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Green Windows of Opportunity: Catching Up in Green Value Chains

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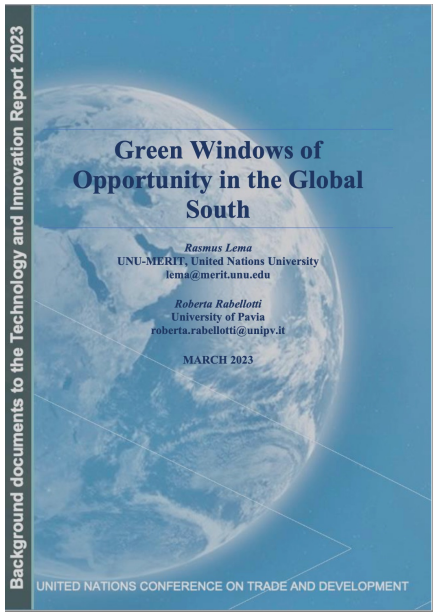

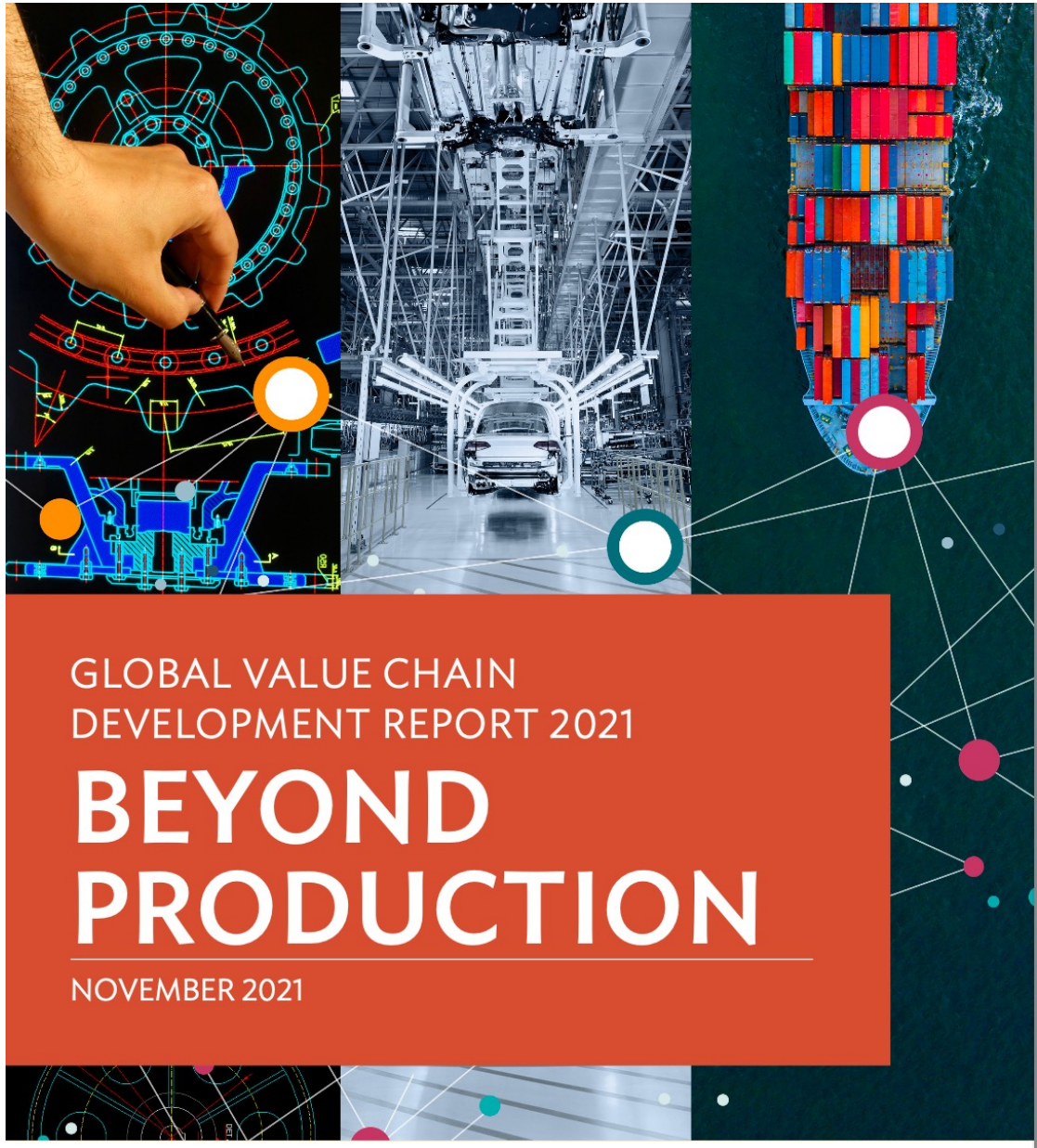

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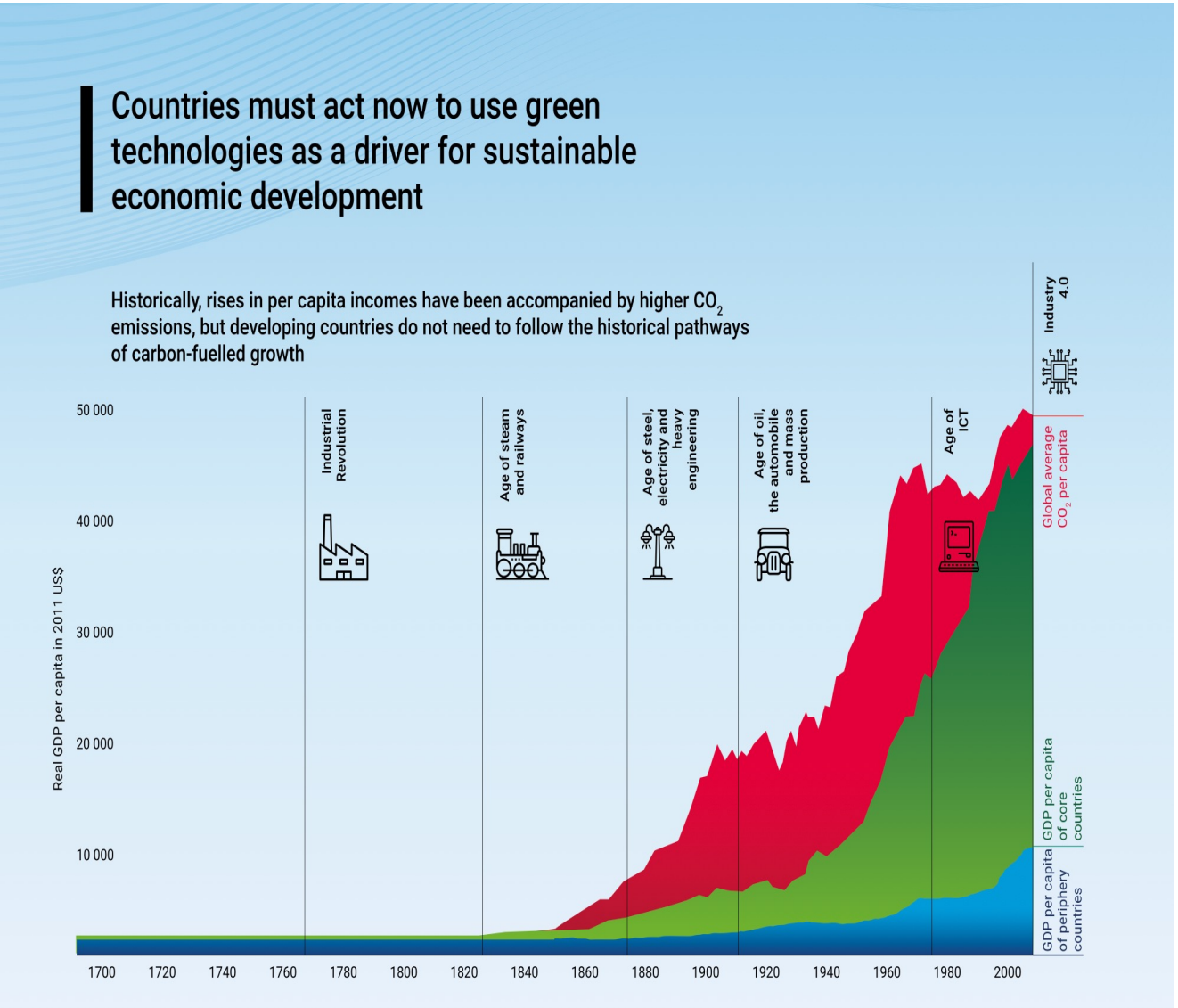
Latecomer countries must catch the green technological revolution early

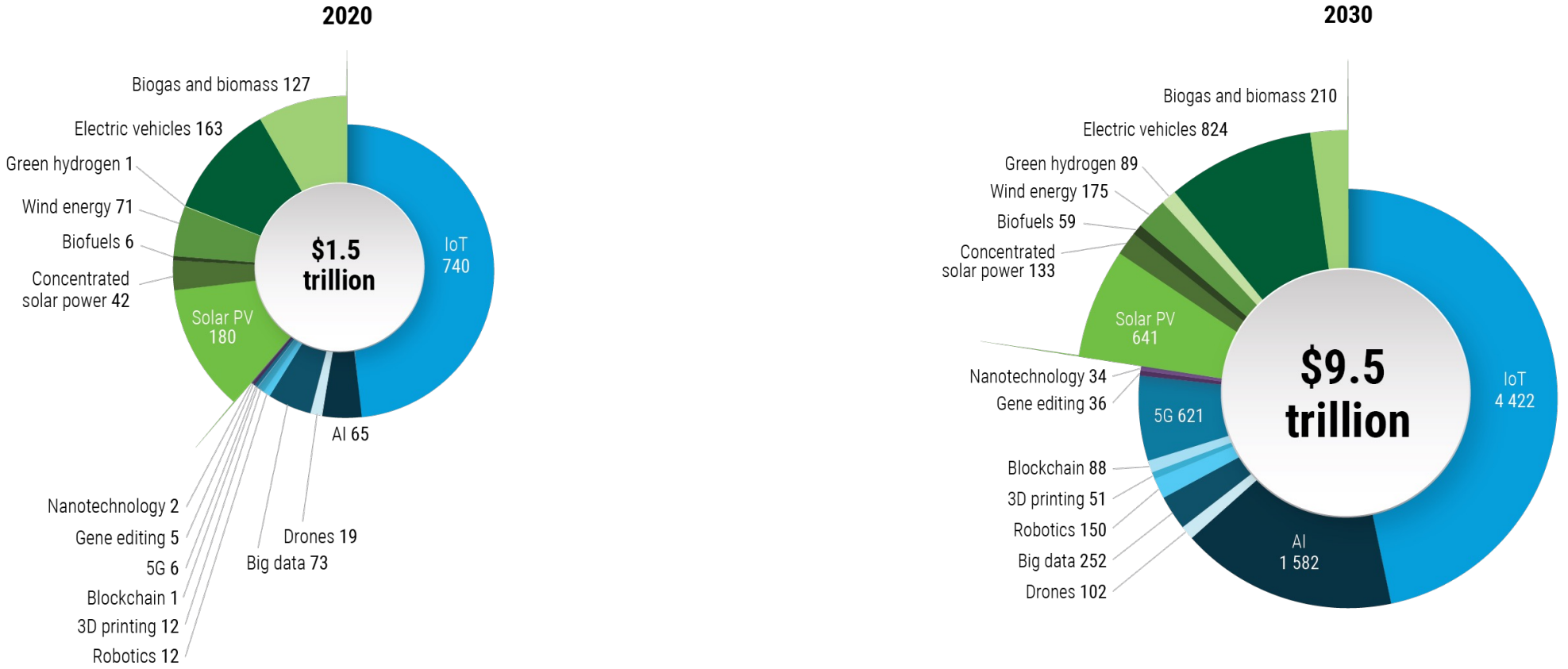


Latecomers should from the outset develop differently rather than catch up along established pathways

Grow first and clean up later models are not viable!

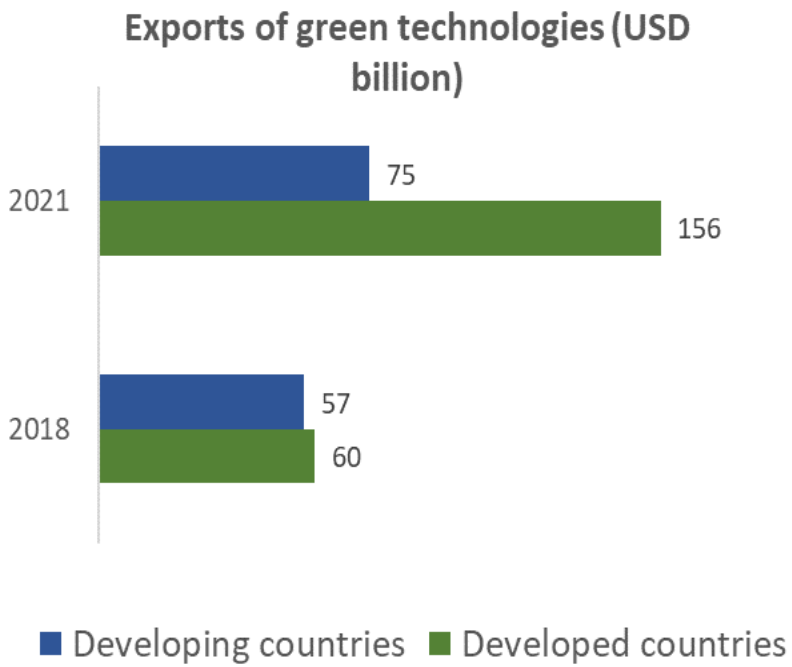
There are enormous opportunities in the development of green frontier technologies

Market size estimates of frontier technologies, $ billion



Source: UNCTAD based on various estimates.

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



Top green frontier technology providers

Biofuels	Wind energy	Green hydrogen	Electric vehicles	Concentrated solar power	Biogas and biomass
Archer Daniels Midland	GE Power	Siemens Energy	Tesla	Abengoa Solar	Future Biogas
ALTEN Group	Mitsubishi Heavy Industries	Linde	Ford	Iberolica Group	Air Liquide
Louis Dreyfus	ABB	Toshiba Energy	Hyundai	ENGIE	PlanET Biogas Global
Brasil Bio Fuels	Siemens Gamesa Renewable Energy	Air Liquide	Chevrolet	NextEra Energy Resources	Ameresco
BIOX Corp	Goldwind	Nel ASA	BYD	BrightSource Energy	Quantum Green
Renewable Energy Group	Enercon	Air Products and Chemicals	Volkswagen		Envitech Biogas
Wilmar international		Guangdong Nation-Synergy Hydrogen Power Technologies	Renault-Nissan-Mitsubishi Alliance		Weltec Biopower

Source: UNCTAD based on various sources.

Notes: American companies in dark blue, Chinese companies in orange, others from developed economies in light blue and developing economies in yellow.

To harness the full potential of green frontier technologies, developing countries have to move fast.

Developing countries need to address the following questions

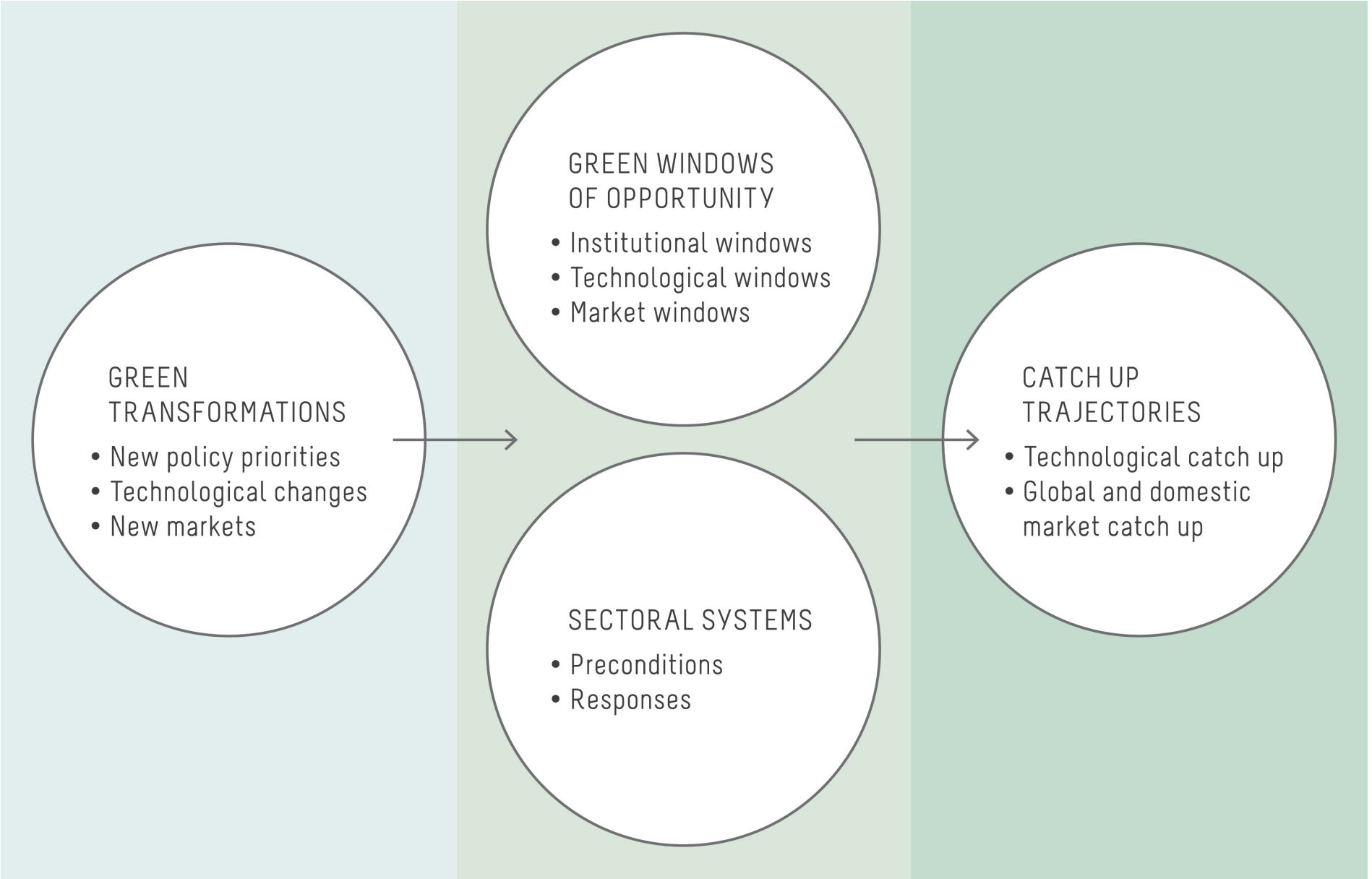
Does the green economy offer opportunities for latecomer catch-up?

What characterizes the capacity to seize these opportunities?

- *What is the role of innovation systems to increase the green innovative capabilities?*
- *What are the prospects for joining green GVCs and upgrading within them?*

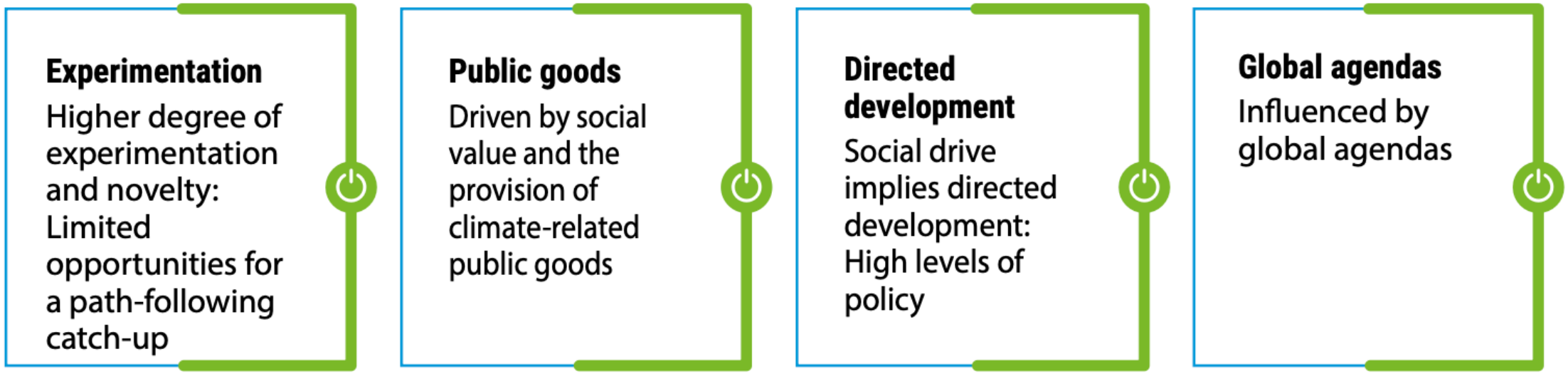
What policy options can support the efforts to take advantage of GWOs?

The GWO framework



What is different in the green techno-economic paradigm

Catching up with green innovation



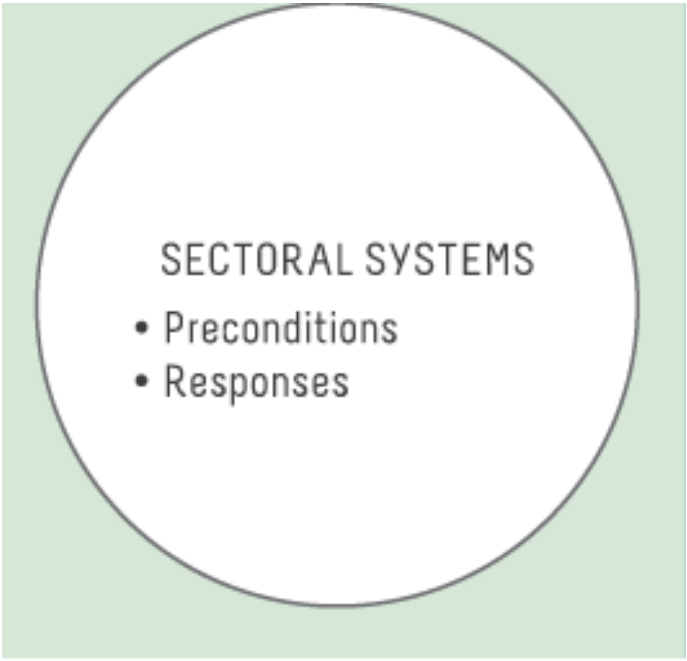
Source: UNCTAD.

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 two key 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.



Seizing GWOs: four scenarios

Four green window scenarios

Responses / Preconditions	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

Scenario 1: Windows open

Example: Renewables in China

Preconditions:

- Large internal market,
- Diversified industrial structure
- Well-developed related capabilities

Responses:

- Co-design of environmental and industrial policies
- Diffusion of knowledge among firms and institutions, such as government stimulation of knowledge spillovers with loose enforcement of property rights and diffusion through state-owned design institutes in biomass
- Acquisition of foreign technology through licensing activity and cross-border acquisitions of foreign firms in solar PV and biomass
- Public R&D experimentation in CSP

Scenario 3: Windows within reach

Example: Biogas in Thailand

Preconditions:

- Limited initial experience, 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 of the Minister of Energy 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
- Support for the strengthening of the sectoral innovation system

GWOs & GVCs

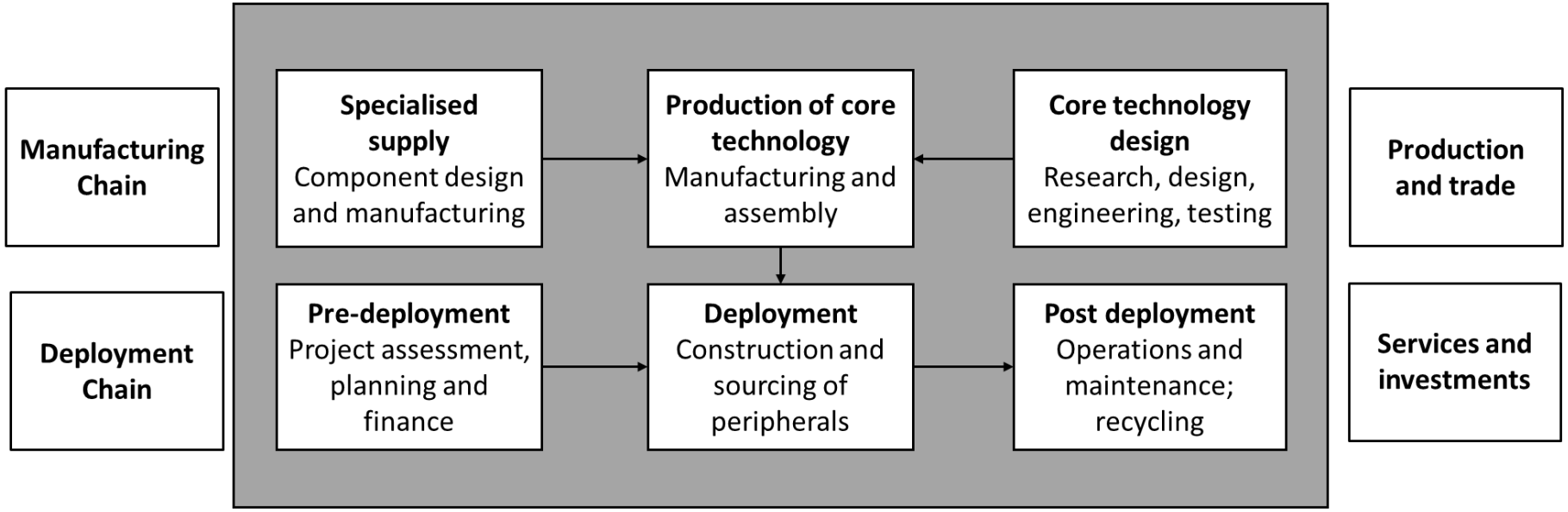
- The scenarios get more complex if we consider that green industries are organized as GVCs. Both preconditions and responses are influenced by GVCs characteristics.

- Many variables to be considered:
  - At GVCs level: governance and upgrading opportunities
  - At industry level: technological maturity and tradability

- To be done……this is the next step of our research we will develop in a book on **Green Windows of Opportunity. Sustainable Global Value Chains and Latecomer Development.**

Renewable energy GVCs

- **Manufacturing chain**: manufacturing of energy-generating equipment. It is led by OEMs and networks of suppliers;
- **Deployment chain**: distribution of renewable energy, i.e. services activities lead by engineering, procurement and construction (EPC) firms.



The main leading actors in the two chains

- **OEMs** are the lead firms in trade-centred global value chains. Manufacturing of core technology is often based in the exporting country (home economy) but may also sometimes be undertaken in the importing country (host economy).
  - The technology provider and its networks of component suppliers manufacture and assembly either offsite (exports) or onsite at the destination (FDI and follow sourcing).
- **EPC firms** lead the deployment chain by bringing together a range of actors, including financiers and specialised service providers, whose location is typically tied to the site of installation.

Solar PV GVC

Governance

- Low transportation costs, high tradability and standardised products.
- Significant power exerted by lead firms which have traditionally been OEMs.
- Economies of scale are important.

Market-based governance with low switching costs throughout the chain

Upgrading

- China: functional expansion strategy (starting from modules) to gain lead-firm status
- ROW: High entry barriers in the manufacturing chain (e.g., lock-in in India despite NSM)
- Opportunities mainly confined to the deployment chain
- GVC-learning constrained due to market-based governance

Who Controls the Solar Panel Supply Chain?

The Manufacturing Process for Solar PV Panels

The primary material for solar PV manufacturing which is melted and cast into ingots.

Polysilicon ingots are sliced into thin wafer sheets ranging from 150-280 micrometers in thickness.

The wafer is then cleaned and doped to manufacture a crystalline solar cell.

Multiple cells are wired together and laminated to form modules, before being connected to panels.

Share of Manufacturing Capacity by Country/Region in 2021

China made up **55%** of global solar panel manufacturing capacity in 2010, with its share rising to **84%** in 2021.

The total value of global solar PV related trade increased by more than **70%** YoY to reach over **$40B** in 2021.

ELEMENTS

Source: IEA

ELEMENTS.VISUALCAPITALIST.COM

Wind GVC

Governance

- Top leading companies are Vestas, Siemens-Gamesa (Europe), GE Wind (North America) Goldwind and Envision (China).
- High transportation costs.
- Significant localisation of production in (sizeable) end markets and widespread follow-sourcing there.

Co-existence of modular and relational governance (between project developers, OEMs and suppliers but switching costs are decreasing)

Upgrading

- China: expanding backward from deployment (licenses and foreign suppliers are key)
- India: initially less success with lead-firm strategy (Suzlon)
- Chile: blade production enabled by lead-firm learning (close interaction)
- ROW: mainly simple components such as towers and foundations

Biomass GVC

Governance

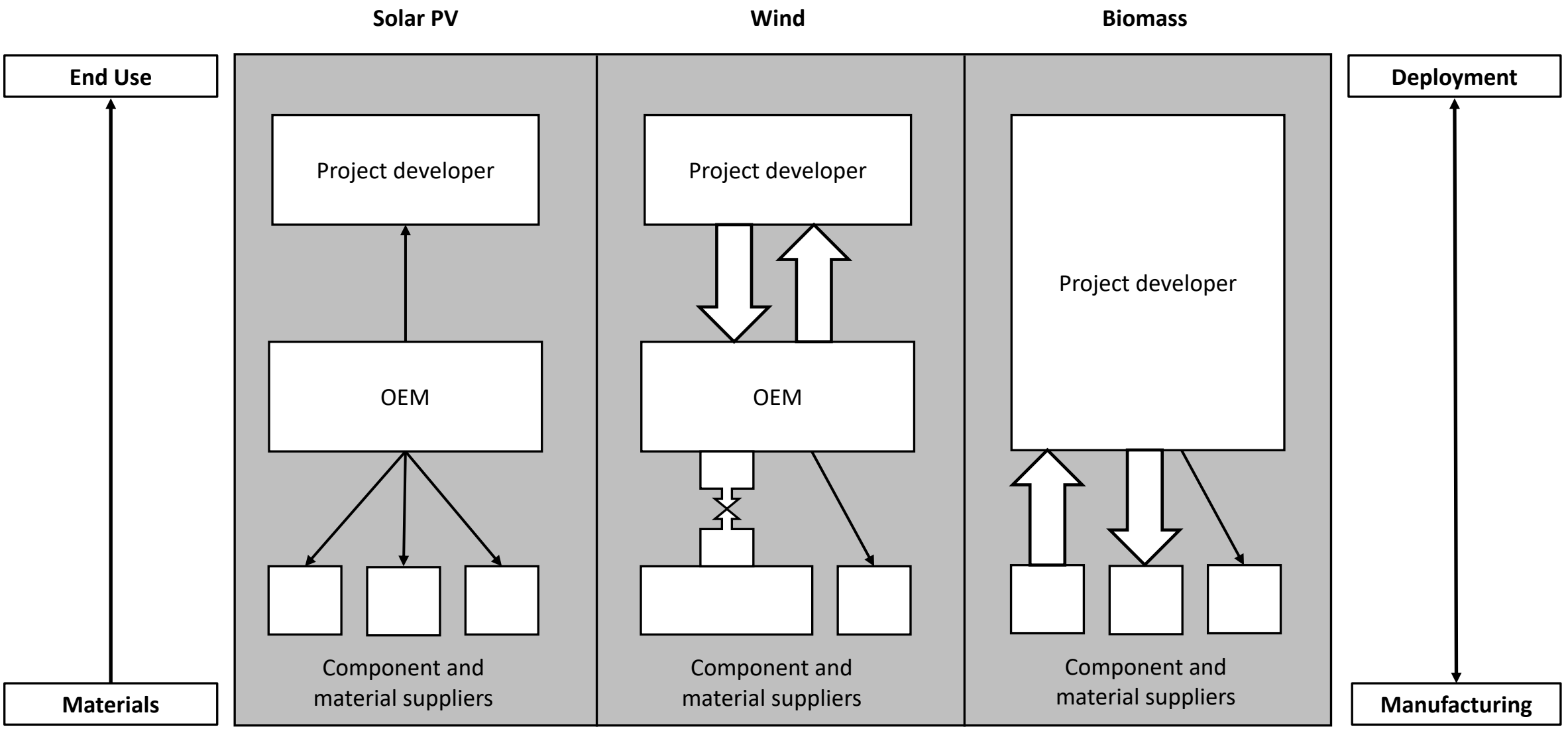
- Very low tradability and integral product architecture.
- Customised solutions depending on feedstock (e.g. cassava or corn residue).
- High importance of design and organisational capabilities.
- Both specialised and generic suppliers.

Vertical governance with integrated EPC lead firms

Upgrading

- China: starting from deployment with firm acquisitions and local diffusion of designs.
- Thailand: feedstock processing firms acquired design capabilities from foreign EPCs and consultants.
- India: Strong indigenous EPC as well as specialised technology suppliers.
- ROW: relatively low entry barriers but tacit knowledge is key.

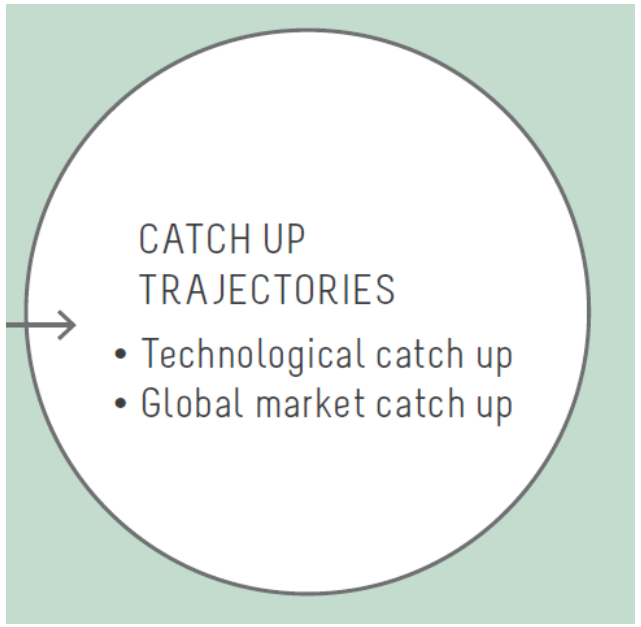
	Solar PV	Wind	Biomass
Governance	Market	Relational/ modular	Vertically integrated
Separation between manufacturing and deployment	High	Medium	Low
Entry barriers in manufacturing	High	Medium	Low
Entry barriers in deployment	Medium	High	
Upgrading opportunities	• Few opportunities in core technology • High entry barriers due to economies of scale by incumbents • Possibilities in the deployment GVC • Opportunities to create manufacturing capabilities in peripheral GVCs such as batteries, inverters, racking solutions etc.	• Upgrading opportunities in core technology • Possibility of moving from domestic market to regional exports of key components • High transportation costs combined with standard designs favour local manufacturing of blades and towers • Competent domestic EPCs may facilitate domestic sourcing	• Key opportunities arise from the significant economic activity necessarily tied to the point of end-use • Domestic firms involved in feedstock processing may upgrade functionally in the value chain, learning from project participation

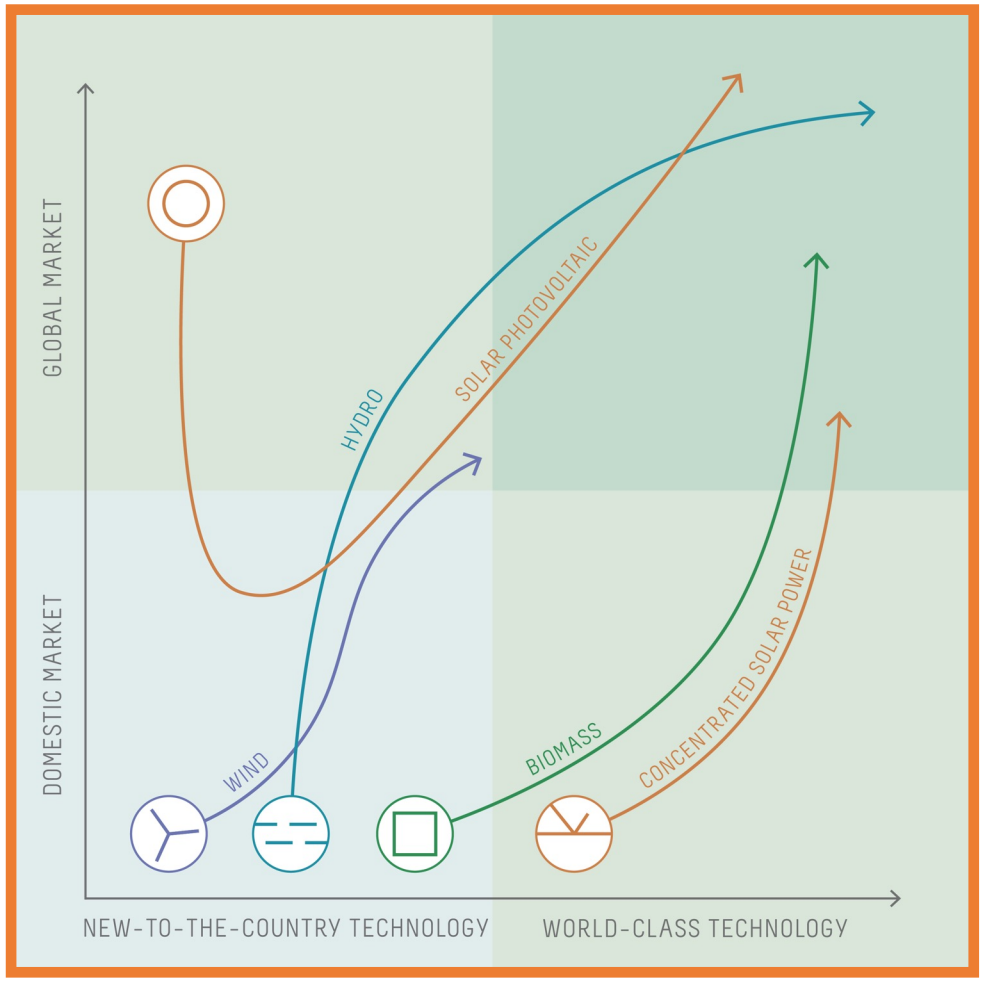

Solar PV
Wind
Biomass
End Use
Deployment
Project developer
Project developer
Project developer
OEM
OEM
Component and material suppliers
Component and material suppliers
Component and material suppliers
Materials
Manufacturing

GWOs & GVCs: the complexity

- Many variables to consider:
  - GVCs: governance and upgrading opportunities
  - Industry specificity: technological maturity and tradability
- All these different variables impact on preconditions and responses and influence our scenarios, which become more complex…
- To be done……

Catch-up trajectories



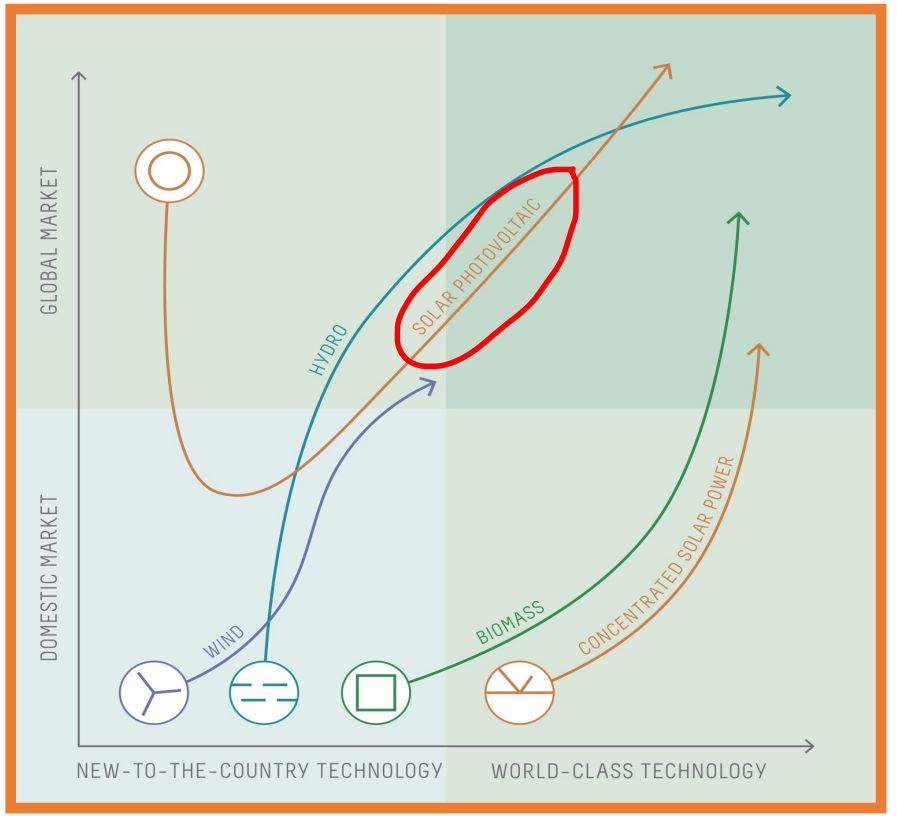


An example: The Chinese Solar PV Industry

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

Table 5: Policies for seizing GWOs

Open and augment GWOs	• Select policy instruments and calibrate the policy design to different local objectives and features Combine relevant policy instruments • Invest in demonstration programs • Support policy interventions with external contributions • Invest in demonstration programs
Assess, address, and sustain sectoral systems	• Evaluate preconditions • Enable and shape responses • Align environmental and energy, STI and industrial policies • Access external knowledge • Invest in domestic R&D • Build domestic capabilities along the value chain • Invest in human capital • Involvement in international collaboration projects • Diffuse knowledge within the domestic sectoral system

The role of international cooperation

- Consistency between international agreements on trade, intellectual property and climate change is critical for the green technology revolution;
- Trade rules should permit developing countries to protect infant green industries through tariffs, subsidies and public procurement;
- Intellectual property should have greater flexibilities for green technologies in developing countries;
- The financial constraint should be addressed by international cooperation. Resources made available so far have been insufficient.

To seize GWOs strong national and international political will is needed to catch the green technological revolution early.

Lema, R., Fu, X., & Rabellotti, R. (2020). Green windows of opportunity: latecomer development in the age of transformation toward sustainability. *Industrial & Corporate Change*, *29*(5).

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