The role of Science, Technology, and Innovation in Industrial Decarbonization in Latin America and the Caribbean

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Abstract

Latin America and the Caribbean (LAC) is one of the most vulnerable regions to the devastating effects of climate change. Setting limits to global warming by 1.5°C is critical to reduce risks in this region that already faces economic and social asymmetries for sustainable development. By acknowledging the classic market/systems failures hampering green transformations, cost-effective allocation, and the urgency to achieve structural change, this policy brief assesses opportunities for industrial decarbonization in LAC based on science, technology, and innovation to reach higher productivity, competitiveness, and social inclusion, achieving the development goals, and transitioning towards a global decarbonized economy by 2050.

Introduction

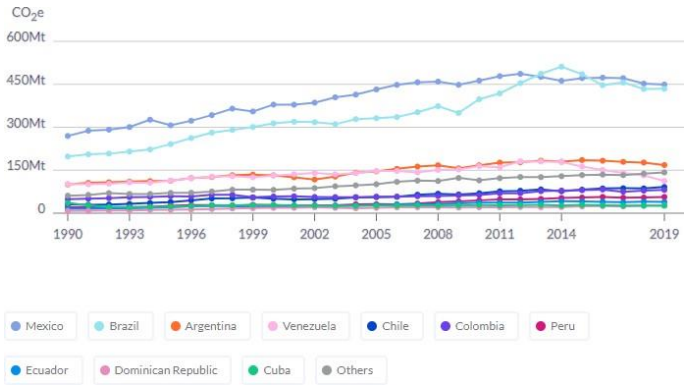
Latin America and the Caribbean (LAC) is one of the most vulnerable regions to climate change. Achieving Paris Agreement's goal to limit global temperature increase to 1.5°C is critical to reduce risks in this region facing pronounced economic and social asymmetries for sustainable development. If this is not achieved, the adverse effects of climate change could cost some countries in LAC up to 10% of their per capita GDP by 2030 (Bárcena *et al*., 2020).

It is imperative to take measures based on science, technology, and innovation (STI) to accelerate decarbonization in the region. All LAC countries have submitted their climate commitments, where most governments have included the industrial sector as part of their mitigation/adaptation actions. This policy brief analyses data from the biggest CO_2 emitters in LAC and provides recommendations to strengthen the role of STI in industrial decarbonization in the region.

The Biggest CO_2 Emitters in LAC

Globally, the industrial sector emits 24% of total CO_2 emissions resulting from burning fossil fuels and industrial processes, corresponding to 22% of total greenhouse gas (GHG) emissions (Fazekas *et al*., 2022). Industrial processes related to the production of steel, cement, and chemicals, including fertilizers, contribute to approximately 6% of global emissions and 5% in LAC (Climate Watch, 2022). Figure 1 presents the CO_2 emissions of LAC countries in the energy and industrial processes[1] sectors over the years. The top three CO_2 emitters are Mexico, Brazil, and Argentina.

Figure 1. LAC countries' CO_2 emissions over the years in Energy and IPPU sectors



Source: Climate Watch (2022).

In Mexico, in the energy sector, most CO_2 emissions result from activities related to fuel combustion, mainly energy industries and transportation (Mexico, 2018; Ritchie *et al*., 2020; Mexico, 2022). Regarding the IPPU sector, the categories with the most CO_2 emissions are mineral industry (mostly for cement and lime production, as well as other uses of carbonates) and metals industry (predominantly for iron and steel production).

In Brazil's energy sector (Brazil, 2020a; Brazil, 2020b; Ritchie *et al*., 2020), CO_2 emissions also result from activities mainly related to fuel combustion, with

[1] In the GHG inventories of each country, emissions related to Industrial Processes and Product Use (IPPU) sector activities are those resulting from production processes in industries, including non-energy consumption of fuels as raw materials. The use of fossil fuels for combustion in industry activities is reported in the Energy sector, to avoid duplication.

transport as the main emitter subsector, followed by energy industries and manufacturing industries and construction. In the IPPU sector, most emissions come from metal industry (mainly iron and steel production) and mineral industry (mainly cement and lime production).

In Argentina (Argentina, 2015; Ritchie *et al*., 2020; Argentina, 2021), in the energy sector, also relating to fuel combustion, the categories with the most CO_2 emissions are energy industries (mainly for electricity and heat generation), transportation, and manufacturing industries and construction. In the IPPU sector, most CO_2 emissions come from the mineral industry (mainly for cement and lime production) and the metals industry (primarily for iron and steel production).

For these countries, CO_2 contribution by the chemical industry is also important, because of petrochemical and carbon black production and ammonia production, and its use as nitrogenous fertilizer.

The role of STI in Industrial Decarbonization in LAC

Investments in clean innovation are key to shaping a new environmentally sustainable and inclusive approach to growth, accompanied by investments in complementary assets including sustainable infrastructure, and human, natural and social capital, which will help achieve net-zero GHG emissions and improve productivity and living standards (Stern and Valero, 2021). To reach higher productivity, competitiveness, and social inclusion, achieving the sustainable development goals by 2030, countries in LAC must base their industrial policies on STI (OECD *et al*., 2022).

Industrial decarbonization implies that the private sector changes technologies, processes, and materials currently in use and adopts cleaner options. There are big challenges, which include, but are not limited to: achieving radical and/or incremental sustainable technological change, technology diffusion, and trade-off calculations between investing in the adoption of currently available clean technologies *versus* waiting to invest in cleaner technologies that are not yet commercially viable (Acemoglu *et al*., 2016; Söderholm, 2020). Carbon taxes and research subsidies can encourage innovation and cleaner technologies adoption, although the transition may be slower. In addition, companies do not have full information on the technological prospects, costs, and benefits, in terms of emissions reduction, productivity and competitiveness.

It is important to assess how existing climate technologies and technologies on the horizon facilitate climate resilience and decarbonization of emission-intensive industries and their value chains. Clear pathways towards the adoption of cleaner technologies can serve as a guide to modernization and improved productivity, and to a more competitive business. The identification of regional advantages in greener production can help LAC industries to better position themselves internationally. Although many clean technologies are still in an early stage of development, meaning they are riskier, green technologies have been shown to have higher knowledge externalities and have become cheaper eventually (IRENA, 2021; WEF, 2021). Empirical analyses found that the spillovers in clean technologies tend to be higher than in dirty ones (Stern and Valero, 2021). For example, clean patented inventions receive on average 43% more citations than dirty inventions (Dechezleprêtre *et al*., 2014).

However, emission-intensive industries are often characterized by a few large and dominant production companies with a value chain that relies on suppliers with typically low levels of R&D investments (Nilsson *et al*., 2021). These industrial features create large information gaps, leading to sub-optimal private sector investment in technological development, adoption, and innovation. In addition to classic market failures in the private sector, sectoral fragmentation, and lack of coordination within the government can create policy gaps.

The State's role and the design of appropriate policy combinations, addressing distributional concerns and impacts, are also fraught with challenges (Söderholm, 2020). One challenge is that this type of innovation policy must address the classic market failures, and special issues related to the failure to act for collective good in the context of climate change policies. Climate change is a common global problem with big implications in terms of free-riding and underinvestment risk, but also involves multidimensional policy goals: there must be enough companies that can successfully reduce emissions to meet climate goals while implementing measures to strengthen their resilience to climate impacts that affect the whole value chain, as well as being economically viable and having social support. This challenge calls for a new industrial policy that considers productivity growth and planetary limits, whose key elements are systematically guiding investment behaviour and expanding experimentation to innovate (Altenburg and Assmann, 2017). Industrial policies should be designed to deal with the dual challenge of shifting economic

structures in a way that prosperity is increased while replacing environmentally unsustainable activities with sustainable ones (Altenburg and Assmann, 2017).

Policy recommendations

The efforts required to decarbonize LAC economies present challenges, but also offer unprecedented opportunities.

A first policy recommendation relates to the *identification of climate technologies options*: those available for adoption and technologies on the horizon that may still need significant investment in R&D to be commercially viable. That involves an analysis of technical aspects: operational mechanism, Technology Readiness Level (TRL), deployment barriers, energy savings, GHG abatement and strengthening climate resilience potential. The assessment of economic aspects of climate technology adoption is also needed, including capital expenditure, operating expenditure, and production costs. The study of investments for climate technologies on the horizon to be commercially viable should consider public and private capital needs, investment risks, de-risking measures, policy and market enablers, technological capabilities, barrier analysis, inaction costs, and supporting market conditions.

Another policy recommendation concerns *financing*. That involves reviewing and assessing existing global and local financing instruments and mechanisms, and their suitability for decarbonizing industrial subsectors, in LAC countries. Based on that, it is possible to design new financing instruments and innovative risk mitigation mechanisms, including analysis of finance sources and Financial Institutions' role, and to develop a roadmap for industrial decarbonization technologies financing in LAC countries, enhancing access to green finance. To that end, the TRL should be assessed to identify suitable innovation financing instruments – e.g., non-reimbursable financing at the earlier levels, moving towards investment and reimbursable financing for the more advanced levels, with the corresponding increase of risk and return (OECD, 2023a).

Institutional strengthening and governance are also paramount to enable decarbonization strategies. Countries must have an institutional framework that enables strategies formulation with political legitimacy. Countries in LAC have made progress in articulating climate goals, but not in articulating climate policy with the objectives for productive development, which may hinder the private sector's integration in the decarbonization transition (Calfucoy *et al*., 2022).

Strengthening public sector capacity and coordination capabilities is important for framing private sector expectations in a way that can lead to more optimal levels of investment in green technologies (Mielke and Steudle, 2018). In this context, innovation agencies play a key role in providing financial and other support to catalyse private sector innovation and should have their institutional capabilities strengthened (Cuello *et al*., 2022).

Another recommendation is identifying a *common framework for distilling regulatory implications between national and international regulations*. It involves a review of existing global and local standards and regulations for industrial sectors, identifying gaps and barriers in a country's current policy frameworks to comply with existing standards and regulations. That relates, for example, to proposing performance standards for the electrification of the industry and audits so that especially micro, small, and medium-sized enterprises know their emissions and understand the opportunity to conduct a technological update.

Discussions on sustainability regulatory frameworks have been addressing *sustainability disclosure frameworks*, which relates to having a requirement/recommendation for companies to disclose verifiable metrics and allow investors to assess the credibility and progress toward meeting sustainability-related goals (OECD, 2023b). One important consideration is market participants capacity to promptly conform to a new regulation; they may face a learning curve on sustainability matters and need time to develop adequate processes and practices.

Finally, it is important to note that decarbonizing investments and climate mitigation/adaptation policies can promote a more competitive productive matrix, boost job creation, contribute to narrowing the gender gap, capacitate new talent, and enhance social inclusion (OECD *et al*., 2022).

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