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Green Windows of Opportunity: Latecomer development in the age of transformations toward sustainability

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August 24, 2022 (14:30-15:30 CET)

Background

- **Is the green transformation a real techno-economic paradigm shift?** The advancement of green as a paradigm, like earlier technological revolutions, is also a process of creative destruction, but there are many differences, including the unrelatedness of green technologies.

- **The green transformation of the global economy is underway**: Shifting discourses, changing national policy regimes, new parameters driving investment decisions, new business strategies etc. The trends are accelerating.

- **Big questions arise**: It is still uncertain what the green transformation means for latecomer development. It could increase entry-barriers making latecomer development more difficult, but it may also open windows of opportunity.

Research questions

- Is the green transformation opening new development opportunities for latecomer countries?
- What are the conditions and the dynamics of green latecomer development?
- Do we need a new conceptual framework to understand the determinants of changes in green industry leadership?

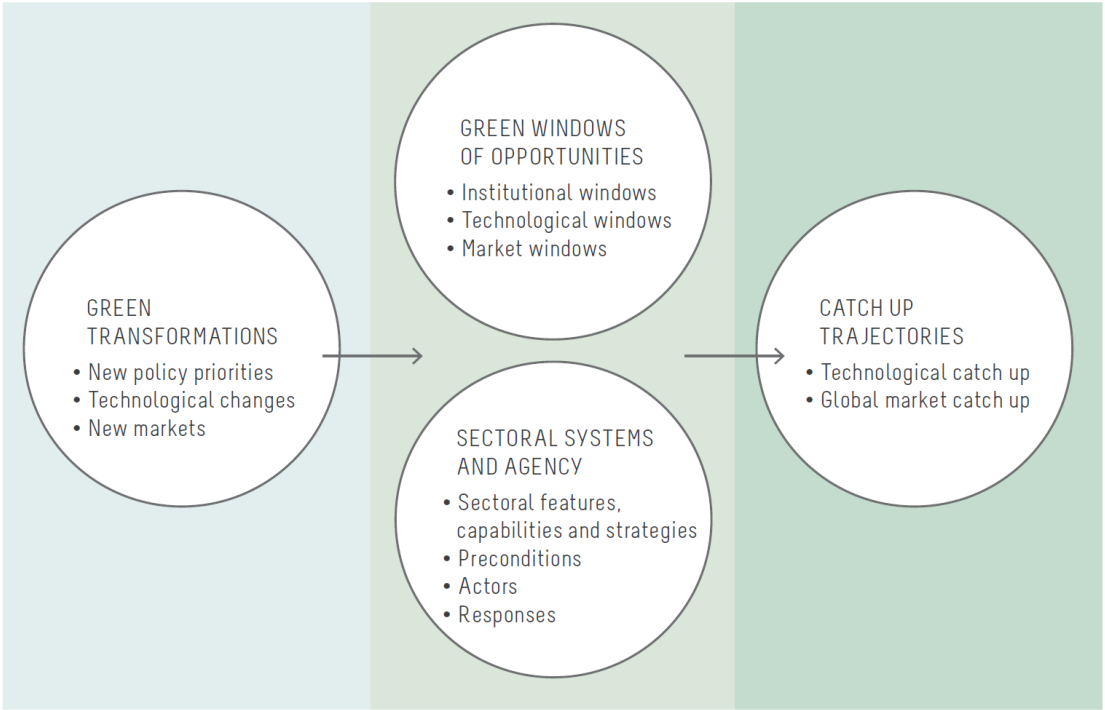
Paradigm change, windows of opportunity and catching up

- Catching up is prompted by **windows of opportunity** which emerge when changes to technological systems reduce the constraints on latecomer development (Perez and Soete 1988, Freeman 1992).

- Shists in technological systems may devalue former competitive advantages and incumbents may experience **lock-in** to increasingly obsolete routines and capabilities. Newcomers with relevant capabilities may benefit from opportunities for **leapfrogging** (Lee 2016).

- Recent research (e.g. Lee and Malerba 2017) provides numerous examples of opportunities arising in particular with **disruptive changes in technology** (e.g. South Korea and the shift from to flat-screen TVs) but also with **disruptive changes in markets** (e.g. Chile and expansion of mass markets in wine). Less is known about the effects of **disruptive institutional change**.

A new tailored analytical framework



- Essential to deviate from the environmentally unfriendly pathways paved by the advanced economies of North America and Western Europe.
- Emerging economies should 'develop differently' from the outset rather than catch up along established pathways.
- The green transformation is the first industrial revolution which has a *deadline.* Explicitly steered by *public policy*, driven by economic utility functions *and* also by social value.

Empirical studies

- Focus on experiences of renewable energy industries in China (and globally)
- Insights from combining sectoral case studies and cross-cutting analysis
- Seven articles brought together in *Industrial and Corporate Change,* Volume 29, Issue 5 (2020)

Sectoral studies

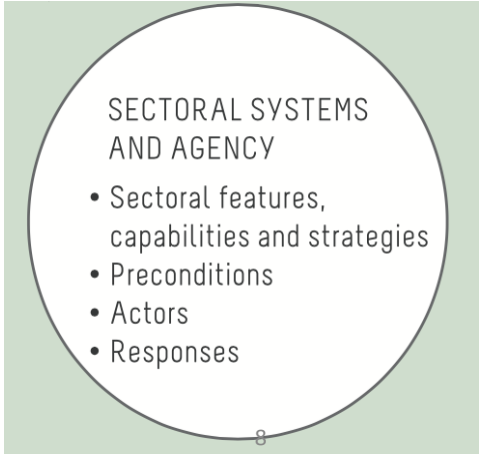
- Biomass
- Concentrated Solar Power
- Hydropower
- Solar PV
- Wind power

Green windows of opportunity

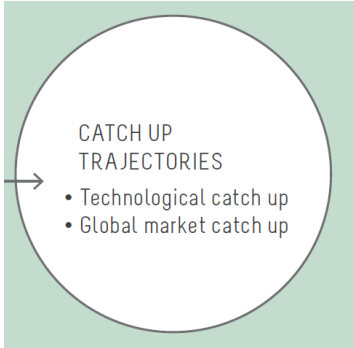
- GWOs in observed cases are **driven mainly by specific institution-cum-policy changes** rather than by modifications in technologies or markets:
  - 2006 Renewable Energy Promotion Law
  - Golden Sun Demonstration Program
  - Ride the Wind Program
- They are **endogenous** and bring together **multiple domains**: energy, industrial and innovation policy.
- Subsequent demand and technological windows are also essential, but tend, ultimately, to be driven by institutional changes. The **interactions** are key.

Firms and other sectoral system actors

- Technological activities were supported, protected and utilized in different ways across sectors, varying with technological specificities.
- Technological maturity and tradability of green technologies significantly affect variations in sectoral trajectories.
  - *Acquisition of world class technology* combined with capital investments and organizational capabilities (e.g., biomass & solar);
  - *Public R&D* (e.g., hydro energy);
  - *Interactions* among lead firms, suppliers, technology providers and financial institutions within the sectoral innovation systems
  - *Domestic trap* and inability of the system to progress from technology absorption to technological leadership in the global market (wind).

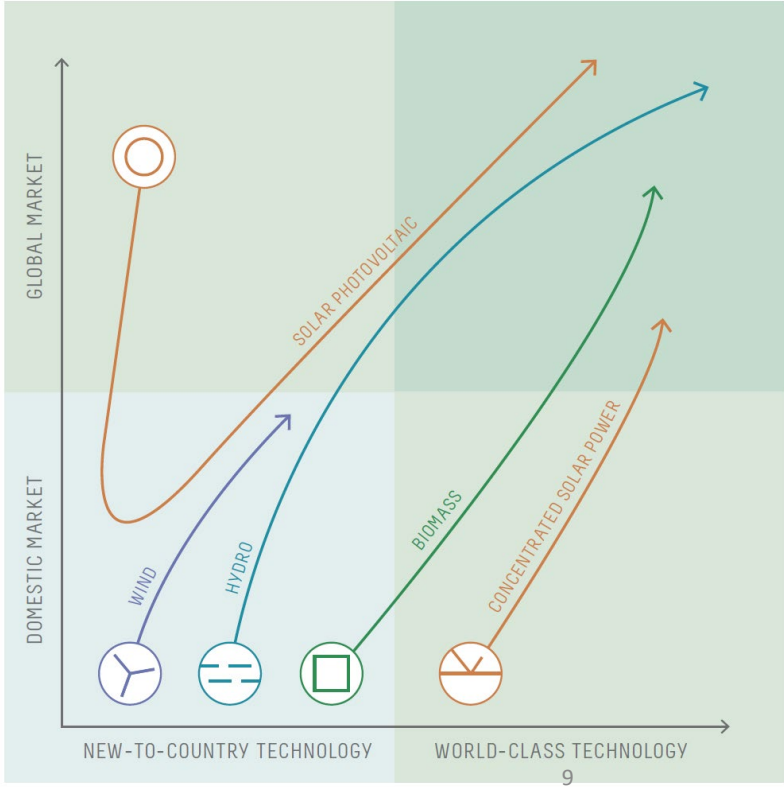


Sectoral catch-up trajectories (1)



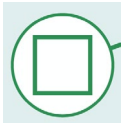
- Two dimensions of latecomer development: market and technology
- Qualitative case data and patent analysis

- Four main types of trajectories identified



Sectoral catch-up trajectories (2)

- **Domestic imitation ⇨ global leadership**
  Clear lead-firm status. Latecomer effects, using technology transfer and borrowed technology aided by state support. Stable technologies.



Biomass

Hydropower

- **Domestic imitation ⇨ limited global progression**
  Technology gap and limited exports. Technology transfer and state support. Rapidly evolving technology regimes such as offshore deployment
  and new hybrid-digital technologies constrain leadership for the moment

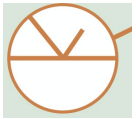
Wind power

Sectoral catch-up trajectories (3)

- **Learning from exporting ⇨ domestic strengthening ⇨ global leadership.** *Clear global leadership in production, less in technology*. Multiple iterations driven by global policy change and domestic policy and innovation system response.

Solar PV

- **World-class technology ⇨ limited global market progression.** *Technological development at the frontier*. Significant investments in domestic demonstration projects. Technological uncertainty and competing standards.



Concentrated Solar Power

Summary of main findings

- GWOs opened by **institutional changes** are central to latecomer catch up in all sectoral 'take off' cases examined. New policies and new legislation related to domestically or global sustainability transformation agendas provides disruption and dynamism.

- There are key variations in trajectories. GWOs characterised by **endogeneity**, **complementarity** and **interaction effects** among different types of internal and external opportunity windows.

- China took **active measures** to enhance their technological capabilities and build **open but strategic** national and sectoral innovation systems through trade and investment policies (including clever protectionist measures) and internationalization of R&D. Achieved fast catch-up and even leadership in several cases.

Policy Implications

- Policymakers need to bring together and **co-design policies** in otherwise distinct domains: environmental and energy policies as well as industrial and innovation policies. Support policies **need sector-specific approaches.**

- The emergence of ‘latecomers’ in the green economy has an **internationally beneficial** effect by reducing the price of energy transition technologies and mobilizing finance and technology for more affordable green energy systems in the global South (and North).

- International organizations and national governments can help **sustain institutional change-led, mission-oriented GWOs** facilitating the entry in the global market of new green innovation leaders.

New questions

- To what extent can Chinese experiences be useful for developing green development strategies elsewhere in particular in **other UMICs**?
- How do GWOs interact with **new and emerging technologies** and how different are the impacts on green transformations in advanced and emerging economies?
- Are there lessons relevant for creating/designing wider **global challenge-led windows of opportunities** in other industries, e.g., in health and digital infrastructure, critical for building an inclusive society:
  - In public goods domains, the global community could help facilitate changes/sharing of leadership to ensure access to affordable, responsible and appropriate services, products and facilities.
  - Global policy coordination in ensuring equal access and responsible provision of global public goods (e.g., COVID vaccines etc.) could create new WOs and distribute benefits.

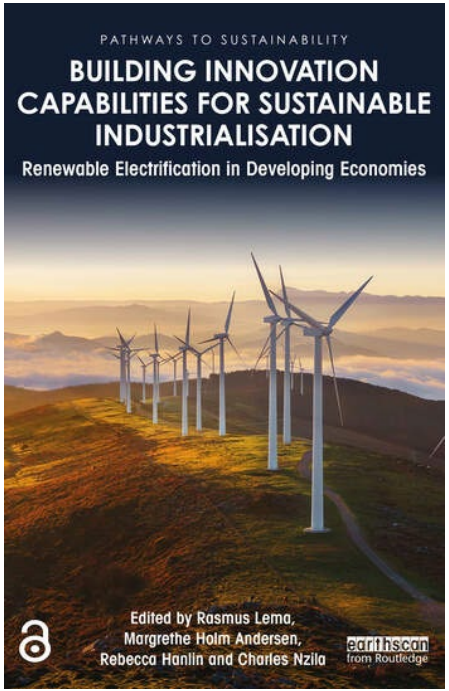
UNCTAD Technology and Innovation Report 2022

‘Green windows of opportunity: Innovation that is good for people and the planet’

Extending the discussion in several ways, including:

- Widening the discussion to new countries (e.g. LMICs) and new technologies, not just RE production
- Examining the emergence of opportunity windows (and constraints) arising with the greening of global value chains
- Addressing the relevance of new and emerging technologies (i.e. 4IR) to the exploitation of GWOs

New book



- Building Innovation Capabilities for Sustainable Industrialisation
- Out in the Routledge/Earthscan Pathways to Sustainability Series
- 12 Chapters examining and discussing 'economic co-benefits' of renewable electrification in developing countries, mainly in East Africa / Kenya
- Available as an open access e-book: https://doi.org/10.4324/9781003054665

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Overview of papers in the GWO special issue

Lema, Fu and Rabellotti (2020): Green windows of opportunity: latecomer development in the age of transformation toward sustainability, ICC (29)5, p. 1193–1209

Zhou, Miao and Urban (2020): China's leadership in the hydropower sector: 'identifying green windows of opportunity for technological catch-up, ICC (29)5, p. 1319–1343

Dai, Haakonsson and Oehler (2020): Catching up through green windows of opportunity in an era of technological transformation: Empirical evidence from the Chinese wind energy sector, ICC (29)5, p. 1277–1295

Hansen and Hansen (2020): How many firms benefit from a window of opportunity? Knowledge spillovers, industry characteristics, and catching up in the Chinese biomass power plant industry, ICC (29)5, p. 1211–1232

Hain, Jurowetzki, Konda and Oehler (2020), From catching up to industrial leadership: towards an integrated market-technology perspective. An application of semantic patent-to-patent similarity in the wind and EV sector, ICC (29)5, p. 1233–1255

Binz, Gosens, Yap and Yu (2020): Catch-up dynamics in early industry lifecycle stages—a typology and comparative case studies in four clean-tech industries, ICC (29)5, p. 1257–1275

Landini, Lema and Malerba (2020) Demand-led catch-up: a history-friendly model of latecomer development in the global green economy, ICC (29)5, p. 1297–1318

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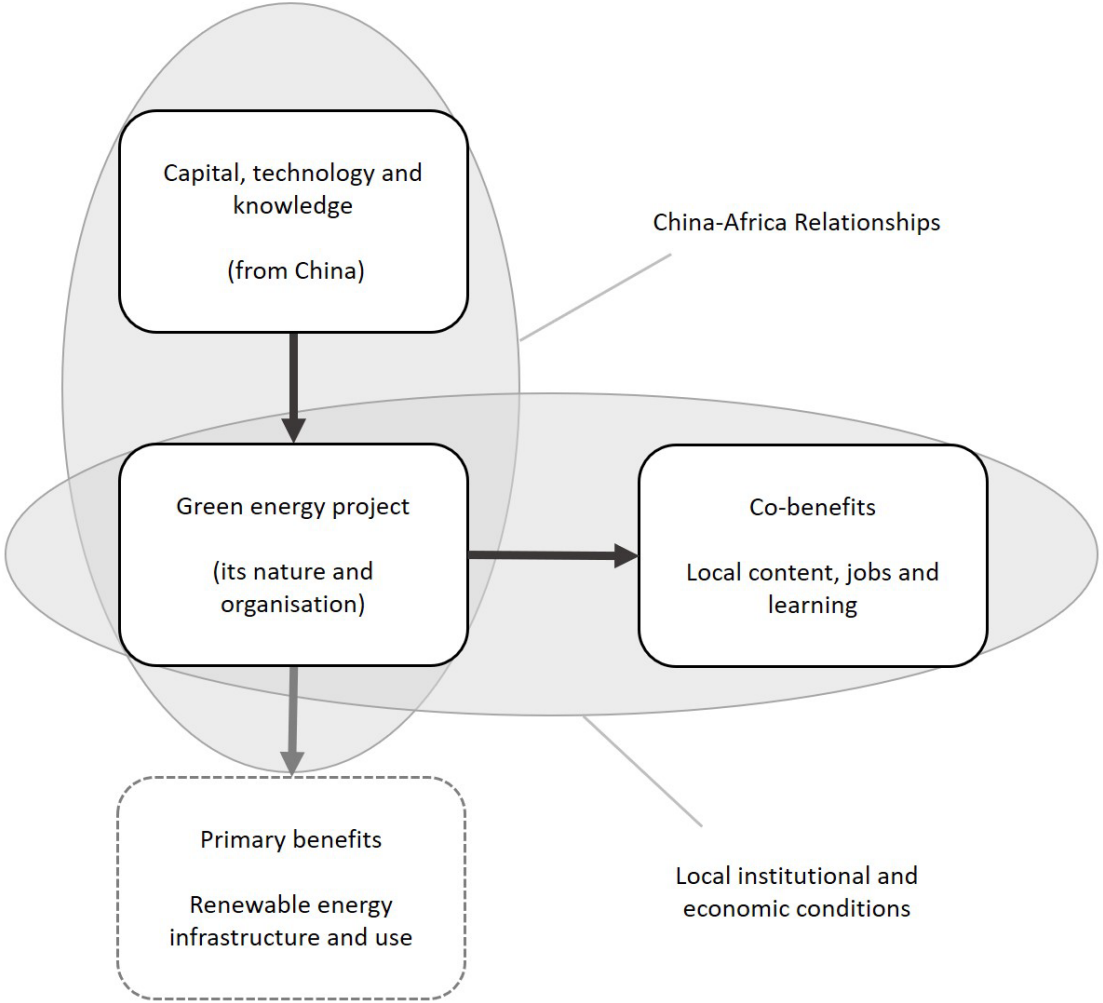
Chinese RE investments in SSA: Background

- **Investments in renewable energy are increasing rapidly in sub-Saharan Africa:** Demand for electricity will require a major expansion of the power system in sub-Saharan Africa. National priorities and international support schemes will boost renewables.

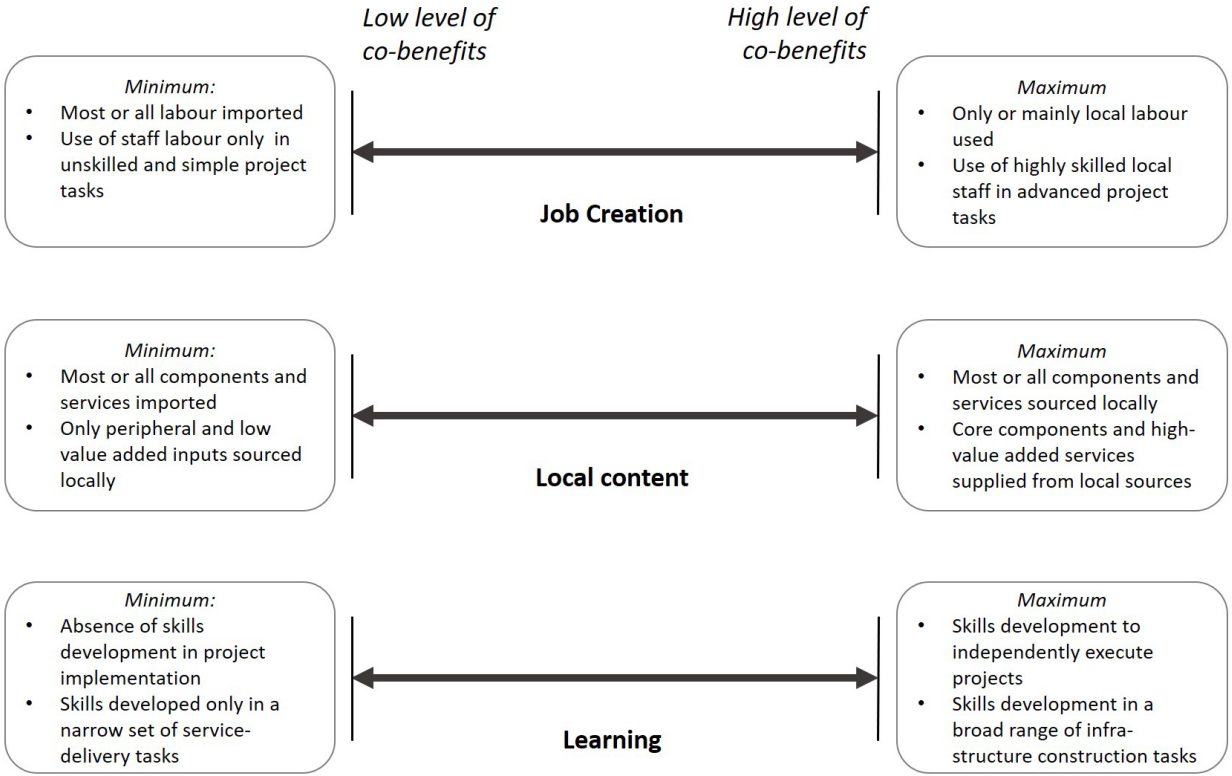
- **Rapid increase and likely future growth of Chinese involvement:** Insights from other sectors in sub-Saharan Africa suggest that China is pursuing a specific Chinese model of investments

- **Important questions arise:** to what extent and under what conditions are these investments producing economic co-benefits in terms of local economic activities, spillovers and linkage development effects?

Conceptual framwork



Assessment of co-benefits



The three projects

Capacity and ownership		Adama	Bui	Garissa
Ownership and Capacity	*Owner/sponsor*	Ethiopian Electricity Power	Bui Power Authority	Kenya Rural Electrification Authority
	Energy source	Wind	Hydro	Solar PV
	Size	204 MW	400 MW	55 MW
	Cost	USD 462 million	USD 560 million	USD 140 million
Infrastructure delivery	*EPC and project management*	HydroChina and CGC Overseas Construction Group	Sino Hydro	China Jiangxi Corporation for International Economic and Technical Cooperation (CJIC)
	Finance	Export-Import Bank of China (85%) and Government of Ethiopia (15%)	Export-Import Bank of China (89%) and Government of Ghana (11%)	Export-Import Bank of China (100%)
	Front-end and detailed engineering	HydroChina and CGC Overseas Construction Group	Coyne et Bellier (France) and Sino Hydro	CJIC and Maknes Consulting
	Core technology supply	Goldwind (China) and Sany (China)	Produced in China by Alstom (France)	JinkoSolar (China) and BYD (China)
Service delivery	*Electricity Distribution*	Ethiopian Electric Services (EES)	ECG/Gridco	Kenya Power and Lighting Company
	Plant operation	Ethiopian Electricity Power	Bui Power Authority	Kenya Electricity Generating Company and CJIC
	Plant Maintenance	Ethiopian Electricity Power	Sino Hydro	KECG

Conclusions: GWOs in SSA?

- Beware of overly optimistic expectations of co-benefits arising from investments in renewable-energy infrastructure projects in sub-Saharan Africa
- Unequal distribution of capabilities and skewed power relations between the users and producers of green infrastructure in Africa
- Important role of policy – focus on economic co-benefits
- Shift om focus from service delivery to infrastructure delivery
- Focus on lateral capabilities relevant for other infrastructure settings
- How unique are Chinese investments?