wp-content/uploads/2016/10/Ponencia-N%C2%AA-35-Viernes-306.pdf (accessed on June 17, 2021)

Humpire, David (2018): Metodología para la evaluación de los mecanismos de incentivo para la generación distribuida fotovoltaica residencial, Universidad Nacional de Ingenieria, http://cybertesis.uni.edu.pe/handle/uni/16382 (accessed July 2,2021)

León, Janina (2017) : Inclusión financiera de las micro, pequeñas y meidanas empresas en el Perú, experiencia de la banca de desarrollo, CEPAL, https://repositorio.cepal.org/bitstream/handle/11362/43157/1/S1701089_es.pdf (accessed June 24, 2021)

Marcelo-Aldana, Daniel; Viera-Sernaqué, Jorge (2017) : Proyecto de implementación de sistemas biodigestores para el aprovechamiento de residuos orgánicos generados por usuarios residenciales en la región Piura, Facultad de Ingeniería Universidad de Piura https://pirhua.udep.edu.pe/bitstream/handle/11042/4097/Proyecto_implementacion_sistemas_biodigestores_para_aprovechamiento_residuos_organicos_generados_usuarios_residenciales_region_Piura.pdf?sequence=1&isAllowed=y (accessed August 2, 2021)

Michaelowa, Axel; Hermwille, Lukas; Obergassel, Wolfgang; Butzengeiger, Sonja (2019): Additionality revisited: guarding the integrity of market mechanisms under the Paris Agreement, Climate Policy, 19:10, p. 1211-1224

Michaelowa, Axel; Moslener, Ulf; Mikolajczyk, Szymon; Hoch, Stephan; Pauw, Paula; Krey, Matthias; Kempa, Karol; Espelage, Aglaja; Weldner, Kaja; Jung, Carsten (2019a): Opportunities for mobilizing private climate finance through Article 6, Perspectives Climate Group, Frankfurt School, Climate Focus, Freiburg

MINEM (2018) : Nama transporte eléctrico, https://www.electrotransporte.com.pe/ponencias/1daniellarouge.pdf (accessed on June 22, 2021)

MINEM (2021a) : Programa masivo fotovoltaico permitió llevar energía eléctrica a más de 208 mil probladores de diversas regiones del país, https://www.gob.pe/institucion/minem/noticias/325084-programa-masivo-fotovoltaico-permitio-llevar-energia-electrica-a-mas-de-208-mil-pobladores-de-diversas-regiones-del-pais (accessed June 2, 2017)

Mongrut, Samuel and Wong, David (2005): Un examen empírico de las prácticas de presupuesto de capital en el Perú, Estudios gerenciales, 21, p. 95-111

Osinergmin (n.d.) : Energias renovables, https://www.osinergmin.gob.pe/empresas/energias-renovables/introduccion-energias-renovables/que-son-las-energias-renovables (accessed June 2, 2017)

Osinergmin (2010a): Primera subasta RER para sumistro de energía al SEIN- primera convocatoria, acta notarial de resultados de adjudicación y buena pro, https://www.osinergmin.gob.pe/seccion/centro_documental/energias-renovables/Subastas/PrimeraSubasta01/primaersubasta1_Acta005.pdf (accessed July 9, 2021)

Osinergmin (2010b): Primera subasta RER para sumistro de energía al SEIN- segunda convocatoria, acta notarial de resultados de adjudicación y buena pro, https://www.osinergmin.gob.pe/seccion/centro_documental/energias-renovables/Subastas/PrimeraSubasta02/primaersubasta2_Acta07.pdf (accessed July 9, 2021)

Osinergmin (2011): Segunda subasta RER para sumistro de energía al SEIN- segunda convocatoria, acta notarial de resultados de adjudicación y buena pro, https://www.osinergmin.gob.pe/seccion/centro_documental/energias-renovables/Subastas/SegundaSubasta/segundasubasta_Acta-Adjudicacion_y_Buena_Pro.pdf (accessed July 9, 2021)

Osinergmin (2013): Tercera subasta RER para sumistro de energía al SEIN- segunda convocatoria, acta notarial de resultados de adjudicación y buena pro, https://www.osinergmin.gob.pe/empresas/energias-renovables/subastas/tercera-subasta (accessed July 9, 2021)

Osinergmin (2016): Cuarta subasta RER para sumistro de energía al SEIN- segunda convocatoria, acta notarial de resultados de adjudicación y buena pro, https://www.osinergmin.gob.pe/seccion/centro_documental/energias-renovables/Subastas/160216%20-%20Acta%20de%20adjudicacion%20y%20Buena%20Pro.pdf (accessed July 9, 2021)

Papadimitriou, Aikaterini; Vassiliou, Vassilios; Tataraki, Kalliopi; Giannini, Eugenia; Maroulis, Zacharias (2020): Economic Assessment of Cogeneration Systems in Operation, Energies, 13, p.2-15

PWC (2019): Caso de Inversión Trujillo, https://southsouthnorth.org/wp-content/uploads/2020/04/investment-case-Trujillo-Caso-de-Inversi%C3%B3n.pdf (accessed on June 8, 2021)

Ramos, Mario (2019) : Diseño de la estrategia de Internacionalización de IPS Ingenería Sevicos de Rigging en Chile, http://repositorio.uchile.cl/bitstream/handle/2250/173737/cf-ramos_mj.pdf?sequence=1&isAllowed=y (accessed on June 10, 2021)

South Pole and Perspectives (2021): PMR Peru: National framework for eligible mitigation outcome activities for Article 6 cooperative approaches, final deliverable, Zurich

Tresierra-Tanaka, Alvaro; Vega Acuña, Luis (2019): Mediana empresa en Peru, una revision de las practicas de presupuesto de capital, Estudios Gerenciales, 150, p. 59-69

UNACEM (2006): 2005 annual report, https://www.unacem.com.pe/wp-content/uploads/2012/07/memoria2005_en.pdf (accessed September 26, 2021)

UNEP DTU (2021): CDM pipeline, www.cdmpipeline.org (accessed May 5, 2021)

World Bank (2011): Peru opportunities and challenges of small hydropower development, energy sector management assistance program, World Bank, https://www.esmap.org/sites/esmap.org/files/7747-ESMAP%20Peru%20English%20Web_4-11-11_0.pdf (accessed July 2, 2021)

Annex 1: CDM projects vs. RE auction awarded projects

Name of the project	Province	CDM Status	Date of CDM registration	MW	Auction awarded projects Peru	Auction not awarded projects
Poechos I Project	Piura	Registered	14 Nov 2005	15.4		
Santa Rosa	Lima	Registered	23 Oct 2005	4.1		
Tarucani I (“the project”)	Arequipa	Registered	06 Sep 2006	49.0		
Quitaracsa I (“the project”).	Ancash	Registered	06 Apr 2007	114.4		
Rehabilitation of the Callahuanca hydroelectric power station	Lima	Registered	04 Jan 2008	7.5		
Carhuaquero IV Hydroelectric Power Plant	Cajamarca	Registered	03 Mai 2008	9.7	Auction 1, first call	
Caña Brava Hydroelectric Power Plant	Cajamarca	Registered	08 Feb 2008	5.7	Auction 1, first call	
La Virgen Hydroelectric Plant	Junín	Registered	17 March 2008	64.0		
Poechos II hydroelectric plant project	Piura	Registered	24 Nov 2008	10.0	Auction 1, first call	
La Joya Hydroelectric Plant	Arequipa	Registered	22 Nov 2008	15.0	Auction 1, first call	

Name of the project	Province	CDM Status	Date of CDM registration	MW	Auction awarded projects Peru	Auction not awarded projects
Fuel Substitution by Hydro Generation in Pasto Bueno	Ancash	Registered	25 Nov 2008	0.8		
Cheves Hydro Power Project, Peru	Lima	Registered	12 Feb 2009	168.0		
Santa Cruz I Hydroelectric Power Plant	Ancash	Registered	17 Sep 2009	6.2	Auction 1 first call	
El Platanal Hydropower Plant	Lima	Registered	17 Sep 2009	220.0		
Ventanilla Conversion from Single-cycle to Combined-cycle Power Generation Project	Lima	Registered	20 Jun 2011	179.0		
Santa Cruz II Hydroelectric Power Plant	Ancash	Registered	12 Oct 2010	6.0	Auction 1 first call	
Yanapampa Hydroelectric Power Plant	Ancash	Registered	18 Dec 2010	9.0	Auction 1 first call	
Huanza Hydroelectric Project	Lima	Registered	24 Feb 2011	90.6		
Pias I Hydroelectric Power Plant	La Libertad	Registered	01 Dez 2011	12.6		Auction second call
Purmacana Hydroelectric Power Plant	Lima Province	Registered	24 Feb 2012	1.8	Auction 1 first call	

Name of the project	Province	CDM Status	Date of CDM registration	MW	Auction awarded projects Peru	Auction not awarded projects
Baños V Hydroelectric Power Plant (BVHPPP)	Lima Province	Registered	06 Sep 2012	9.2		
Huasahuasi I and II Hydroelectric Power Plant	Junín	Registered	22 Mai 2012	15.9	Auction 1 first call	
Energy Efficiency at Malvinas gas plant	Cusco	Registered	18 Dez 2012	0.0		
Marañon Hydroelectric Project	Huánuco	Registered	30 Oct 2012	88.3		
Nuevo Imperial Hydropower Plant	Lima	Registered	26 Jul 2012	4.0	Auction 1 first call	
Runatullo III Hydroelectric Power Plant	Junín	Registered	25 Jul 2012	19.8	Auction 2	
Chancay Hydroelectric Power Plant	Lima Province	Registered	20 Jul 2012	19.2	Auction 1 first call	
Runatullo II Hydroelectric Power Plant	Junín	Registered	24 Jul 2012	19.1	Auction 3	
Manta Hydroelectric Power Plant	Ancash	Registered	01 Oct 2012	18.4	Auction 2	
Santa Cruz III Hydroelectric Power Plant	Ancash	Registered	13 Aug 2012	3.0		Auction second call
Las Pizarras Project	Cajamarca	Registered	19 Oct 2012	18.0	Auction 1; second call	

Name of the project	Province	CDM Status	Date of CDM registration	MW	Auction awarded projects Peru	Auction not awarded projects
Olmos 1 Hydroelectric Power Plant	Lambayeque	Registered	20 Nov 2012	51.0		
Angel I, Angel II and Angel III Hydroelectric Power Plants	Puno	Registered	18 Oct 2012	60.0	Auction 1; first call	
Conversion of Open Cycle Gas Turbines to Combined Cycle at Kallpa Thermoelectric Power Plant	Lima	Registered	31 Dec 2012	292.9		
RenovAndes H1, Small Hydropower Project	Junín	Registered	15 Oct 2012	20.0	Auction 2	
Nueva Esperanza	Huánuco	Registered	25 Oct 2012	8.0		Auction 4
8 de Agosto	Huánuco	Registered	20 Nov 2012	19.0	Auction 2	
Potrero Hydropower Plant, Peru	Cajamarca	Registered	30 Nov 2012	19.9	Auction 3	
Cerro del Aguila Hydroelectric Project	Huancavelica	Registered	30 Dec 2012	507.0		
Chaglla Hydroelectric Power Plant CDM Project	Huánuco	Registered	04 Jun 2013	462.0		
Taurichuco Hydropower Project	Ancash	Registered	28 Dec 2012	13.8		

Name of the project	Province	CDM Status	Date of CDM registration	MW	Auction awarded projects Peru	Auction not awarded projects
Santa Teresa Hydropower Plant	Cusco	Registered	09 Jul 2015	98.0		

Source: authors based on UNEP DTU (2021) and Osinergmin 2010, 2010b, Osinergmin 2011, Osinergmin 2013 and Osinergmin 2016

Annex 2: GHG emissions of the energy sector as per the IPCC 2006 guidance

IPCC category				Sources	GHG emissions [$MtCO_2eq$]
1				**ENERGY**	**58.1**
	1A			**Fuel combustion activities**	**50.9**
		1A1		Energy industries	15.9
			1A1a	Heat and electricity production as main activity	11.1
			1A1b	Petroleum refining	2.7
			1A1c	Solid fuel fabrication and other energy industries	2.2
		1A2		Manufacturing and construction industries	8.4
			1A2i	Mining (except for fuels) and stonework	0.9
			1A2m	Non specified industry	7.6
		1A3		Transport	21.0
			1A3a	Civil aviation	1.1
			1A3b	Overland transport	19.3
			1A3c	Railways	0.1
			1A3d	Deep sea and waterway navigation	0.5
			1A3e	Other types of transport	0
		1A4		Other sectors	5.4
			1A4a	Commercial/Institutional	2.0
			1A4b	Residential	3.0
			1A4c	Agriculture	0.2
			1A4c	Fishing	0.2
	1B			**Fugitive emissions from fuel fabrication**	**7.3**
		1B1		Solid fuel	0
			1B1a	Mining and coal handling	0
		1B2		Petroleum and natural gas	7.2
			1B2a	Petroleum	1.2
			1B2b	Natural gas	5.9

Source: Government of Peru 2021

Annex 3: Energy mitigation measures

Table 5 Mitigation measures proposed for the stationary combustion sector

Type of energy	Mitigation measure	Implementation time-frame	GHG emission reduction potential (Mt CO_2eq 2020-2030)
Renewables	Renewable energy mixture	Short term	3.8
Renewables	Electricity supply with renewable energy sources in areas without electric grid connection	Short term	0.008
Energy efficiency	Cogeneration	Short term	0.7
Energy efficiency	Lightning market in residential sector transformation	Short term	0.1
Energy efficiency	Public lightning lamps of high pressure sodium lamps (HSP lamps) with LED lights	Short term	1.1
Energy efficiency	Energy efficiency labeling	Short term	0.5
Energy efficiency	Energy audits in the public sector	Short term	0.1
Energy efficiency	Replacement of low efficiency lamps for LED lights in the public sector	Short term	0.002
Energy efficiency	Clean cookstoves	Short term	1.9
Energy efficiency	Energy effiency in industry	Medium term	0.1
Energy efficiency	Energy efficiency in the commercial sector	Medium term	0.004
Renewables	Distributed generation	Short term	0.036
Renewables	Replacement of electric heaters for water solar heaters	Medium term	0.5
Energy efficiency	Fan installation and change to gasifier stove furnaces in artisanal brick manufacturers	Medium term	0.2
Energy efficiency	Change to furnaces with better energy efficiency and fuel change in industrial brick manufacturers	Medium term	0.5
Fuel replacement	Residues derived fuels as replacement for solid fuels in clinker production furnaces	Short term	0.2
Energy efficiency	Energy efficiency enhancement in cement production processes to reduce electric energy consumption	Long term	0.1

Type of energy	Mitigation measure	Implementation time-frame	GHG emission reduction potential (Mt CO_2eq 2020-2030)
Energy efficiency	Energy efficiency through integral interventions in the industrial manufacturing sector	Short term	0.02
Energy efficiency	Promotion of sustainable construction in new buildings	Short term	0.009
Energy efficiency	Energy efficiency in sanitation services	Short term	0.008
Energy efficiency	Reduction of Non-invoiced water in sanitation services reduction	Medium term	0.016
Energy efficiency	Pressure control in water service	Medium term	0.016
Renewable	Renewable energies use and energy generation in the sanitation services systems	Medium term	0.028
Material Valuation	Inorganic solid residues segregation for their material valorisation	Medium term	0.007
Total			**10.1**

Table 6 14 Mitigation measures proposed for the mobile combustion sector

Type of energy	Mitigation measure	Implementation time-frame	GHG emission reduction potential (Mt CO_2eq 2020-2030)
Sustainable transport	Complementary corridor implementation of the Transport Integrated System of Lima	Short term	0.2
Sustainable transport	Current activity of Metropolitano (buses) and extensions	Short term	0.1
Sustainable transport	Implementation of Line 1 y 2 of Metro de Lima y Callao implementation	Short term	0.1
Sustainable transport	Vehicular Natural Gas promotion for light vehicles	Short term	0.2
Energy efficiency	Cleaner fuels use promotion	Short term	0.5

Type of energy	Mitigation measure	Implementation time-frame	GHG emission reduction potential (Mt CO_2eq 2020-2030)
Sustainable transport	Electric vehicles use promotion at a national level	Long term	0.2
Energy efficiency	Promotion of liquified natural gas (LNG) promotion for cargo transport	Medium term	2.7
Energy efficiency	Efficient driving training for professional drivers	Short term	0.4
Sustainable transport	National Program of Sustainable Urban Transport	Medium term	0.1
Sustainable transport	National Program of Scrapping and vehicle renovation	Medium term	0.1
Energy efficiency	Energy efficiency labeling for light vehicles	Medium term	2.2
Railway infrastructure	Project “Trans-Andean tunnel construction”	Long term	0.1
Railway infrastructure	Rail transport service enhancement in Tacna – Arica section	Long term	0.004
Railway infrastructure	Integral recovery of railway Huancayo - Huancavelica	Long term	0.008
Total			**6.9**

Source: Government of Peru 2018

Annex 4: CDM energy projects in Peru and IRR

Technology	Country	IRR	IRR benchmark
Hydro power	Hydropower Poechos I Project		
Hydro power	Hydropower Santa Rosa		
Hydro power	Hydropower Tarucani I		
Hydro power	Quitaracsa I ("the project").		
Hydro power	Rehabilitation of the Callahuanca hydroelectric power station		
Hydro power	Carhuaquero IV Hydroelectric Power Plant	10.5	12
Hydro power	Caña Brava Hydroelectric Power Plant		
Hydro power	La Virgen Hydroelectric Plant	9.1	12
Hydro power	Poechos II hydroelectric plant project	9.7	12
Hydro power	La Joya Hydroelectric Plant	7.7	12
Hydro power	Fuel Substitution by Hydro Generation in Pasto Bueno		
Hydro power	Cheves Hydro Power Project, Peru	9.3	9.68
Hydro power	Santa Cruz I Hydroelectric Power Plant	7.6	12
Hydro power	El Platanal Hydropower Plant	9.3	12
Hydro power	Santa Cruz II Hydroelectric Power Plant		12
Hydro power	Yanapampa Hydroelectric Power Plant	5.9	12
Hydro power	Huanza Hydroelectric Project	8.6	12
Hydro power	Pias I Hydroelectric Power Plant	8.4	12
Hydro power	Purmacana Hydroelectric Power Plant	7.3	
Hydro power	Baños V Hydroelectric Power Plant (BVHPPP)	7.5	12
Hydro power	Huasahuasi I and II Hydroelectric Power Plant	10.3	12
Hydro power	Marañon Hydroelectric Project	9.0	12
Hydro power	Nuevo Imperial Hydropower Plant	10.7	12
Hydro power	Runatullo III Hydroelectric Power Plant	10.4	12
Hydro power	Chancay Hydroelectric Power Plant	10.8	12
Hydro power	Runatullo II Hydroelectric Power Plant	8.5	12
Hydro power	Manta Hydroelectric Power Plant	9.5	12
Hydro power	Santa Cruz III Hydroelectric Power Plant	8.5	12

Technology	Country	IRR	IRR benchmark
Hydro power	Las Pizarras Project	9.8	12
Hydro power	Olmos 1 Hydroelectric Power Plant	9.5	12
Hydro power	Angel I, Angel II and Angel III Hydroelectric Power Plants	10.6	12
Hydro power	RenovAndes H1, Small Hydropower Project	10.8	12
Hydro power	Nueva Esperanza	6.4	12
Hydro power	8 de Agosto	11.2	12
Hydro power	Potrero Hydropower Plant, Peru	7.5	12
Hydro power	Cerro del Aguila Hydroelectric Project	8.3	12
Hydro power	Chaglla Hydroelectric Power Plant CDM Project	11.2	12
Hydro power	Taurichuco Hydropower Project	10.3	12
Hydro power	Santa Teresa Hydropower Plant	11.6	12
Biomass Energy	Triplay Amazonico Methane Avoidance Project	No data	No data
	Maple Bagasse Cogeneration Plant	No data	No data
EE supply side	Ventanilla Conversion from Single-cycle to Combined-cycle Power Generation Project		
EE supply side	Energy Efficiency at Malvinas gas plant		
EE supply side	Conversion of Open Cycle Gas Turbines to Combined Cycle at Kallpa Thermoelectric Power Plant	12.5%	
Fossil Fuel switch	Peruvian fuel-switching project	No data	No data
Fossil Fuel switch	Fuel Switching at Atocongo Cement Plant and Natural Gas Pipeline Extension, Cementos Lima, Peru.	No data	No data
Landfill gas	Huaycoloro landfill gas capture and combustion	4	14
Landfill gas	Ancon – EcoMethane Landfill Gas Project		
Landfill gas	Bionersis Project Peru 1		
Landfill gas	Modelo del Callao Landfill Gas Capture and Flaring System		
Solar	TACNA SOLAR 20 TS: 20 MW Solar Photovoltaic Power Plant	10.2	12

Technology	Country	IRR	IRR benchmark
Solar	PANAMERICANA SOLAR 20 TS: 20 MW Solar Photovoltaic Power Plant	10.3	12
Solar	MOQUEGUA FV: 16 MW Solar Photovoltaic Power Plant	10.1	12
Solar	MAJES SOLAR 20T: 20 MW Solar Photovoltaic Power Plant	8.0	12
Solar	REPARTICION SOLAR 20T: 20 MW Solar Photovoltaic Power Plant	8.2	12
Wind	Marcona Wind Farm	9.6	12
Wind	Cupisnique Wind Farm Project	8.2	12
Wind	Talara Wind Farm Project	9.9	12

Perspectives
Climate Group GmbH
Hugstetter Str. 7
79106 Freiburg, Germany
info@perspectives.cc
www.perspectives.cc