



Green Windows of Opportunity: Catching Up in Latecomer Countries

Roberta Rabelotti

University of Pavia – University of Pavia

with

Rasmus Lema - UNU MERIT

How latecomer 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

Rasmus Lema ^{1,*}, Xiaolan Fu² and Roberta Rabellotti^{1,3}

¹Department of Business and Management, Aalborg University, Aalborg, Denmark. e-mail: lema@business.aau.dk, ²Department of International Development, Oxford University, Oxford, UK. e-mail: xiaolan.fu@qeh.ox.ac.uk and ³Department of Political and Social Sciences, University of Pavia, Pavia, Italy. e-mail roberta.rabellotti@unipv.it

*Main author for correspondence.

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.

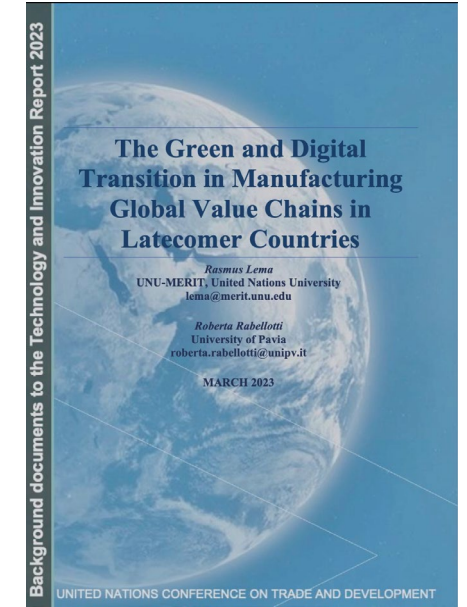
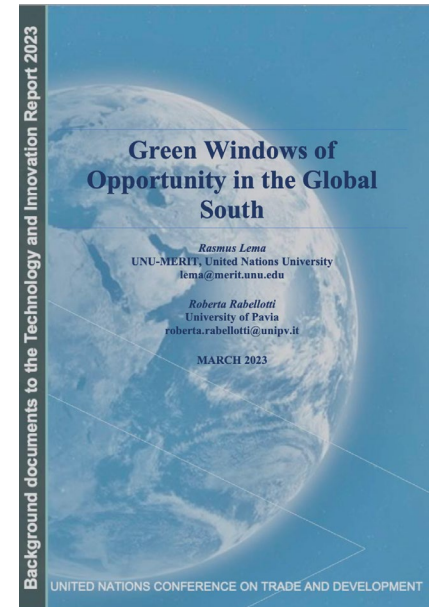
JEL classification: L10, L50, O10, O20, O30, O20, Q40

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).

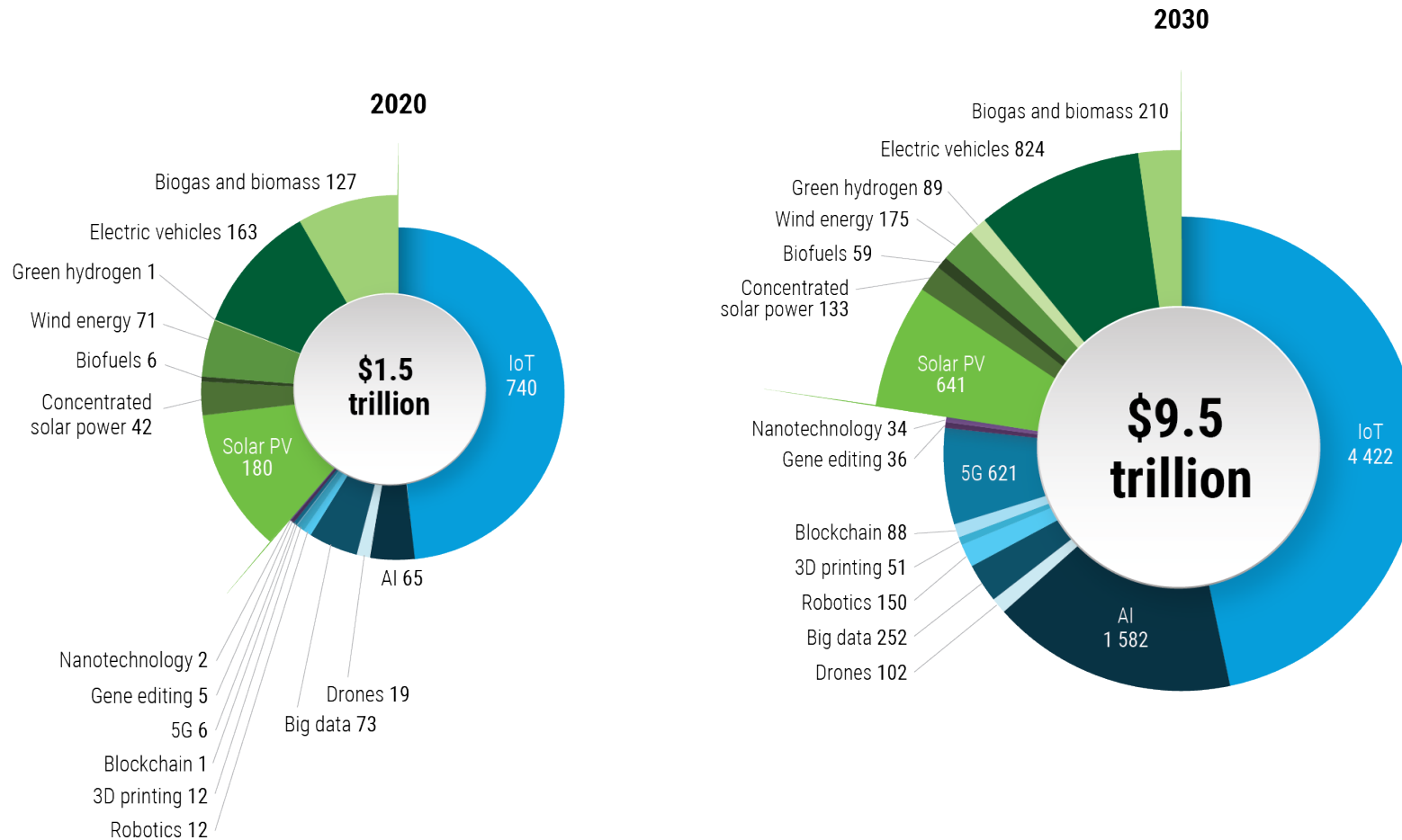
Until recently, the idea of green growth was limited to the advanced economies, with developing countries reluctant to take up the challenge of sustainability. Today, the dichotomous relationship between green transformation and latecomer development, inherent in the environmental Kuznets curve (Stern, 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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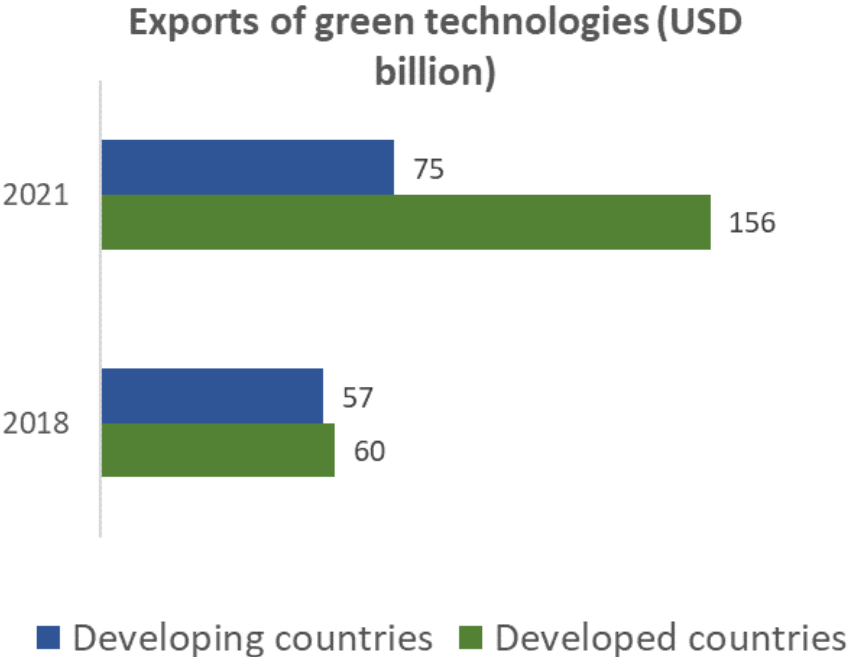
There are enormous opportunities in the development of green frontier technologies

Market size estimates of frontier technologies, \$ billion

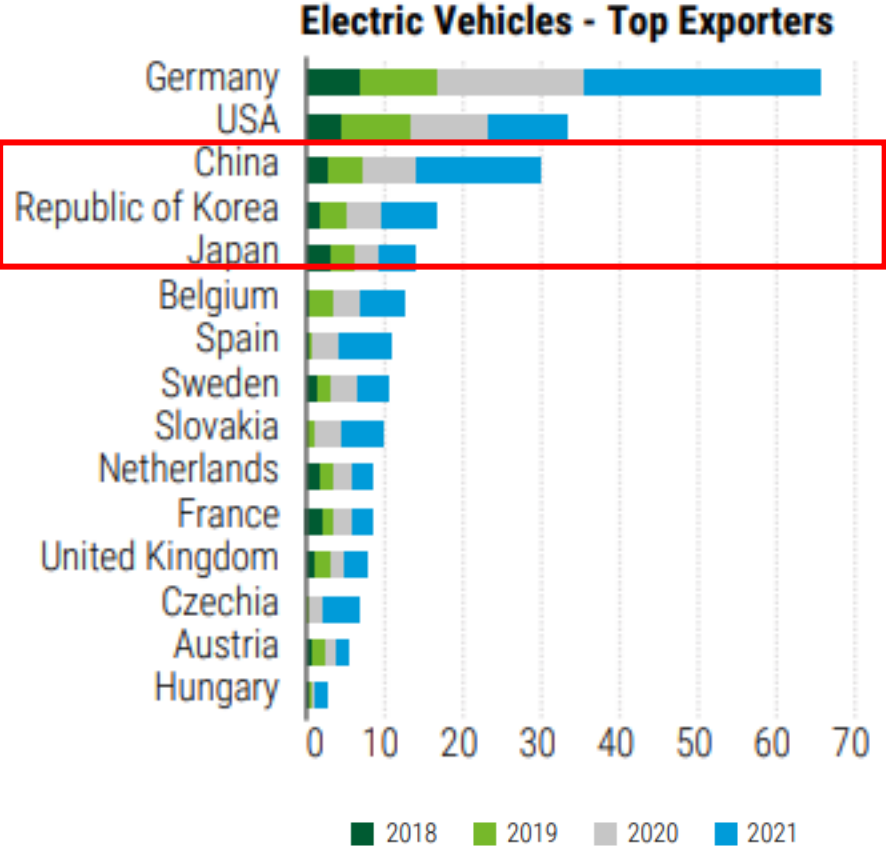


Source: UNCTAD based on various estimates!

But so far, developed economies are seizing most of the opportunities

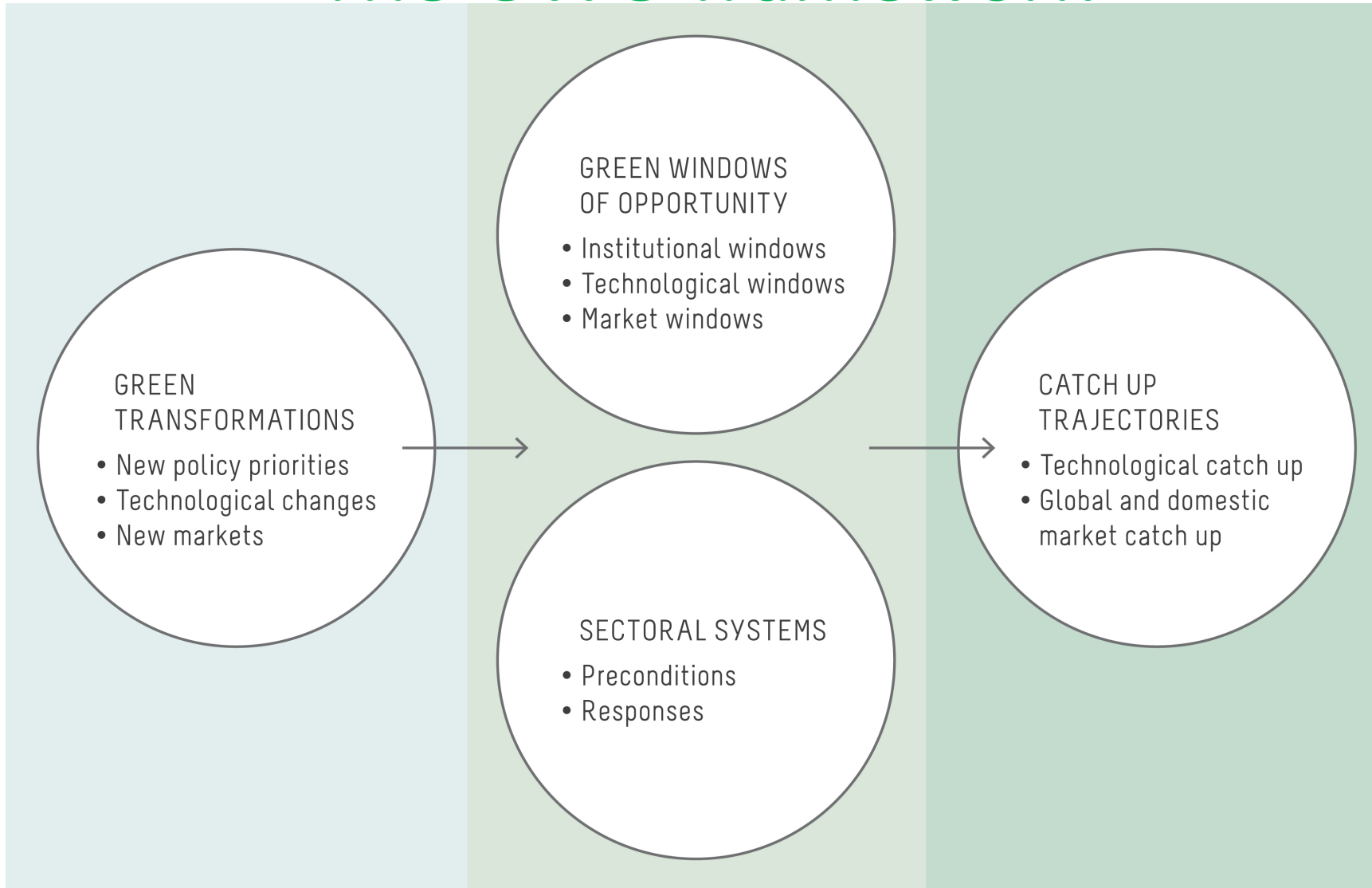


Technology imports and exports by top countries, 2018-2021 (USD billions)



How to seize these opportunities?

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

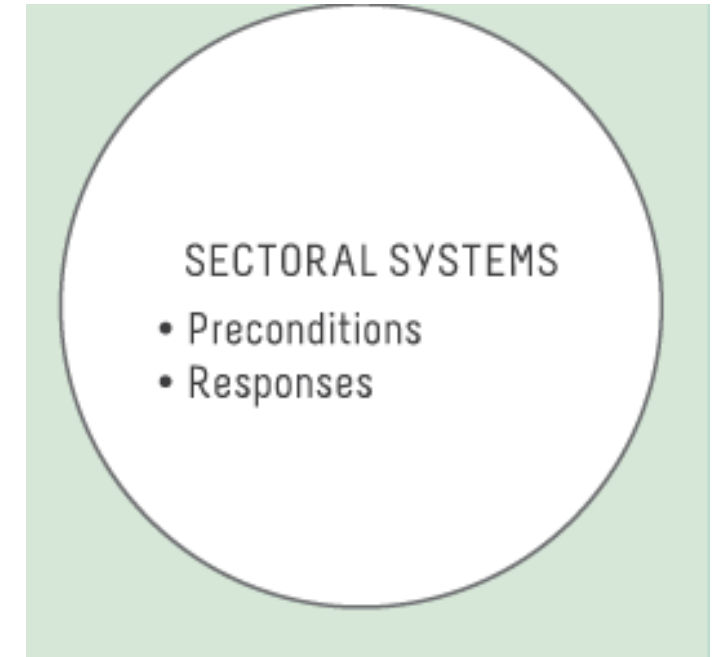
Green windows of opportunity

- GWO are mainly endogenous, created by governments and influenced by *domestic and global* environmental and industrial policies;
- This is different from previous catch-up processes in industries such as mobile phones or steel production in which windows of opportunity have been predominantly exogeneous, created by technological or market changes.
- 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:** green hydrogen national strategies.



Sectoral systems: preconditions & responses

- The exploitation of GWO depends on the **existing preconditions** and on the **responses of firms and other public and private actors**;
- **Technological maturity and tradability** of green technologies significantly affect sectoral 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.



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

Windows Open

Example: Renewables in China

- **Preconditions:**
 - large internal market
 - diversified industrial structure
 - well-developed related capabilities such as, for example, design and engineering capabilities for biomass plant construction
- **Responses**
 - Co-design of environmental and industrial policies
 - Diffusion of knowledge among firms and knowledge institutions
 - In biomass government stimulation of knowledge spillovers with loose enforcement of property rights and diffusion through state-owned design institutes
 - In solar PV and biomass: acquisition of foreign technology through licensing activity and cross-border acquisitions of foreign firms
 - In CSP public R&D experimentation

Windows to be open

Example: Solar in India and biogas in Bangladesh

- **India:** National Solar Mission prioritized deployment at low costs above domestic manufacturing, and this resulted in a high dependency on imports.
 - Insufficient attention was paid to training, and promotion of linkages to relevant stages of the value chain and R&D to boost domestic competitiveness.
 - When local content requirements were introduced, there were not enough domestic capabilities to effectively mitigate import dependence due to the lack of domestic business creation in the early stages.
- **Bangladesh:** A portfolio of R&D investments in biogas energy projects was not complemented with the strengthening of the production system.
 - No appropriate incentives to encourage biogas plant installations.
 - Very little done to increase awareness among farmers about the potential of correct waste management.

Windows within reach

Example: Biogas in Thailand

- **Preconditions:**

- Absence of domestic firms and fragmentation of actors: factories (e.g. of casava starch) were not interested to invest in biogas production due to high investment costs
- Pilot projects supplied by foreign firms (no domestic suppliers in the 1990s/2000s)

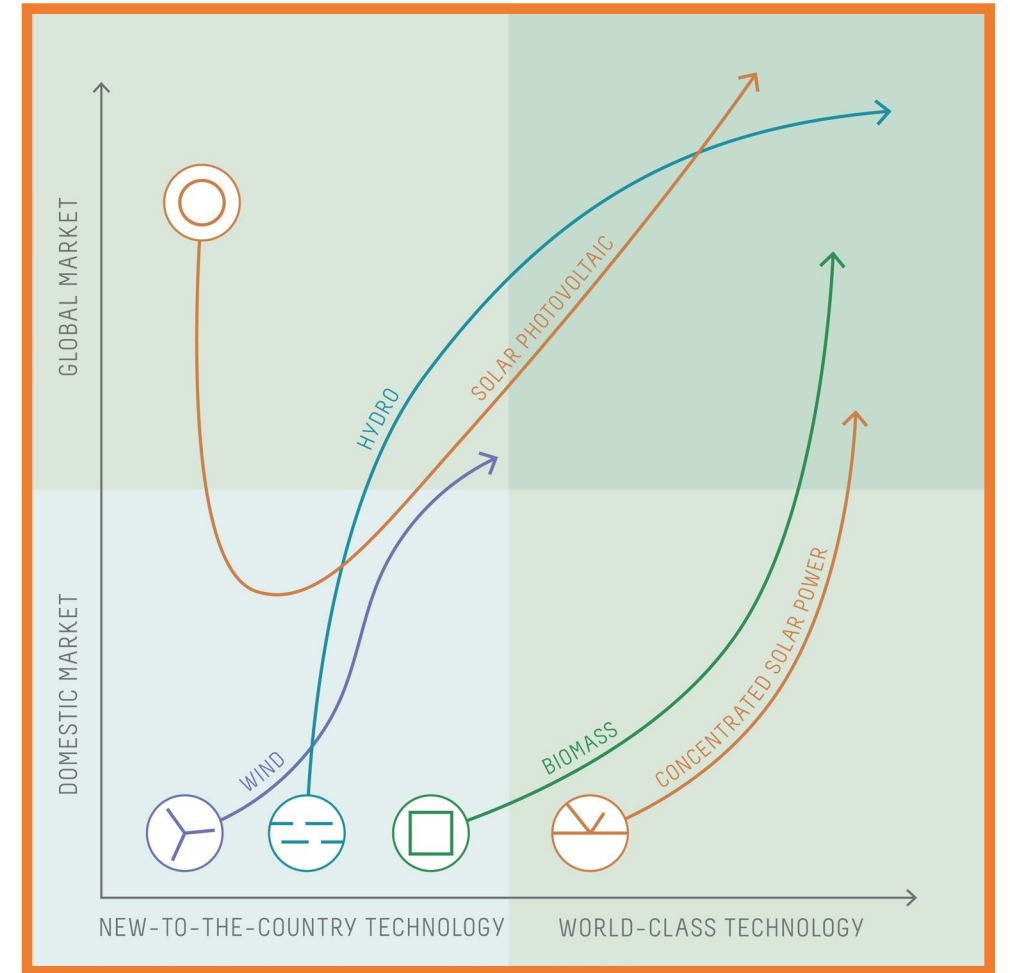
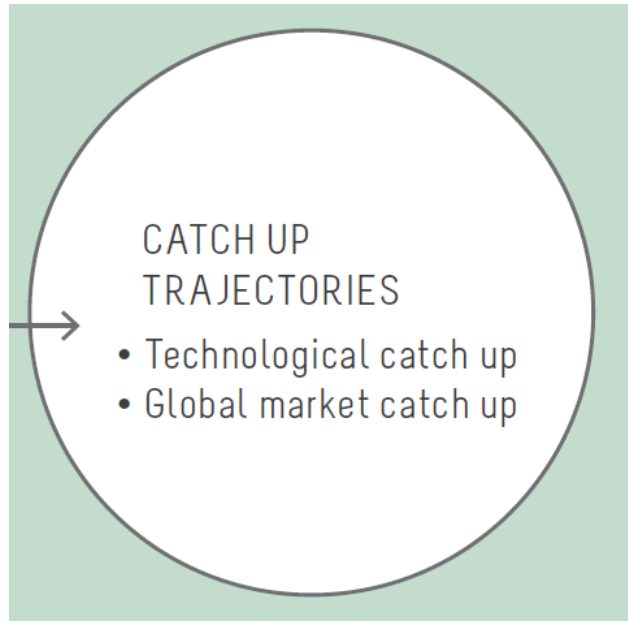
- **Responses:** proactive strategy to attract private investors to the biogas industry
 - Financial subsidies for the construction and design of biogas production plants
 - Tax incentives for firms involved in waste transformation
 - Small Power Purchase Tariff program for increasing the proportion of electricity generation from biogas
 - Enforcement of an environmental law taxing companies producing pollution.

Windows in the distance

Example: bioenergy in Mexico

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

Catch-up trajectories



An example: The Chinese Solar PV Industry

- ❖ Started in the global market exporting solar panels made with imported technology

→ *Learning from export*

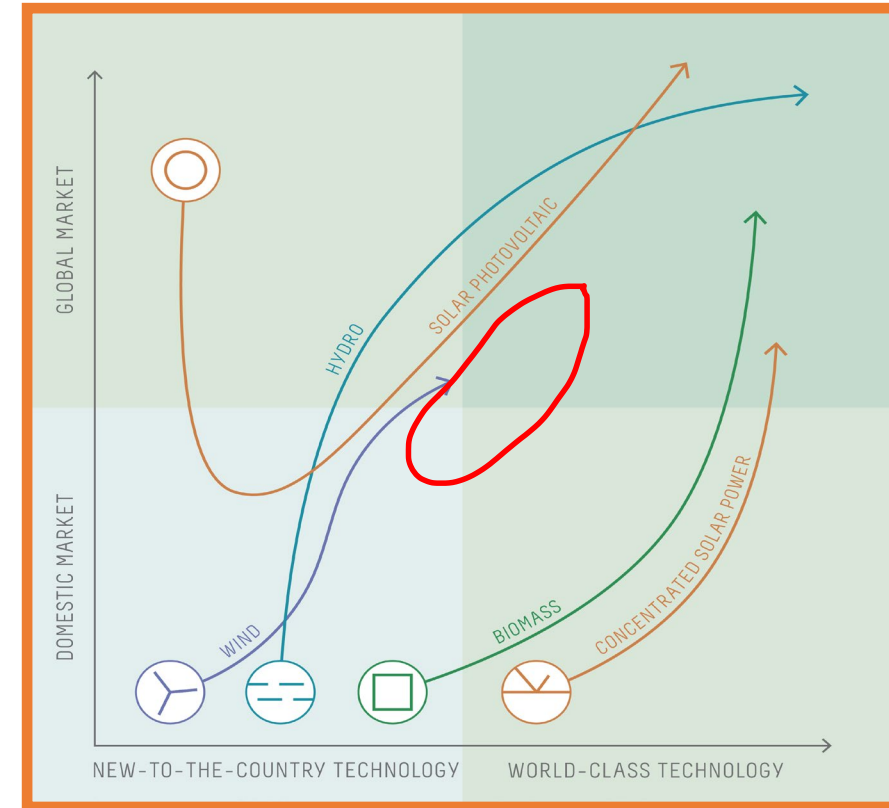
- ❖ After a fall in global demand, Chinese companies focused on domestic demand thanks to the incentives created by public policy

- ❖ Huge investments in building domestic technological capacity and domestic capacity in the whole solar value chain

→ *Domestic strengthening*

- ❖ Chinese companies went back to international markets as technological and market leaders

→ *Global leadership*



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
- 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.
- 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.

