



Green Windows of Opportunity: Catching Up in Latecomer Countries

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How developing countries can harness the full potential of green frontier technologies?

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Green windows of opportunity: latecomer development in the age of transformation toward sustainability

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Abstract

The world is in the early stages of a paradigm transition toward a global green economy. In this article, we propose the notion of green windows of opportunity, highlighting the importance of institutional changes in the creation of new opportunities for latecomer development. We emphasize how demand and mission-guided technical change influence the directionality of latecomer development and highlight the important role emerging economies may attain in the global green transformation. We provide important insights regarding opportunities for green development in emerging economies, how these opportunities emerge in different renewable energy sectors and their implications for the global green economy.

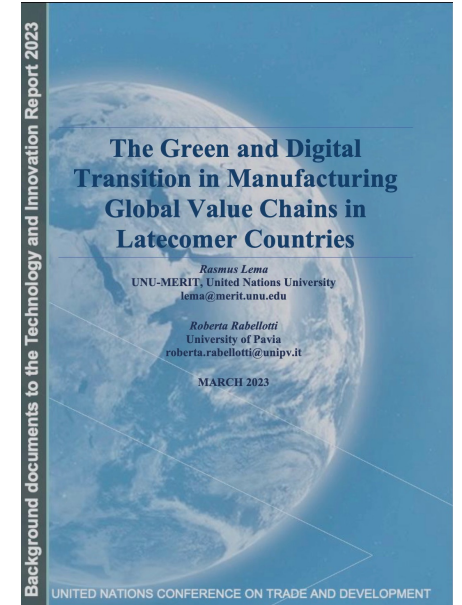
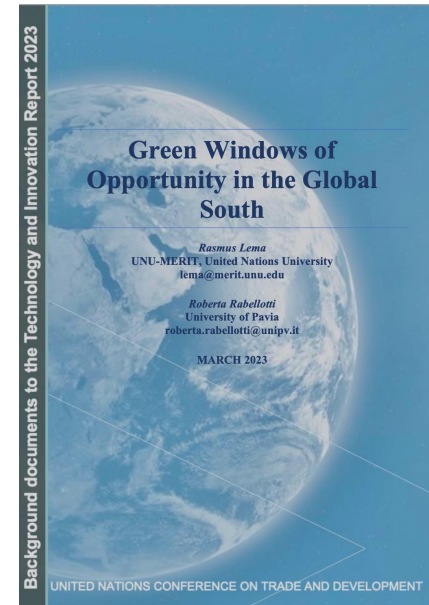
JEL classification: L10, L50, O10, O20, O30, Q20, Q40

1. Introduction

Although the transformation toward a global green economy is still in its early stages, there is little doubt that a major disruption in the capitalist world economy is under way. As popular pressure increases in line with the mounting global effects of climate change, the transformation agenda and associated investments in the green economy are likely to accelerate (Mazzucato and Perez, 2015; Roberts and Geels, 2019; Schmitz and Scoones, 2019).

Until recently, the idea of green growth was limited to the advanced economies, with developing countries reluctant to take up the challenge of sustainability. Today, the dichotomic relationship between green transformation and latecomer development, inherent in the environmental Kuznets curve (Stern, 2004), has been turned on its head. The “clean up later” model where developing countries wait for the environmental Kuznets curve to set in (Altenburg and Pegels, 2020) is being replaced by a leapfrog strategy, which offers an alternative way to bypass the high pollution models of growth. Countries such as China, India, Brazil, and South Africa, are not only reacting to the paradigm change but also are actively contributing to the green transformation, adopting environmental transformation policies and supporting the emergence of domestic sustainability-oriented industries (Mathews, 2013; Harrison *et al.*, 2017).

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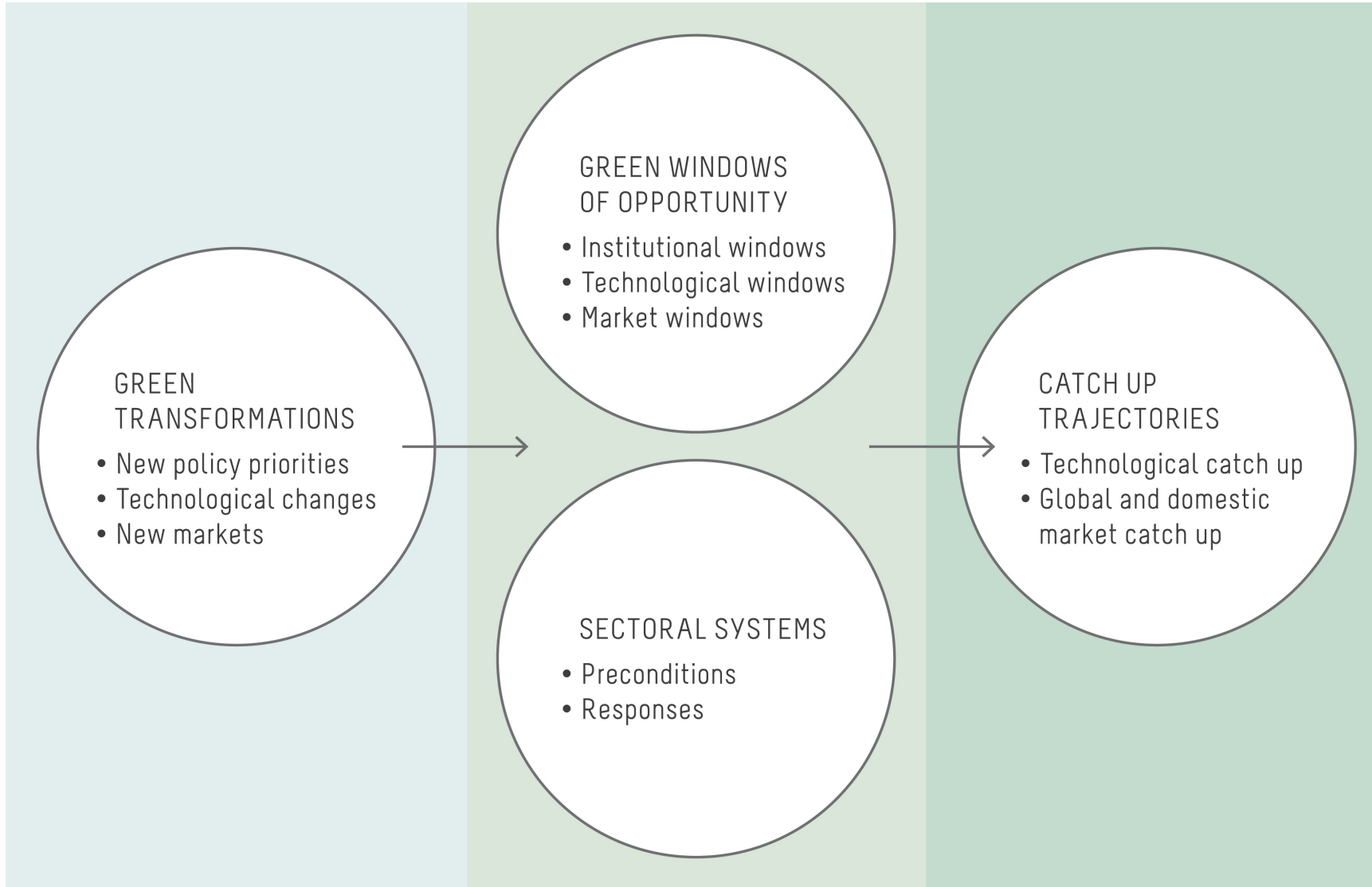
Research questions

1. Does the green economy offer opportunities for latecomer catch-up in developing countries?
2. What characterizes the capacity of developing countries to seize these opportunities?
3. What policy options can support developing countries in their efforts to take advantage of GWOs?

How?

- Evidence about cases from a large set of countries and sustainability-oriented industries at different levels of development analysed following an analytical framework developed in Lema et al. (2020).

The GWO framework



1. Green Windows of opportunities
2. Sectoral system of production and innovation: preconditions and responses of public and private actors
3. Catch up trajectories resulting from the interactions of GWO with stakeholders' actions

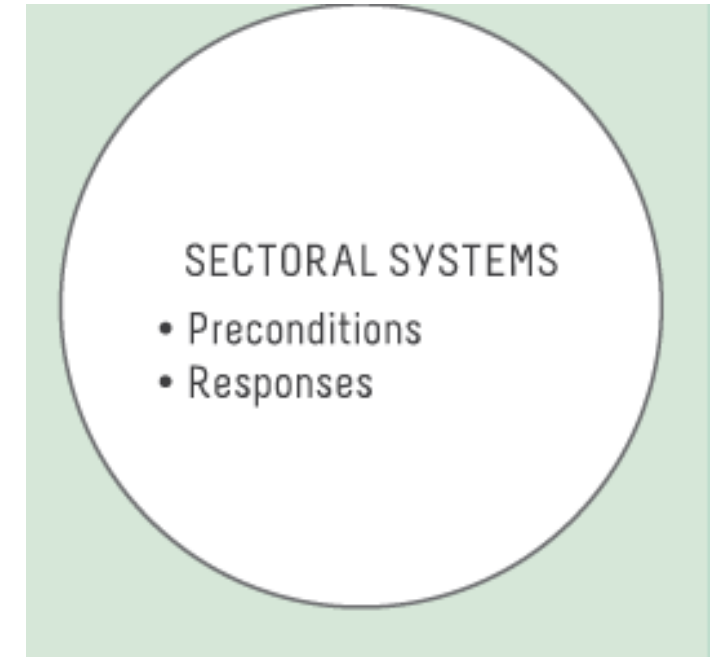
Green windows of opportunity

- GWO are mainly endogenous, created by governments and influenced by *domestic and global* environmental and industrial policies;
- Examples are:
 - **China:** 2006 Renewable Energy Promotion Law; Golden Sun Demonstration Program; Ride the Wind Program.
 - **Brazil:** Sugarcane-based ethanol fuel program.
 - **India:** 2020 National Electric Mobility Mission Plan.
 - **Brazil, Chile, Uruguay, Viet Nam, Turkey, Morocco, Namibia and South Africa:** existing or forthcoming green hydrogen national strategies.



Sectoral systems: preconditions & responses

- The ability to take advantage of GWOs in developing countries differs across green technologies and countries.
- To investigate and understand how they differ, we focus on the two components of the sectoral system:
 - the preconditions to take advantage of the opportunity
 - the strategic responses of public and private actors for seizing the GWOs
- Responses to GWOs differ depending on technological maturity and tradability.



The maturity and tradability levels of technologies affect GWOs

- ❌ Immature technologies require stronger initial conditions in science and R&D
- ✅ Mature technologies tend to entail more market competition
- ↔ Tradability involves different dimensions that influence the competitive dynamics and modes of technological learning

Seizing GWOs: four scenarios

Combining different levels of existing preconditions and responses we propose four different possible scenarios

Four green window scenarios

Responses Preconditions	Strong	Weak
	Strong	Weak
Strong	Scenario 1: Windows open Solar PV, Biomass, CSP – China Bioethanol – Brazil Hydrogen – Chile (potentially)	Scenario 2: Windows to be open Solar PV – India Biogas – Bangladesh CSP – Morocco Wind – China
Weak	Scenario 3: Windows within reach Biomass – Thailand and Viet Nam Hydrogen – Namibia	Scenario 4: Windows in the distance Wind – Kenya Bioenergy – Mexico and Pakistan

Windows Open

Example: Bioethanol in Brazil

- Preconditions

- Over many years, Brazil has built the preconditions to take up opportunities in sugar and ethanol processing plants and the technological learning linked to these sectors.
- Technology suppliers and research institutions have cooperated in sugarcane-related technology development.

- Responses

- Private firms have responded to these opportunities by establishing collaborative consortia to develop cars with flex-fuel systems (i.e., engines that run on a combination of gasoline and methanol or ethanol).
- Although driven initially by the local market, Brazil has been moving to a leadership position in the global market.

Windows Open

Example: Green hydrogen in Chile

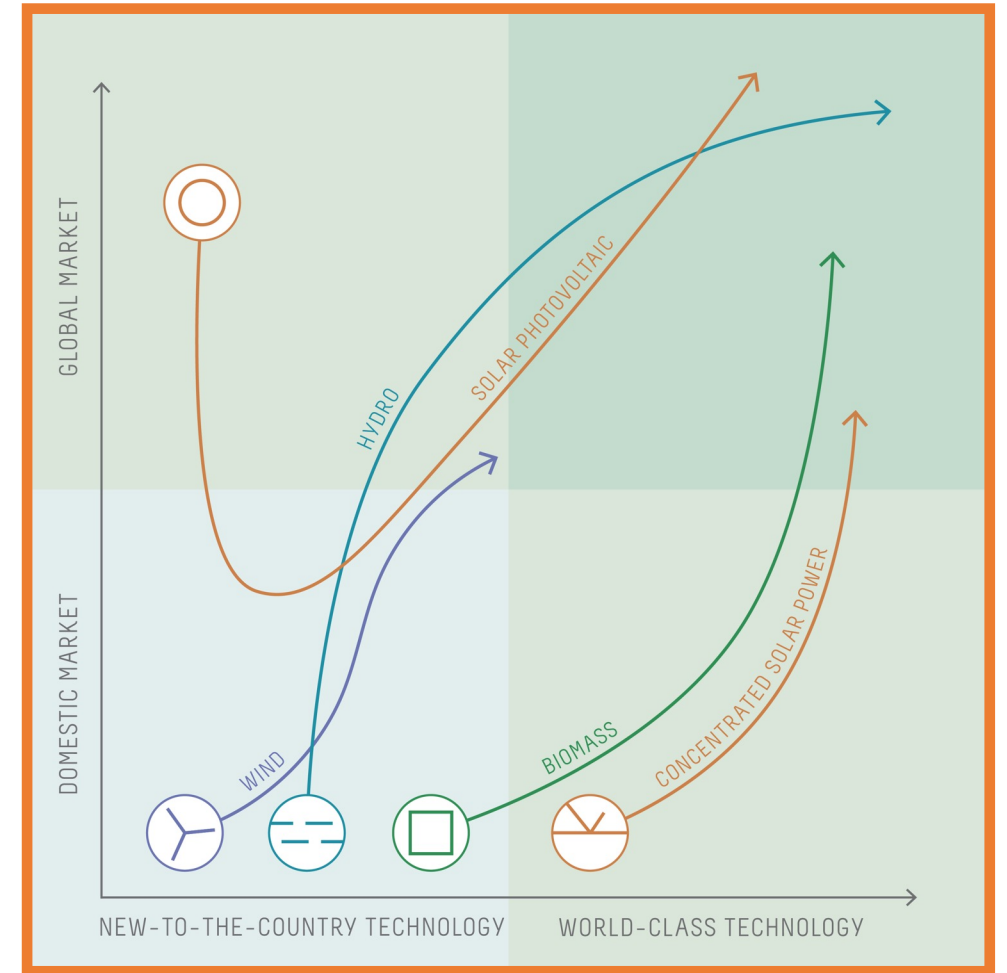
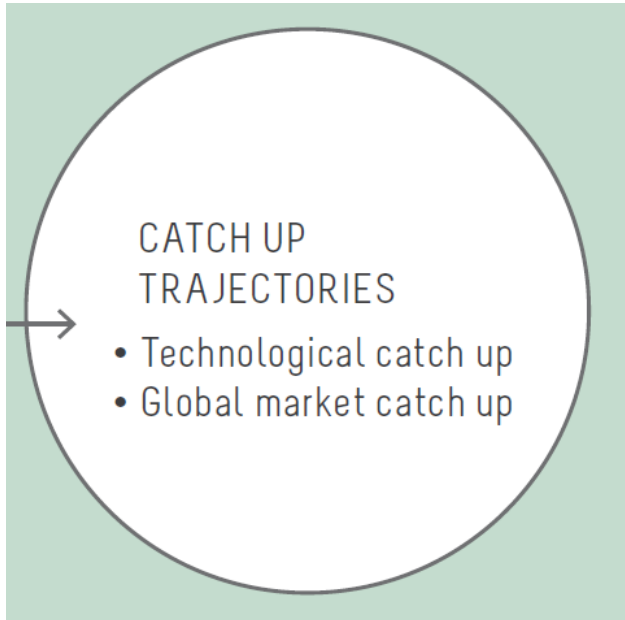
- **Preconditions**
 - Large solar resources in the North of Chile and wind resources in the South.
 - Since 2017, Chile has had micro-grids powered by green hydrogen, providing 24-hour clean energy without requiring diesel-based power backup systems, developed by the Italian company.
- **Responses**
 - In 2020 the Government published a three-phase Green Hydrogen Strategy. The first phase, starting from 2025, will mainly target the domestic market, replacing grey hydrogen for heavy and long-distance transportation. The second stage from 2030 extends local use along with exports. The third, long-term stage after 2035 anticipates opening new markets both domestic well and international
 - The plan includes:
 - Funds – For supporting companies, and national and international consortiums to invest in scalable and replicable green projects.
 - Pricing – A roadmap for pricing of fossil fuel emissions to level the playing field.
 - Regulations and standards – To be clear and stable throughout the value chain to ensure safety and give certainty to investors.
 - Community participation – Early and transparent involvement of local communities in green hydrogen-related projects.
 - Innovation system – An R&D system involving industry, academia and technological centers.

Windows in the distance

Example: bioenergy in Mexico

- Preconditions:
 - Huge potential for bioenergy activities
 - Lack of technical capacities
- Responses
 - Little policy attention and weak regulations lead to insufficient private investments
 - Lack of sufficient incentives to develop the sector

Catch-up trajectories

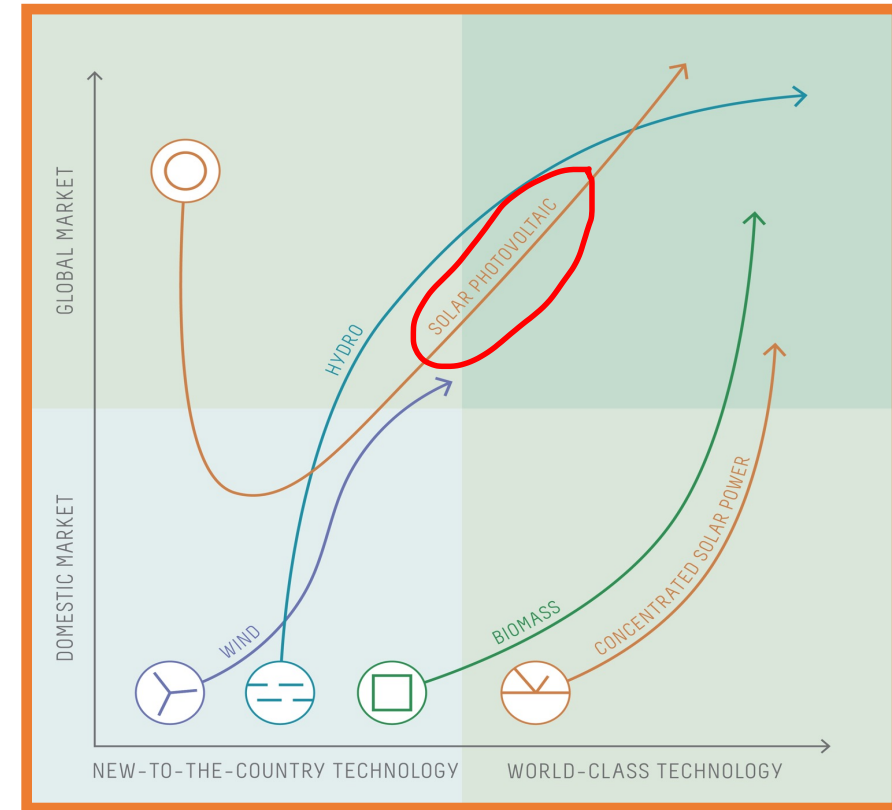


An example: The Chinese Solar PV Industry

From learning from exporting to domestic strengthening and then to global leadership

Chinese Solar PV Industry

- ❖ Started in the global market exporting solar panels made with imported technology (learning from export)
- ❖ After a fall in global demand, Chinese companies substituted the international demand with domestic demand thanks to the incentives created by public policy
- ❖ Huge investments in building domestic technological capacity and domestic capacity in the whole solar value chain
- ❖ Chinese companies went back to international markets as technological and market leaders.



Opening green windows



Set the direction towards green technologies and innovation

International cooperation

Trade rules should permit developing countries to protect infant green industries through tariffs, subsidies and public procurement

Consistency between international agreements on trade, intellectual property and climate change is critical for green technology revolution

Intellectual property should have greater flexibilities for developing countries with regard to green technologies

To address the financial constraint the role of international cooperation should be key but so far the resources made available have been insufficient.

Better coordination between public and private actors, and also between domestic and international actors, is needed to reduce systemic redundancies and maximize the impact of investments.

Key takeaways

- New green windows of opportunities are typically opened by institutional (policy) changes
- The seizing of GWOs depends on the country's preconditions and the response patterns of public and private actors –green sectors are specific
- There is significant variability in catch up trajectories at the sector and country level
- Tradability and technological maturity are key in explaining the variability of the catch-up trajectories:
 - In mature sectors such as biomass or solar PV, readily available technologies can provide a relatively fast track to the boosting of economic activities.
 - Less mature technologies such as green hydrogen, CSP, or EVs are more demanding in terms of new technological capabilities and require significant investments in R&D and innovation system development.

Latin America has high technical potential for renewable energy.

What is required to seize GWO is strong political will to enact timely innovation, industrial and energy policies to catch the green technological revolution early.



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