United Nations TD/B/C.II/MEM.4/28

United Nations Conference on Trade and Development

Distr.: General
17 July 2023

Original: English

Trade and Development Board
Investment, Enterprise and Development Commission
Multi-year Expert Meeting on Investment, Innovation and Entrepreneurship for Productive Capacity-building and Sustainable Development
Tenth session
Geneva, 27–28 September 2023
Item 3 of the provisional agenda

Recent developments, challenges and opportunities in sustainable economic diversification

Summary

The world is experiencing the initial phase of a new technological paradigm based on renewable energy sources and green technologies. This shift opens green windows of opportunity, that is, time-bound favourable conditions for developing countries to catch up and diversify economies along greener paths. There are three main paths by which developing countries can capture the benefits of the green revolution, as follows: develop domestic renewable energy industries and technologies; explore the synergies between digital and green technologies, creating a twin transition, to promote the greening of global value chains while using available opportunities to move up value chains; and identify greener and more productive products that can build on current capacities, to diversify economies. However, none of these paths is pursued automatically. Governments need to carefully design and implement policies, to strengthen national capabilities, improve access to external knowledge and technology and provide an enabling environment for the development of green industries. Developing countries also need support from the international community. Active efforts need to be made to collaborate, to provide support for the development of green innovation and to ensure that all have access to the knowledge and technology generated. The international community should improve consistency between trade, intellectual property rights and environmental agreements, ensuring that international trade rules and intellectual property rights do not hinder the efforts of developing countries to adopt and develop green technologies, thereby promoting economic diversification and development through sustainable pathways.

I. Introduction

1. The world is facing social and economic challenges of an unprecedented nature. Many countries are attempting to reverse the losses caused by the cascading crises that have followed the pandemic, including the repercussions of the war in Ukraine. In particular, climate change impacts threaten hard-won development gains and make the achievement of the Sustainable Development Goals more difficult. These challenges necessitate a transformation towards more diversified, productive and sustainable economies, to spur economic growth, create more and better jobs and increase resilience to future crises. This is in line with the Bridgetown Covenant, which identifies "transforming economies through diversification" as one of the four major transformations needed to move to a more resilient, digital and inclusive world of shared prosperity.[1] In such pursuits, developing countries strive to foster the emergence of more productive and sustainable economic activities given the technological level of the current production base and the incentives created by domestic and global demand.

2. A green transformation, supported by frontier technologies, offers a viable route by which developing countries can claim agency in the development narrative and move from crisis to sustainable development. Developing countries are urged to seize the opportunity presented by the green revolution, which holds the potential to significantly improve livelihoods, enhance productivity and reduce greenhouse gas emissions. Experience has shown that missing out on the early stage of a technological revolution creates gaps that, later, are difficult to close. At the beginning of a new technology wave, each country is in a similar position; early adopters move ahead quicker and create advantages that make it difficult for others to catch up. However, at present, few developing countries have the needed capacities to take advantage of green technologies. Developing countries need strong responses, including government policies and private sector initiatives, and the support of the international community, to build absorptive and innovation-related capacities to use, adopt and adapt new technologies and innovations.

3. Challenges and opportunities in developing countries with regard to diversifying economies towards sectors associated with lower levels of emissions are examined in this note, along with the policies, instruments and institutional reforms needed at the national and international levels to promote more sustainable diversification in developing countries, to bring about innovations that are good for people and for the planet. The document addresses the following: challenges in opening green windows of opportunity, in chapter II; technological opportunities for sustainable economic diversification, in chapter III; and the role of national policies and international collaboration in supporting developing countries in harnessing the benefits of green technologies and diversifying production in a sustainable manner, in chapter IV. Questions for discussion are proposed in chapter V.

II. Challenges in opening green windows of opportunity

4. The world economy is undergoing the beginning of a green technological revolution, characterized by green windows of opportunity, that is, time-bound favourable conditions for developing countries to catch up and promote economic diversification and development through new technologies and innovations. Demand for and the application of technologies that address climate change are quickly increasing, encompassing not only green technologies, such as those related to the use of renewable energy sources, but also the strategic use of other frontier technologies such as artificial intelligence, big data and nanotechnology.

5. UNCTAD, in *Technology and Innovation Report 2023: Opening Green Windows – Technological Opportunities for a Low-Carbon World*, highlights green windows of opportunity and discusses 17 frontier technologies, defined as new and rapidly developing technologies that take advantage of digitalization and connectivity, which are divided into

[1] TD/541/Add.2.

three broad categories.[2] Estimates indicate that these technologies already represent a $1.5 trillion market, which could grow to $9.5 trillion by 2030. Such expansion embodies significant economic gains, such as through the creation of new jobs. For example, 3.3 million direct jobs are expected to be created in the wind energy sector by 2025.[3]

6. Many developing countries have abundant natural resources to develop renewable energy sources, yet the opening of green windows of opportunity is not automatic. New sectors build on existing knowledge, skills and infrastructure in an economy, and the development of new sectors often requires investment in research and development and support and incentive measures from the Government. Developing countries often face barriers in these areas, particularly in terms of infrastructure, financing and innovation capabilities. As discussed in *Technology and Innovation Report 2023*, there is a gap between developed and developing countries in the ability to adopt and develop frontier technologies. The market of frontier technologies is supplied primarily by a few countries, notably China, the United States of America and countries in Western Europe. There is a similar pattern of concentration in knowledge generation. Publications and patents related to frontier technologies are largely concentrated in China and the United States, which together account for around 30 per cent of global publications and almost 70 per cent of patents in each technology category. In addition, the pace of trade expansion is not equal. With regard to green technologies, for example, in 2018–2021, the total exports of developed countries grew from around $60 billion to $156 billion (increasing by a factor of 2.6), while the total exports of developing countries grew from $57 billion to $75 billion (increasing by a factor of 1.3). To date, developed countries have taken advantages of most of the opportunities; in order to capture the gains associated with green windows of opportunity, developing countries need to enhance relevant capabilities in a timely fashion, since timing influences success in this endeavour.

7. Preparedness among countries to use, adopt and adapt frontier technologies reflects these disparities. The following five dimensions are considered under the UNCTAD frontier technology readiness index in order to assess such preparedness: information and communications technology (ICT) deployment; skills; research and development activity; industry activity; and access to finance.[4] The assessment in 2023 considered 166 economies, ranked according to readiness level. The ranking is dominated by high-income countries, led by the United States and followed by Sweden, Singapore, Switzerland and the Kingdom of the Netherlands. Emerging economies are primarily found in the second quarter of the list with, in particular, lower scores in skills and ICT.

8. The gaps are wide between developed countries, developing countries, the least developed countries, landlocked countries, small island developing States and commodity-dependent developing countries, yet are starting to narrow. Policies and incentive measures are important in improving frontier technology readiness. Some developing countries have moved up the index ranking or ranked higher than expected due to policies and incentives in place. For example, Brazil, following improvements in ICT development, has moved up the ranking compared with in 2021. Other countries ranked higher than expected according to estimated rankings based on gross domestic product per capita, in particular the following: India, which ranked 67 positions higher than estimated, reflecting achievements related to research and development and ICT, as well as the significant availability of

[2] UNCTAD, 2023, Technology and Innovation Report 2023: Opening Green Windows – Technological Opportunities for a Low-Carbon World (United Nations publication, Sales No. E.22.II.D.53, Geneva), available at https://unctad.org/publication/technology-and-innovation-report-2023. Frontier technologies include the following: artificial intelligence, big data, blockchains, drones, fifth-generation networks, Internet of things, robotics and three-dimensional printing (industry 4.0 technologies); biofuels, biogas and biomass, concentrated solar power, electric vehicles, green hydrogen, solar photovoltaics and wind energy (green technologies); and nanotechnology and gene editing (other technologies).
Note: All websites referred to in footnotes were accessed in June 2023.

[3] See https://cdn.ihs.com/www/pdf/IHS-Technology-5G-Economic-Impact-Study.pdf and https://gwec.net/wind-can-power-over-3-3-million-jobsover-the-next-five-years/.

[4] UNCTAD, 2021, Technology and Innovation Report 2021: Catching Technological Waves – Innovation with Equity (United Nations publication, Sales No. E.21.II.D.8, Geneva).

skilled human capital at relatively low costs; the Philippines, which ranked 54 positions higher; and Viet Nam, which ranked 44 positions higher. The Philippines and Viet Nam have a high ranking in industry, with significant foreign direct investment in high-technology manufacturing.

9. A high ranking on the index does not necessarily mean a country will be able to open green windows of opportunity, as appropriate policies and investments are also required. Overall, the index highlights areas in which countries need to improve in order to be better placed in the race to develop new sectors based on frontier technologies and to be established as leaders.

III. Technological opportunities for sustainable economic diversification

10. The concept of green windows of opportunity serves to show the synergy between economic development and climate change mitigation. Developing countries seeking to promote economic development through greener pathways have three main routes by which to leverage green technologies for sustainable economic diversification, namely, development and deployment of renewable energy technologies; greening of global value chains; and diversification towards more complex and greener sectors.

A. Development and deployment of renewable energy technologies

11. The depth of capacities in latecomer countries to produce, distribute and use renewable energy technologies, along with the speed of development of such capacities, vary by country and sector. Mature sectors such as those for biomass or solar photovoltaics have readily available technologies and can provide a relatively fast track to boosting economic activities. However, market competition in mature sectors tends to be greater, imposing barriers to new entrants related to higher efficiency production processes. In addition, even mature technologies need to be acquired and adapted to national contexts. In contrast, immature sectors such as those for concentrated solar power and green hydrogen present more space for newcomers to disrupt the industry, yet the technologies tend to be more difficult to operate, demanding greater capabilities and levels of research and development, which may often be lacking in developing countries.

12. To be able to open green windows of opportunity, therefore, developing countries need to successfully identify opportunities at particular stages of a value chain and orient efforts towards developing the capabilities of the labour force and of firms. There are several examples of countries that have deployed renewables technologies with different levels of success in terms of opening green windows of opportunity and using them to foster development. All successful examples showcase the importance of proactively fostering the development of green energy technologies through policies and incentive mechanisms on both the demand and supply sides. For example, China has become a world leader in the solar photovoltaics market by supporting a domestic production and innovation system that combines public and private business actors and by incentivizing and regulating research institutions, which took place following a setback in exports in 2008, after which leading enterprises collaborated to build up domestic demand, with support from national policies and the central bank, as well as, at a later date, collaboration between five State-owned enterprises in attracting investment, project management, integrated construction, research and development, training, hardware maintenance and the setting of industry standards.[5]

13. Countries are in a better position to open green windows of opportunity when there are strong preconditions in terms of national capabilities and infrastructure related to the targeted green sector. However, policy responses are still required in order to exploit such preconditions, to open green windows of opportunity. Policy measures can also affect preconditions, that is, weak preconditions do not necessarily mean that opening green

[5] See http://www.xinhuanet.com/nzzt/135/.

windows of opportunity will not be possible. Considering the different combinations between the strengths of preconditions and responses, national experiences can be grouped into four scenarios (table 1).

Table 1
Four green window scenarios

Responses / Preconditions	**Strong**	**Weak**
Strong	**Scenario 1** *Open windows* Brazil: Bioethanol Chile: Green hydrogen (potentially) China: Biomass, concentrated solar power, solar photovoltaics	**Scenario 2** *Windows to be opened* Bangladesh: Biogas China: Wind India: Solar photovoltaics Morocco: Concentrated solar power
Weak	**Scenario 3** *Windows within reach* Namibia: Green hydrogen Thailand and Viet Nam: Biomass	**Scenario 4** *Windows in the distance* Kenya: Wind Mexico and Pakistan: Bioenergy

Source: UNCTAD, 2023.

14. The best scenario with regard to opening green windows of opportunity is one in which strong preconditions are combined with strong responses. For example, in Brazil, the bioethanol sector received support from policy frameworks and governmental measures incentivizing investment through programmes such as a climate fund.[6] In the second scenario, there are strong preconditions but insufficient policy responses translating them into opportunities. For example, in India, greater efforts in training, research and development and promoting linkages to relevant stages of value chains could help boost the competitiveness of the solar photovoltaics sector.[7] In the third scenario, notwithstanding weak preconditions, proactive measures are being taken to build capacity and open green windows of opportunity. For example, in Viet Nam, efforts are being made to develop a dynamic sectoral system in the biomass industry.[8] In the fourth scenario, there is limited potential for green windows due to weak preconditions and inadequate responses. For example, in Mexico, there is a lack of capabilities to upgrade bioenergy technology.[9]

15. Green windows of opportunity are particular to each technology. In identifying possible opportunities, Governments should therefore take into consideration technological characteristics, such as maturity and tradability.

16. Technologies are mature when they are at a stage of complete development, with established designs and the necessary regulations, market and technical standards, infrastructure and maintenance networks, as well as user behaviours.[10] Immature sectors offer opportunities but might be difficult to operate in since they require greater initial investment in research and development that is often only available in countries equipped with the necessary infrastructure, technology and labour and financial resources required to support extensive research and development activities. Mature technologies tend to be less demanding in terms of research and development, yet often involve higher levels of competition, requiring strong and efficient production processes.

[6] Furtado AT, Scandiffio MIG and Cortez LAB, 2011, The Brazilian sugarcane innovation system, Energy Policy, 39(1):156–166.

[7] Landini F, Lema R and Malerba F, 2020, Demand-led catch-up: A history-friendly model of latecomer development in the global green economy, Industrial and Corporate Change, 29(5):1297–1318.

[8] See https://www.international-climate-initiative.com/PROJECT1387-1.

[9] Ordoñez-Frías EJ, Azamar-Barrios JA, Mata-Zayas E, Silván-Hernández O and Pampillón-González L, 2020, Bioenergy potential and technical feasibility assessment of residues from oil palm processing: A case study of Jalapa, Tabasco, Mexico, Biomass and Bioenergy, 142.

[10] Geels FW, 2002, Technological transitions as evolutionary reconfiguration processes: A multi-level perspective and a case study, Research Policy, 31(8–9):1257–1274.

17. Tradability is also an important factor, since it affects the protection of the domestic market and learning modes. Sectors with a high level of tradability may need a higher degree of market protection initially, along with design and implementation strategies to boost demand.[11] In addition, taking advantage of a high level of tradability in capital equipment requires a strong production capacity. However, a low level of tradability offers a degree of natural protection in the domestic market, and learning could initially be facilitated through foreign direct investment. Countries can take advantage of technologies with a low level of tradability and maturity if the necessary research and development capabilities are in place, as well as the capacity to supply components.

18. To open green windows of opportunity and seize the benefits, Governments first need to be able to identify opportunities and focus on targeted technologies. Different policy domains therefore need to be aligned in order to develop renewable energy sectors and at the same time stimulate industrial development. For example, government procurement programmes for renewable energy can take into consideration local content requirements aimed at building local production and innovation capacity. Needs with regard to each technology should be taken into consideration when defining support. In addition, nascent industries require greater support regarding experimentation. Countries that aim to develop immature technologies should therefore establish programmes to build knowledge and experience. For example, in Chile, the National Research and Development Agency has established several green hydrogen pilot projects with the support of international investors.

19. In order to stimulate the development of green sectors and achieve the desired results, policymakers need to employ a policy mix that is adequate to particular contexts, adapting selected instruments to local circumstances, since similar programmes may lead to different outcomes. For example, in Mexico and South Africa, auction systems are in place for acquiring energy; Mexico has prioritized low-cost deployment and South Africa has included requirements with regard to local content and social considerations in the evaluation of winning bids, to establish a domestic industry and promote social development.[12] In addition, it is necessary to assess the current state of domestic capabilities and sectoral innovation systems. Countries need to build productive and innovation-related skills; enhance human capital and access to and diffusion of knowledge; and invest in domestic research and development through both public and private investments.

20. Ensuring the availability of funding can be challenging. Governments need to provide support mechanisms while building capabilities, and development programmes require investments from both the public and private sectors. It is therefore essential to promote access to varied funding resources, including development banks, public investments and external funds.

B. Greening of global value chains

21. In most countries, moving to more complex and greener production depends on trade and placement in global value chains, which have been at the centre of the global economic framework since the 1990s. Many developing countries have utilized them to leverage strengths and expertise in particular tasks. However, to reap the full benefits of global value chains, countries need to upgrade production to more sophisticated manufacturing and services along a chain. Countries can diversify economies and upgrade production through participation in global value chains by taking advantage of the push for greater sustainability. Consumer preferences are shifting towards products and processes with smaller carbon footprints and more ecofriendly life cycles.[13] Simultaneously, there are opportunities for firms to not only meet consumer demand but also ensure savings by

[11] Landini et al, 2020.

[12] Matsuo T and Schmidt TS, 2019, Managing trade-offs in green industrial policies: The role of renewable energy policy design, World Development, 122:11–26.

[13] Gallagher J, Basu B, Browne M, Kenna A, McCormack S, Pilla F and Styles D, 2019, Adapting stand-alone renewable energy technologies for the circular economy through ecodesign and recycling, Journal of Industrial Ecology, 23(1):133–140.

implementing more efficient manufacturing practices and optimizing material utilization. Such changes are transmitted along value chains through new designs, standards and specifications. Firms can ensure the greening of global value chains through the following two approaches: produce inputs for green production, such as solar photovoltaic panels and wind turbines; and ensure the greening of traditional manufacturing industries, such as food, garments and textiles, prevalent in low-income and middle-income countries.

22. The initiative to ensure the greening of global value chains and its implementation depends on the type of governance, that is, the nature of the relationship between links in a value chain. There are five types of global value chain governance involving different monitoring degrees and coordination modes, namely, captive, hierarchy, market, modular and relational; for example, under captive governance, there is a high level of monitoring and control exerted by leading firms, and smaller suppliers have a high level of dependence on larger buyers, making it difficult for smaller suppliers to switch between buyers. In such cases, leading firms might bear the costs of upgrading system providers, given the gains related to cost savings or reputational reasons.[14]

23. There are other potential issues in the process of greening global value chains. Leading firms may shift the costs of sustainability compliance onto suppliers, as observed, for example, in the wine and coffee sectors, leading to a "supplier squeeze".[15] In addition, greater demand may raise barriers for entry and thereby deter smaller producers and deepen imbalances of power between firms in the Global North and Global South. Greater demand for sustainability from buyers, generally from the Global North, should be accompanied by greater support to suppliers, often from the Global South. For example, the environmental upgrading of global value chains of olive oil from Tunisia remains limited, since there has been a lack of financial and technical assistance from buyers.[16]

24. The application of voluntary sustainability standards can be a good practice in upgrading global value chains. Such standards outline requirements for producers, traders, manufacturers, retailers and service providers, with the primary objective of advancing sustainability by fostering collaboration among non-governmental organizations, industry associations and multi-stakeholder groups.[17] They cover various aspects, such as upholding human rights, ensuring worker health and safety, mitigating environmental impacts of production, fostering positive community relations and implementing responsible land use planning. An increasing number of export-oriented economies are adopting voluntary sustainability standards. By 2020, the number of standards had expanded to 150 in agriculture and around 30 in mining and industrial products; 14 organizations covered eight agricultural commodities worldwide. In 2019, the standards provided certification for nearly 20 million hectares of the eight agricultural commodities that accounted for approximately 8 per cent of the global area for these crops.[18]

25. Industry 4.0 technologies have the potential to contribute to the greening of global value chains. Such technologies, while not inherently climate-friendly, can help enhance productivity and improve safety, and also reduce environmental impacts if used strategically. There is a need to explore the synergies between the digital and green transitions, which have to date developed in parallel, and to produce a twin transition. The greening of global value chains through the incorporation of digital technologies into production processes can be achieved in many ways. For example, standard-setting organizations can leverage new technologies to enhance monitoring capabilities in the areas of food, forestry and fisheries.[19] Instead of conducting annual field audits, officials can

[14] Gereffi G, Humphrey J and Sturgeon T, 2005, The governance of global value chains, Review of International Political Economy, 12(1):78–104.

[15] Ponte S, 2020, The hidden costs of environmental upgrading in global value chains, Review of International Political Economy, 29(3):818–843.

[16] Achabou MA, Dekhili S and Hamdoun M, 2017, Environmental upgrading of developing country firms in global value chains, Business Strategy and the Environment, 26(2):224–238.

[17] See https://unfss.org/home/about-unfss/.

[18] See https://vss.fibl.org/vss-report.

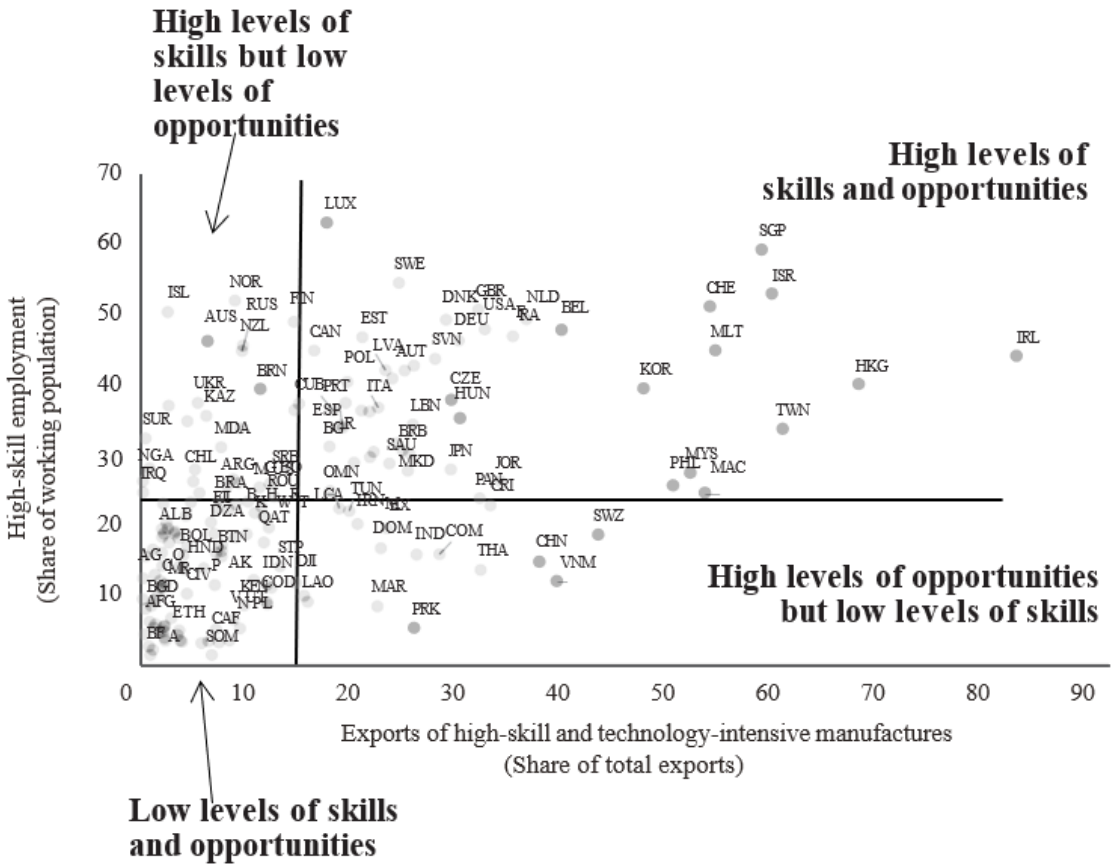
[19] Gale F, Ascui F and Lovell H, 2017, Sensing reality? New monitoring technologies for global sustainability standards, Global Environmental Politics, 17(11):65–83.

deploy fixed or mobile sensors to gather real-time data, and data collected from online sensors and global positioning system trackers can make logistics more effective and significantly reduce carbon emissions.[20] In addition, smart grids enabled by artificial intelligence technologies can optimize green energy use.

26. A simplified way to assess the readiness of countries to benefit from the diffusion of industry 4.0 technologies is through the analysis of the level of high-skill employment in an economy as a share of the working population, and the share of high-skill and technology-intensive manufactures in total exports, whereby the higher the level of both indicators, the better positioned a country is. The best-positioned countries in this regard are the United States and countries in East and South-East Asia and in Europe (figure 1). Countries are considered less ready if they often import high-technology goods but lack the skills needed for the widespread diffusion of industry 4.0, such as China, India, Mexico, Thailand and Viet Nam. Countries may have a skilled workforce but lack the necessary companies or infrastructure to fully leverage potential, including many countries that rely heavily on commodity exports, such as Argentina, Brazil, Chile, Kazakhstan and Nigeria. Finally, countries considered to be the least prepared, including most developing countries, are those that do not have many high-technology sectors in the economic structure nor many high-skill jobs.

Figure 1

Determining which economies may initially be better positioned to benefit from industry 4.0: Indicators of readiness



Source: UNCTAD, 2023.

Note: The solid lines represent the unweighted global averages under these two indicators. Data labels use International Organization for Standardization economy codes.

[20] Mangina E, Narasimhan PK, Saffari M and Vlachos I, 2020, Data analytics for sustainable global supply chains, Journal of Cleaner Production, 255.

27. Governments, the private sector and other stakeholders can favour the greening of global value chains by establishing the necessary policies, infrastructure, digital competencies, institutions, capabilities and funding. National digital and green strategies should be aligned, to take advantage of green windows of opportunity. Moreover, there should be public and private investment in ICT infrastructure, ensuring equal access throughout a country and among the population. With regard to the development of digital skills, Governments can support businesses and provide incentives for training and education. For example, in Malaysia, the Penang Skills Development Centre promotes technical knowledge and training programmes for advanced industrial operations. [21] International partnerships can facilitate access to knowledge and the diffusion of technology in developing countries through programmes such as Prospecta Americas, which aims to improve knowledge about technologies and evaluate impacts.[22] Countries can also benefit from international standards and regulations that facilitate interoperability, such as those established by the International Telecommunication Union. Finally, ensuring the necessary funding is often a challenge in developing countries. Since firms are mostly motivated by investment returns, the public sector should ensure that demonstration projects take place to advise firms. Governments can also establish innovation and technology funds, in cooperation with international donors and multinational development banks. There are many examples in this regard. For example, in Malaysia, Bank Pembangunan allocated RM3 billion through the Industry Digitalization Transformation Fund.[23] Such initiatives can be supplemented by foreign direct investment, which can be attracted by public investment in infrastructure and the provision of incentives to companies that adopt digital and green technologies.

C. Diversification towards more complex and greener sectors

28. Economic diversification in developing countries is a path-dependent process, since it consists of a steady move towards new sectors that build on already existing activities.[24] Countries that already produce machinery and electronics, for example, tend to have a greater number of closer activities to which they can move more easily, since there are more products that require similar technology, compared with countries with a specialization in primary products. To assist countries in diversifying through green pathways, UNCTAD has produced indices of economic complexity and carbon footprints for over 43,000 products traded in international markets. The analysis indicates that there is considerable variation within each industry, similar to that found in national analyses that show that the outputs of countries usually involve products with a wide range of carbon footprint levels.[25] Historically, countries start with less complex sectors such as agriculture and move towards industries with increasing levels of complexity. However, increasing complexity does not necessarily lead to greener production, since the result depends on the product mix. The leading 20 products that are greener than the global average are relatively expensive since they involve skilled labour, yet they are diverse, involving activities related to both primary commodities and precision manufacturing products (table 2).

[21] Lee K, Wong C-Y, Intarakumnerd P and Limapornvanichal C, 2020, Is the fourth industrial revolution a window of opportunity for upgrading or reinforcing the middle-income trap? Asian model of development in South-East Asia, Journal of Economic Policy Reform, 23(4):408–425.

[22] See https://www.comcytcentral.org/prospecta-americas.

[23] UNCTAD, 2022, Industry 4.0 for Inclusive Development (United Nations publication, Geneva).

[24] Hausmann R and Hidalgo CA, 2011, The network structure of economic output, Journal of Economic Growth, 16(4):309–342; Petralia S, Balland P-A and Morrison A, 2017, Climbing the ladder of technological development, Research Policy, 46(5):956–969; Reinert ES, 2008, How Rich Countries Got Rich...and Why Poor Countries Stay Poor (Public Affairs, New York).

[25] UNCTAD, 2023.

Table 2
Degree of complexity of 20 products greener than global average, 2018

Product (Harmonized System code)	*Complexity*	*Carbon dioxide per unit of gross domestic product*	*Carbon dioxide per capita*
Fish preparations; anchovies, prepared or preserved, whole or in pieces (but not minced) (160416)	2.41	-1.50	-0.04
Cocoa; paste, wholly or partly defatted, $105–331 (180320)	2.41	-1.50	-0.04
Coke and semi-coke; of coal, lignite or peat, whether or not agglomerated; retort carbon (270400)	2.41	-1.50	-0.04
Cotton; garnetted stock waste (520291)	2.41	-1.50	-0.04
Cotton yarn; (not sewing thread), multiple or cabled, of uncombed fibres, 85 per cent or more by weight of cotton, less than 125 decitex (exceeding 80 metric number), per single yarn, not for retail sale (520535)	2.41	-1.50	-0.04
Yarn, artificial; filament, monofilament (less than 67 decitex), of viscose rayon (not high tenacity), single, untwisted or twisted 120 turns per metre or less, not for retail sale, not sewing thread (540331)	2.41	-1.50	-0.04
Lace; mechanically made, of textile materials, (other than man-made fibres), in the piece, in strips or motifs, (other than fabrics of headings 60.02 to 60.06) (580429)	2.41	-1.50	-0.04
Iron or non-alloy steel; (not in coils), flat-rolled, width 600mm or more, cold-rolled, of a thickness of 0.5mm or more but not exceeding 1mm (720927)	2.41	-1.50	-0.04
Titanium, unwrought, waste and scrap, powders (810810)	2.41	-1.50	-0.04
Weighing machines; constant weight scales and scales for discharging a predetermined weight of material into a bag or container, including hopper scales (842330)	2.41	-1.50	-0.04
Machinery; for preparing, tanning or working hides, skins or leather, other than sewing machines (845310)	2.41	-1.50	-0.04
Lathes; for removing metal, horizontal, other than numerically controlled (845819)	2.41	-1.50	-0.04
Glass; unworked, tubes, of glass having a linear coefficient of expansion not exceeding 5x10 (to the minus 6), (or 0.000005) per Kelvin within a temperature range of 0–300 degrees C (700232)	2.25	-2.01	-0.14
Lighters; pocket, cigarette, gas fuelled, refillable (961320)	2.25	-2.01	-0.14
Rags; used or new, scrap twine, cordage, rope and cables and worn out articles of twine, cordage, rope or cables, of textile materials; sorted (631010)	2.14	-1.46	-0.00
Fabrics; narrow woven fabrics, not elsewhere classified in heading 5806, of textile materials not elsewhere classified in item 5806.3 (excluding goods of heading 5807) (580639)	2.13	-1.53	-0.03
Fabrics, woven; of synthetic staple fibres, containing 85 per cent or more by weight of acrylic or modacrylic staple fibres, unbleached or bleached (551221)	2.09	-1.85	-0.06
Sound recording or reproducing apparatus; parts and accessories thereof, pick-up cartridges (852210)	2.09	-1.85	-0.06
Clock cases and similar cases for other goods of chapter 91; other than watch cases, parts thereof, except metal (911280)	2.09	-1.84	-0.18
Skis; for snow (950611)	2.09	-1.84	-0.18

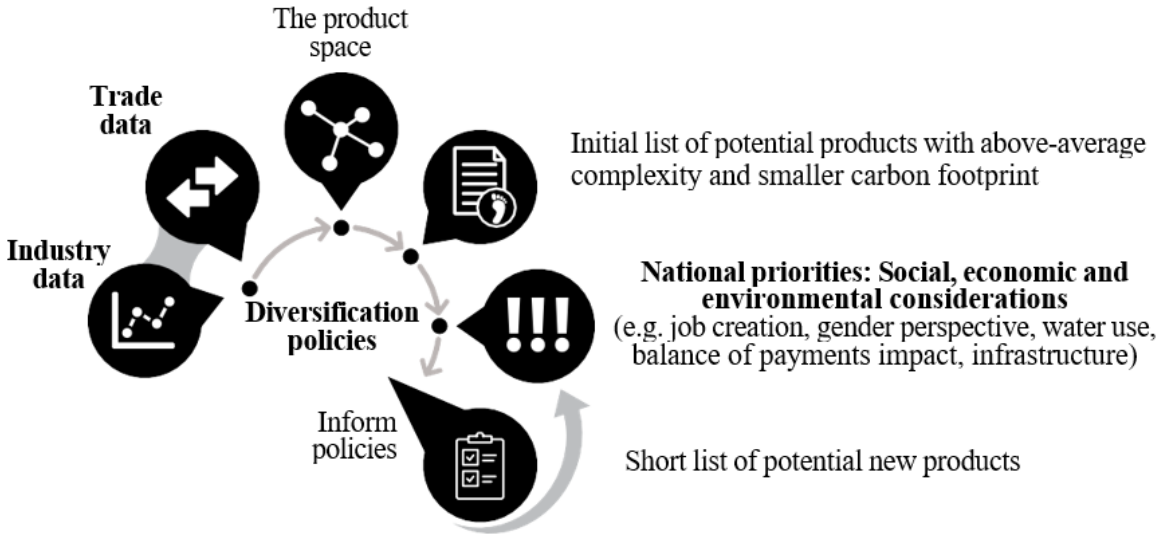
Source: UNCTAD, 2023.
Note: Zero is the global average and 1 is the standard deviation of the distribution.

29. The possibility of diversifying economies along cleaner paths while emulating the production levels of developed countries decreases as countries develop. According to analysis by UNCTAD, once countries reach around 3,000 products in the export basket, the number of potential new products that are greener starts to decrease. Countries above this threshold, such as Brazil, China and South Africa, could therefore focus on innovating instead of emulating, and need to invest further to develop innovation capabilities through research and development and knowledge creation, providing the necessary support for developing new and greener products.

30. The selection of strategy in diversifying towards greener products depends on each particular case. First, countries need to be able to identify more complex and greener

products towards which they can diversify. Since policymakers may have incomplete information and technologies and markets are continually changing, it is crucial to strengthen capacity to assess and analyse potential new sectors and to involve a wide range of stakeholders, both within and outside the Government. For example, different ministries should be included, such as those responsible for science, technology and innovation (STI), trade and education, along with the private sector and civil society organizations (figure 2).

Figure 2
Identification and selection of opportunities for diversification



Source: UNCTAD, 2023.

31. The evaluation requires updated trade and industry data that captures the production and exports of the economy. Governments can then apply approaches, such as growth diagnostics and product space, in evaluations and also take advantage of international resources, such as the UNCTAD catalogue of diversification opportunities, the International Trade Centre Export Potential Map and the Atlas of Economic Complexity.[26] Governments, the private sector and development partners can then consider each potential new product, taking into account social, economic and environmental issues in evaluations regarding the diversification strategy. This interactive process should produce a shortlist of potential products, and needs to be repeated periodically, to consider changes in national production structures and in opportunities in international markets.

32. Countries that aim to develop production capacity in new sectors need to establish infant industry protection policies, to enable entrant firms to reach the levels of productivity required to compete with more technologically advanced countries. As the industry becomes more competitive, protection policies can be phased out in order that competition and market incentives can guide further productivity increases. To foster green technologies, Governments can also take measures such as establishing clusters of industries, starting pilot and demonstration projects and setting out technology road maps.

[26] See https://unctad.org/publication/catalogue-diversification-opportunities-2022; https://exportpotential.intracen.org/en/; and https://atlas.cid.harvard.edu/.
Note: Growth diagnostics is a methodology for identifying the binding constraints to growth, which is key in the formulation of growth strategies. Product space is a network representation of the similarity between products traded in the global market in terms of the technology required for their production, use of which helps in the identification of potential new products for economic diversification based on current productive capabilities. See https://growthlab.cid.harvard.edu/policy-area/growth-diagnostics and https://growthlab.cid.harvard.edu/policy-area/product-space.

33. Participating in global value chains offers opportunities to diversify by producing and exporting new products or upgrading existing outputs. Policies to promote greater integration into global value chains include improving transportation infrastructure, supporting trade and trade facilitation, lowering tariff and non-tariff barriers, particularly for intermediate goods, and lowering barriers to trade in services. Other more general policies not targeted to particular industries or products may improve productivity and insertion into global value chains, such as investing in basic and dedicated education, fostering university and industry linkages and reforming intellectual property laws and patent processes.[27]

IV. The role of national policies and international collaboration

34. In addition to the measures discussed in the previous chapters, national policies are key in order to ensure the better placement of countries for seizing opportunities from the green revolution, regardless of which pathways are selected.

35. In general, Governments should ensure the alignment of measures in different areas, including environmental, industrial, energy-related and STI-related policies, to ensure that competing priorities do not hinder efforts to develop green technologies. In addition, they should take measures to enhance preconditions and better position the country to take advantage of green windows of opportunity. Governments need to enhance infrastructure and capabilities through public and private investment, and improve labour skills through training programmes and educational measures. Policies can also foster the growth of emerging sectors. New sectors require infant industry protection, to incentivize domestic demand and shield them from excessive competition before they reach economies of scale and greater efficiency in production processes. Finally, as noted, ensuring sufficient funding, required to develop green sectors, is often challenging, especially in developing countries. Governments can mobilize funds through development banks and other sources and take measures to attract greater foreign direct investment.

36. The involvement of the private sector is important in this endeavour. The private sector needs to be engaged and incentivized in developing new sectors and greener production processes. Governments and other stakeholders should, in this regard, make clear the potential gains involved through demonstration projects. Moreover, to identify and assess potential sectors, Governments and the private sector should exchange information, including with other relevant actors, in order to make a correct assessment of current capabilities and demands.

37. The success of national policies depends on international cooperation, and the international community plays a crucial role in supporting developing countries in building local innovation capabilities and marshalling the necessary technologies. Developing countries often lack preconditions such as infrastructure and an effective sectoral system in order to open green windows of opportunity. In addition, there is a widening gap between the Global North and the Global South in green innovation, as indicated by numerous STI-related indicators. The concentration of knowledge creation is a concern because the narrow research paradigms that reproduce the cultural perspectives and priorities of the Global North can keep the Global South marginalized.[28] International cooperation could help change this situation and support developing countries in leveraging green technologies to diversify their economies in a sustainable manner.

38. First, official development assistance (ODA) targeting STI capacities and green technologies, as well as more international funding sources, can help ease financial constraints in developing countries. Since the adoption of the Paris Agreement under the United Nations Framework Convention on Climate Change, most countries have increased climate-change–related green ODA, but the level remains insufficient. The goal of achieving net zero emissions by 2050 requires around $4 trillion in annual investment in

[27] UNCTAD, 2018, Climate Policies, Economic Diversification and Trade (United Nations publication, New York and Geneva).

[28] UNCTAD, 2023.

clean energy. At present, however, $520 billion is available for climate finance per year, with only a quarter of this amount provided for developing countries. The main instrument of climate-related public finance in developing countries is ODA, serving to show the urgent need to increase amounts. The absolute value of climate-related ODA commitments has increased, but remains far below the level of $100 billion per year by 2020 to be mobilized under the Paris Agreement. The amount of ODA supporting STI capacities is particularly in need of expansion; only around 2 per cent of total ODA is designated for STI capacities.[29]

39. Second, the diffusion and transfer of green technologies often happen through international trade; stronger cooperation in this regard could therefore help promote sustainable production. The conditions for the international trade of the production and consumption of green technology-related products plays a significant role. Trade rules should allow developing countries to protect infant green industries through tariffs, subsidies and public procurement. Doing so can helps meet local demand and also enable economies of scale that make exports more competitive. However, trade rules could be reviewed to make them more consistent with the Paris Agreement. To support innovation for cleaner and more productive production, developed countries could open markets to production from latecomer economies. A pilot project could involve an international programme of a guaranteed purchase of tradable green items, such as the products, parts and components used for renewable energy technologies.

40. Third, the international community should work to align the international framework applicable to intellectual property rights with the principle of common but differentiated responsibilities and respective capabilities under the United Nations Framework Convention on Climate Change. A less-stringent intellectual property rights regime at the global level would increase opportunities for less technologically advanced countries to take advantage of green technologies for development. Flexibilities under the Agreement on Trade-Related Aspects of Intellectual Property Rights should be given for environmentally-sound technologies, to make the trade regime more consistent with climate change agreements.[30] The principle that sustainable development should take precedence over commercial objectives was demonstrated during the pandemic.

41. Fourth, global efforts should be put in place to accelerate the development and deployment of green technologies under the philosophy of common contributions to common goods.[31] The Intergovernmental Panel on Climate Change is a model of this approach, along with the processes leading up to the adoption of the Paris Agreement and the 2030 Agenda for Sustainable Development. In addition, governance mechanisms need to be put in place to avoid North–South divide in knowledge management and to ensure that the views and priorities of developing countries are fully considered. Partners for green technology exist and there are successful examples with results shared among all participating countries, particularly in the natural sciences, including the European Organization for Nuclear Research, the International Thermonuclear Experimental Reactor and the Square Kilometre Array Observatory. Similar collaborations can also shape international cooperation on green innovation that equitably incorporates the views and priorities of developing countries.[32]

42. Fifth, STI is a critical driver of economic growth and development globally. However, countries with different levels of socioeconomic development and ecological conditions have diverse priorities with regard to research and development agendas. The international community could address such priority differences by shifting the focus of

[29] Ibid.

[30] World Trade Organization, 2013, Contribution of intellectual property to facilitating the transfer of environmentally rational technology, Communication from Ecuador, IP/C/W/585, Geneva, 27 February.

[31] Pandey N, De Coninck H and Sagar AD, 2022, Beyond technology transfer: Innovation cooperation to advance sustainable development in developing countries, Wires Energy and Environment, 11(2):1–25.

[32] Blicharska M, Smithers RJ, Kuchler M and Agrawal GK, 2017, Steps to overcome the North–South divide in research relevant to climate change policy and practice, Nature Climate Change, 7(1):21–27.

green innovation from the national to the multinational level. Multilateral research based on open innovation, with results made available to global knowledge communities, can help achieve this goal. The Consultative Group on International Agricultural Research is a useful model in this regard. Multilateral research can cover an entire value chain or focus on particular areas. For example, research institutions could bring products or processes close to technology maturity and invite private companies to handle rapid deployment.

43. Sixth, each country has unique needs, priorities and concerns with regard to technology. To date, technologies have been assessed from the perspective of developed countries or emerging economies, omitting many developing countries. UNCTAD is carrying out pilot projects in three countries in Africa to help build capacity for technology assessment.[33] However, a more general multilateral system is needed to assess new technologies based on opportunities and risks for different countries, and can also support developing countries in using such technologies effectively.[34]

44. Seventh, researchers and investors in developing countries often lack incentives to cooperate with regional peers and are more likely to be part of projects with developed countries. This leaves small and vulnerable countries with limited domestic markets, making it difficult to attract local or international investment in green innovation. In addition, cooperation among countries in the same region, even on shared issues, is often limited. More technologically advanced developing countries can lead the way in promoting regional and South–South cooperation on green innovation. Developed countries can support regional centres of excellence for green technologies and innovation, such as the Southern African Science Service Centre for Climate Change and Adaptive Land Management.

45. Finally, successful innovation systems create multiple incentives for companies and entrepreneurs to develop their ideas and put them into practice. However, most developing countries lack the financial or management capacities to develop similar incentives. To address this challenge, UNCTAD, in *Technology and Innovation Report 2023*, proposes a multilateral challenge fund that would mobilize creative thinking and stimulate innovations that could respond to many global challenges, which could be funded by international organizations, donors and philanthropic organizations. The next step would be to design a global green innovation competition, to assess projects based on criteria that incorporate North–South and South–South STI-related cooperation for green innovation, in order to encourage innovative solutions that promote sustainable development and support countries in achieving their national priorities.

V. Questions for discussion

46. Delegates at the tenth session of the Multi-year Expert Meeting on Investment, Innovation and Entrepreneurship for Productive Capacity-building and Sustainable Development may wish to consider the following issues:

(a) What are the key factors in promoting catch-up with green innovations? How should countries formulate strategies considering their respective targeted sectors and current socioeconomic structures and national innovation systems?

(b) What are the main barriers that hinder developing countries from adopting green technologies and harnessing their potential with regard to renewable energy?

(c) What policies have been successfully employed to develop domestic renewable energy industries? How can such policies be adapted to specific sectors and local contexts, especially in developing countries with lower levels of productive capabilities?

[33] See https://unctad.org/project/technology-assessment-energy-and-agricultural-sectors-africa-accelerate-progress-science.

[34] Stamm A, 2022, North–South divide in research and innovation and the challenges of global technology assessment: The case of smart technologies in agriculture, in Kurz HD, Schütz M, Strohmaier R and Zilian SS, eds., The Routledge Handbook of Smart Technologies (Routledge, London):555–571.

(d) What are the key challenges and opportunities for developing countries in leveraging technologies to green and move up global value chains, as well as to diversify towards more complex and greener sectors?

(e) How can Governments, the private sector, academia, civil society organizations and other stakeholders contribute to supporting the greening of global value chains and sustainable economic diversification?

(f) What are the major challenges that developing countries face when implementing national policies for sustainable economic diversification and how can the international community help address such challenges?

(g) What are the key mechanisms in strengthening financial and technical support, to empower developing countries to diversify production in a sustainable manner? In particular, how can technology transfer be facilitated and multilateral research collaboration be strengthened, to promote the deployment and development of green technologies?

(h) How can international trade rules and intellectual property rights be made more consistent with international climate change agreements, to support less technologically advanced developing countries in building cleaner and more productive sectors?