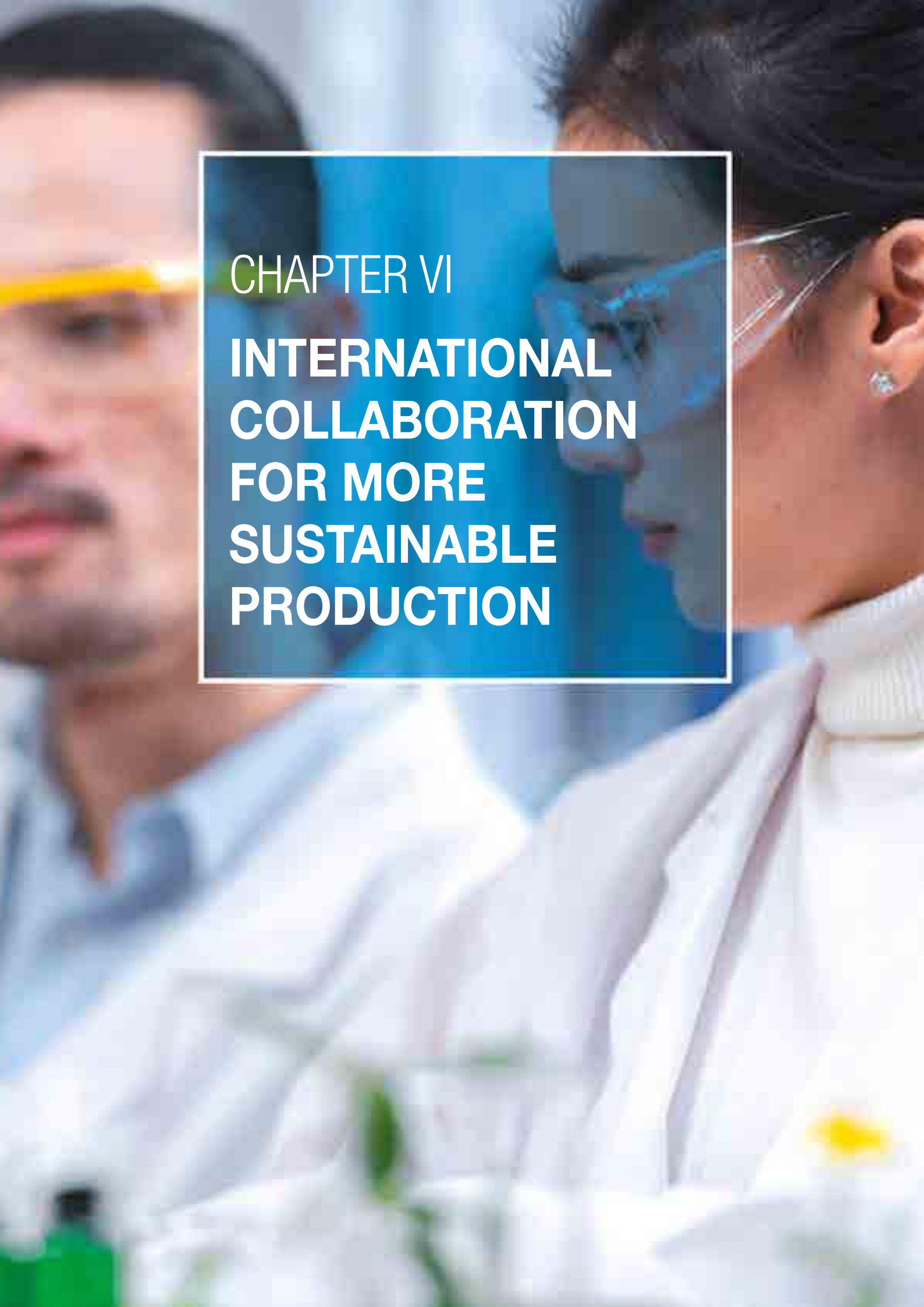
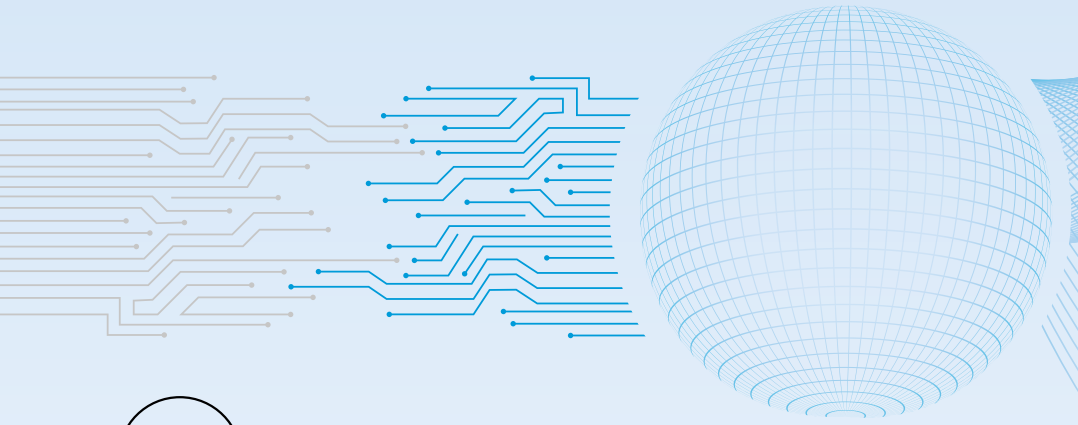


CHAPTER VI

INTERNATIONAL COLLABORATION FOR MORE SUSTAINABLE PRODUCTION

Developing countries may not, on their own, take advantage of green windows of opportunities. International cooperation and improving the consistency of the trading system with the Paris Agreement are critical



Priorities for opening green windows:

1 Set the direction:

- Aligning environmental, STI and industrial policies
- Investing in more complex and greener sectors
- Shifting consumer demand to encourage recycling and the circular economy

2 Build green productive and innovative capacities:

- Investing in nascent green technologies
- Raising awareness of green technologies
- Building required digital infrastructure and skills

Action lines to foster international cooperation for green innovation:

1. Align trade with the Paris Agreement
2. Reform international protection of IPRs for less technologically advanced countries
3. A more partnership-oriented approach to green technology development
4. Shifting research for green innovations from the national to the multilateral level, including open innovation approaches
5. Multilateral approaches to technology assessment
6. Support South-South STI cooperation for green innovation
7. A multilateral challenge fund “Innovations for Our Common Future”

The least technologically able countries lack many preconditions for seizing green opportunities, such as effective sectoral innovation systems, the required digital infrastructure, or adequate finance. These countries may thus depend on the support of the international community – through an enhanced architecture that facilitates sustainable global growth.[1] At present, however, there is little international cooperation for green innovation.

Innovation will require novel business models, new approaches to financing, and policy innovations within national and global institutions.[2] As developing countries' technological needs and capabilities change and international political and economic landscapes shift, support for innovation also has to evolve.[3]

This support should be based on equitable partnerships to build local innovation capabilities and marshal the necessary technologies. Collaboration can promote access to green technologies for climate change mitigation and adaptation, human resource development, and building local capacity.[4] Such technology transfer can facilitate the enhancement of national capabilities, adding to the accumulation of knowledge necessary for countries to promote the structural change of the economy. [5]

Effective innovation transfer not only offers capital goods and equipment, but it also enables people to develop the skills needed to operate and maintain the equipment (know-how) and understand why it is running (know-why).[6] These capabilities are essential for green technologies, which typically need adaptation to specific conditions on the ground. Enabling and empowering developing countries to take advantage of green windows of opportunities and build national innovation systems thus requires broad and comprehensive international cooperation strategies.

A. COOPERATING FOR GREEN INNOVATION

1. A WIDENING NORTH-SOUTH DIVIDE

The gap between developed and developing countries is evident in the expenditure on research and development (R&D). Many countries in the European Union reach R&D expenditure of 3 per cent of GDP, while the top global performers, such as Israel and the Republic of Korea, invest around 5 per cent (Table VI-1). For developing countries, the proportions are far lower. Only a few are around 1 per cent, such as Brazil, Egypt, Thailand and Türkiye, while others, such as South Africa and Viet Nam, range between 0.5 and 1 per cent. Mexico and Colombia invest around 0.3 per cent. The average for the lower middle-income countries is 0.53 per cent.

Table VI 1
R&D expenditure, selected countries and regions (percentage of GDP)

	2013	Latest
World	1.99	2.63 (2020)
Lower Middle-Income Countries	0.44	0.53 (2017)
High-Income Countries	2.40	2.97 (2020)
Colombia	0.26	0.29 (2020)
China	2.00	2.40 (2020)
Brazil	1.20	1.20 (2019)
Egypt	0.64	0.96 (2020)
European Union	2.10	2.32 (2020)
Israel	4.07	5.43 (2020)

Japan	3.28	3.26 (2020)
Mexico	0.42	0.30 (2020)
Republic of Korea	3.95	4.81 (2020)
South Africa	0.66	0.62 (2019)
Thailand	0.44	1.14 (2018)
Türkiye	0.81	1.09 (2020)
United States	2.71	3.45 (2020)
Viet Nam	0.37	0.53 (2019)

Source: UNCTAD based on World Development Indicators (accessed in June 2022).

Another concern is that even the relatively advanced developing countries have not increased that expenditure. In Brazil, between 2013 and 2019, R&D expenditure as a percentage of GDP was largely unchanged at 1.2 per cent, while in South Africa, it decreased from 0.66 to 0.62 per cent. Exceptions were Thailand, where between 2013 and 2018, the figure grew from 0.44 to 1.14 per cent, and Egypt, which grew from 0.64 to 0.96 per cent.

Other important indicators of the strengths of national innovation systems are the percentage of researchers per million inhabitants (Table VI-2) and the number of scientific and technical papers published in journals (Table VI-3). This latter table separates China from the statistical group of middle-income countries, as 48 per cent of the total number of publications from that group are from China.

Table VI 2
Researchers in R&D per million inhabitants

	2010	Latest
World	1,279	1,592 (2018)
Middle-Income Countries	650	812 (2018)
High-Income Countries	3,776	4,671 (2019)
Colombia	57 (2013)	88 (2017)
China	885	1,585 (2020)
Brazil	686	888 (2014)
Egypt	492	838 (2020)
European Union	3,092	4,258 (2020)
Japan	5,104	5,455 (2020)
Mexico	337	349 (2020)
Republic of Korea	5,331	8,714 (2020)
South Africa	366	484 (2019)
Thailand	539 (2011)	1,790 (2019)
Türkiye	890	1,775 (2020)
United States	3,883	4,821 (2019)
Viet Nam	679 (2013)	757 (2019)

Source: UNCTAD based on World Development Indicators (accessed in January 2023).

Table VI 3
Scientific and technical journal articles, 2018

Country Group	Absolute number of articles	Articles per million people
Low-Income Countries	5,429	8
Middle-Income Countries (MIC)	1,105,887	192
MIC without China	577,624	133
China	528,263	377
High-Income Countries	1,450,500	1,177

Source: UNCTAD based on World Development Indicators (accessed in December 2022).

Note: The table separates China from the statistical group of middle-income countries, as 48 per cent of the total number of publications from the group are from China.

Even in fields critical for the global South, most of the science is carried out in the North. One analysis found that between 2000 and 2014, for the 93,584 publications on climate change, more than 85 per cent of author affiliations were from OECD countries, less than 10 per cent were from any country in the South, and only 1.1 per cent were from low-income economies.[7] This has the effect of narrowing research paradigms to the cultural settings and perspectives of the global North and of countries mainly in the West, while depriving the scientific community of considerable intellectual capital. Similarly, only 10 per cent of funding for health research is spent in the South, which has 90 per cent of the world's disease burden.[8]

Another important perspective is shown by the number of patents granted for green technologies. [9] These have been increasing, but primarily in the traditional industrial economies and newly industrialized economies (Table VI-4).

Table VI 4
Top green patenting economies - cumulative number of patents, 1975-2017

All patent offices			**USPTO**		
Country	**Patents**	**Percentage of total patents**	**Country**	**Patents**	**Percentage of total patents**
Japan	155,501	18.6	United States	133,219	42.7
China	148,032	17.7	Japan	72,837	23.3
United States	143,145	17.1	Germany	21,464	6.9
Republic of Korea	112,699	13.5	Republic of Korea	19,490	6.3
Germany	94,927	11.4	China, Taiwan Province of	9,441	3.1
France	27,764	3.3	France	7,222	2.3
China, Taiwan Province of	22,389	2.7	China	6,238	2.0
Russian Federation	21,915	2.6	Canada	6,191	2.0
United Kingdom	12,813	1.5	United Kingdom	5,249	1.7
Canada	9,477	1.1	Sweden	3,135	1.0

Source: Corrocher and Morrison, 2020

China has had a very fast take-off in green patenting, mostly since 2000. From 1975 to 2017, more than 6,200 patents granted in the United States Patent Office (USPTO) were to inventors from China – two per cent of all patents.[10] This is a remarkable result, given that relatively few patents had been granted in the previous 25 years. None of the other emerging economies has registered many patents and the gap with the industrialized world does not seem to be narrowing. Between 1980 and 2009, only 1 per cent of all international patents in clean energy were filed in Africa, and 85 per cent of these came from South Africa.[11] In the majority of Lower Middle-Income Countries and Low-Income Countries, patenting activities are hardly measurable.

Table VI 5

Green patents from emerging countries (number of patents and per cent of total)

All patent offices			USPTO		
Country	**Number**	**Percentage**	**Country**	**Number**	**Percentage**
China	148,032	17.70	**China**	6,238	2.00
Russian Federation	21,915	2.62	**India**	1,003	0.32
Brazil	4,676	0.56	**Brazil**	277	0.09
India	1,663	0.20	**Russian Federation**	273	0.09
Mexico	1,130	0.14	**Mexico**	209	0.07
Türkiye	875	0.10	**South Africa**	202	0.06
South Africa	437	0.05	**Türkiye**	79	0.03
Argentina	363	0.04	**Argentina**	75	0.02
Chile	267	0.03	**Chile**	66	0.02
Egypt	97	0.01	**Egypt**	21	0.01
Indonesia	35	0.00	**Indonesia**	9	0.00

Source: Corrocher and Morrison, 2020.

2. ODA FOR GREEN INNOVATION

Following the Paris Agreement of 2015, most countries have increased their climate-change-related, green official development assistance (ODA). [12] In 2016/2017, many large international donors committed at least 40 per cent of their development assistance as green ODA (Table VI-6). Nevertheless, ODA directed to green innovation urgently needs to increase.

Table VI 6

Green ODA as a percentage of all ODA in leading donor countries (2016/2017)

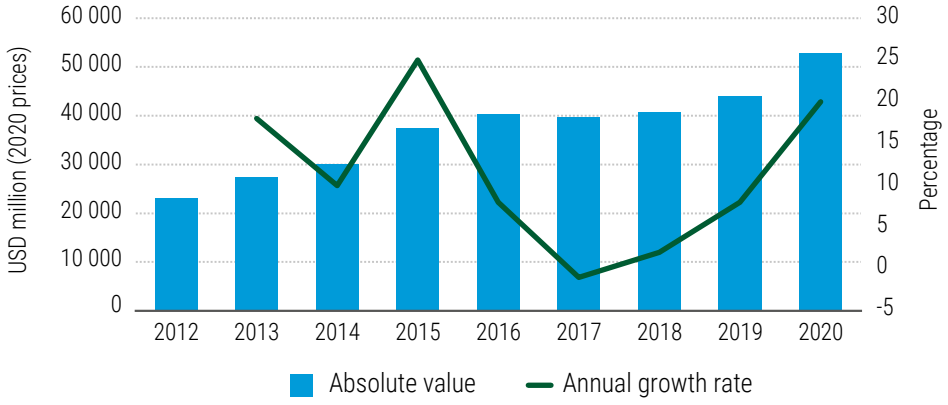
Country	Percentage
Canada	41
EU institutions	34
France	67
Germany	42
Japan	48
Sweden	47
United Kingdom	42
Republic of Korea	9
United States	7

Source: UNCTAD based on Rijsberman (2021).

In general, climate finance is still falling far short. Reaching net zero by 2050 will require around $4 trillion in annual investment in clean energy by 2030.[13] At present, only around $520 billion is available for climate finance per year, and only about $130 billion of this is being spent in developing countries.[14]

The primary instrument of public climate finance for developing countries is ODA.[15] Between 2012 and 2020, as reported by bilateral donors, the absolute value of climate-related ODA increased from $23.2 billion to $52.9 billion (Figure VI-1).[16] However, this falls short of the Paris Agreement pledge of $100 billion per year by 2020. It should also be noted that this reflects commitments, not disbursements which are typically considerably less.

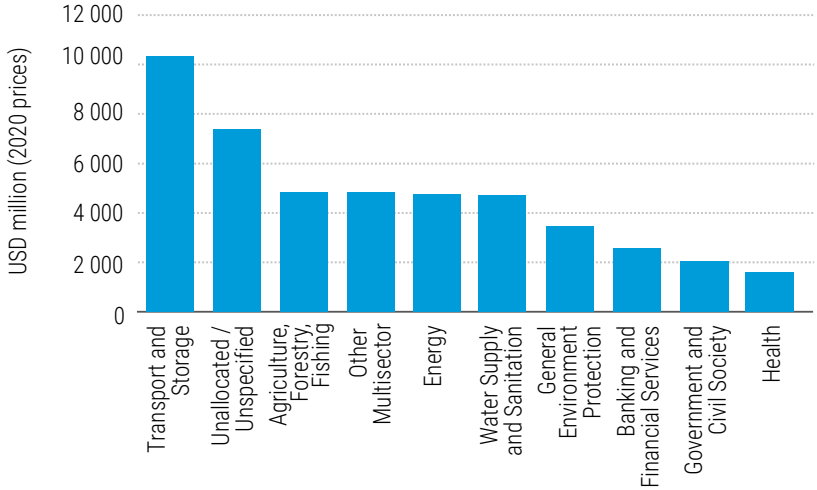
Figure VI 1
Changes in climate-related ODA 2012-2020



Source: UNCTAD based on data from OECD.[17]
Note: The values include both bilateral and imputed multilateral development finance.

Figure VI-2 shows that the sectors that attracted green ODA the most in 2020 were transport and storage, and agriculture, forestry, and fisheries. Of this, 51 per cent was in the form of grants, and 45 per cent in debt instruments.

Figure VI 2
Top ten sectors in 2020 (bilateral provider perspective)

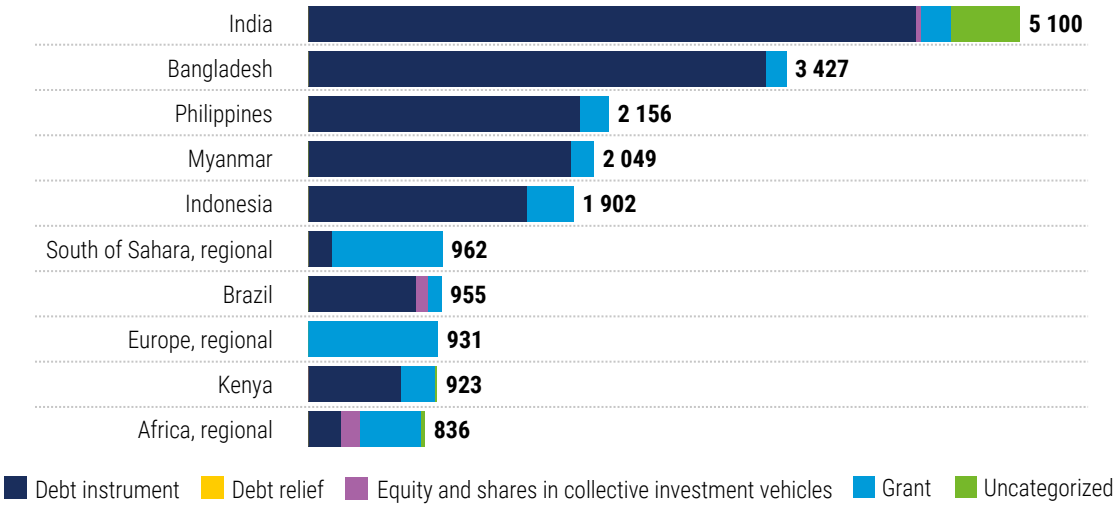


Notes: Values refer to commitments and are expressed in $ million, 2020 constant prices. Unallocated/unspecified are largely imputed values. Imputed multilateral contributions are calculated by estimating, per international organisation, the climate-related share within its portfolio and attributing it back to bilateral providers, based on their core contributions (disbursements) to the organisation in a given year, it is an approximation.[18]
Source: UNCTAD based on data from OECD.[19]

Of total green ODA, 41 per cent went to Asia, and 25 per cent to Africa (Figure VI-3). One concern is the use of debt instruments which appears to be highest, surprisingly, in the lower middle-income countries, at 75 per cent, followed by upper-middle-income countries – at 67 per cent. Other low-income countries received ODA solely through grants, though in far lower amounts (Figure VI-4).

Figure VI 3

Financial instrument by the top ten recipients in 2020 ($ millions, 2020 prices)

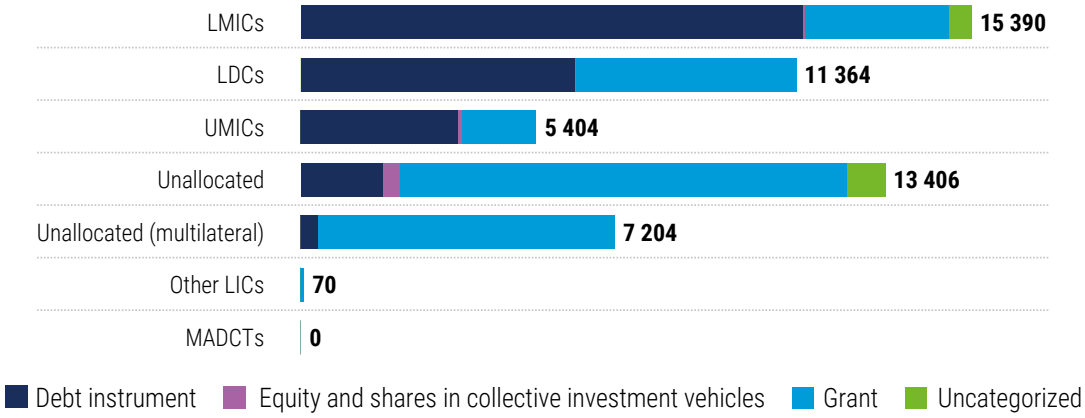


Notes: As reported by bilateral donors. Imputed multilateral contributions and financial flows from non-DAC members not included.

Source: UNCTAD based on data from OECD.[20]

Figure VI 4

Financial instrument by income group of recipients in 2020, $ millions, 2020 prices



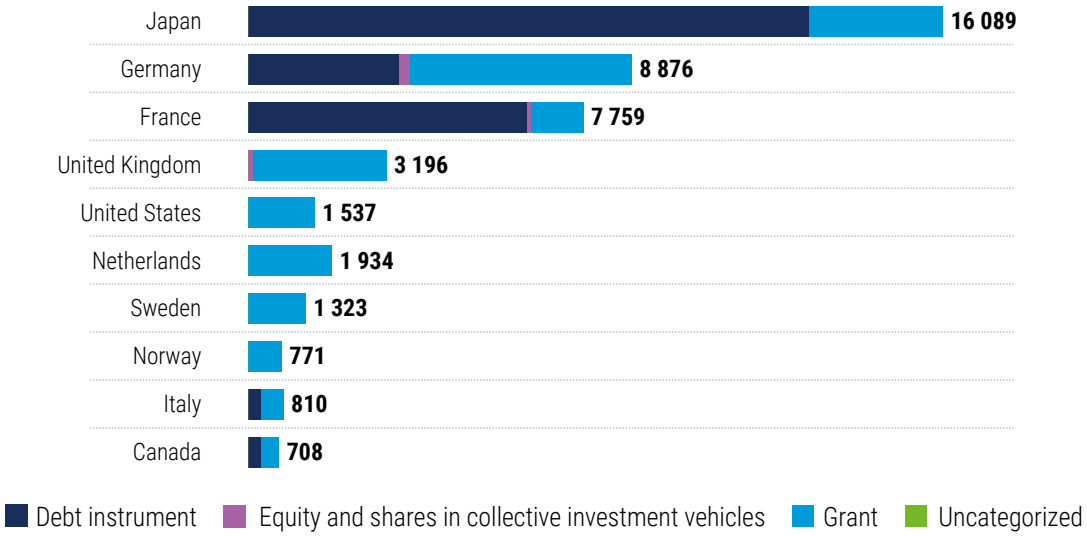
Note: Notes: As reported by bilateral donors. Imputed multilateral contributions and financial flows from non-DAC members not included.

Source: UNCTAD based on data from OECD.21

The three largest donors of green ODA in 2020 were Japan, Germany, and France (Figure VI-5). Between 2019 and 2020, the commitment from Japan doubled while that of France increased by 40 per cent.[22] There are, however, differences between these countries. From Germany, 58 per cent of green ODA took the form of grants, while the other two countries primarily gave support as debt instruments, which represented 81 per cent and 83 per cent of Japanese and French ODA, respectively.[23]

Figure VI 5

Top ten providers of green ODA and used financial instruments in 2020, $ millions, 2020 prices



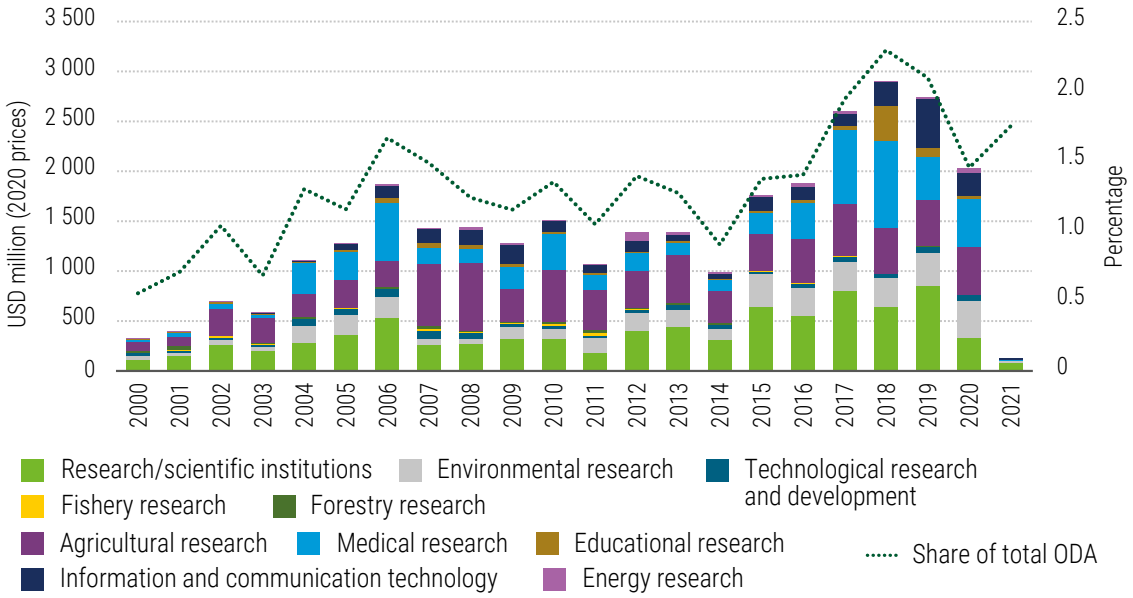
Notes: As reported by bilateral donors.

Source: UNCTAD based on data from OECD.[24]

In the European Union, the backbone of recovery and of the green growth strategy is the EU Green Deal. As a proportion of total ODA, some European countries are arguing that green ODA, for both environment and climate finance combined, should rise from 30 to 50 per cent.[25] In October 2021, the OECD Development Assistance Committee (DAC) adopted a new approach to align development cooperation with the Paris Agreement on Climate Change.

Only around 2 per cent of total ODA is for STI capacities, and even that proportion has been fluctuating (Figure VI-6). The greatest growth, though from quite low values, has been for environmental and medical research and ICT. In 2020, of total ODA targeting STI capacities, 24 per cent was for medical research and 16 per cent went to research/scientific institutions, at $327 million, though this represents a significant decline. Additionally, the share of ODA targeting specifically technological research and development of total ODA for STI fell from 11 to 3 per cent in from 2000 to 2020, though increasing in absolute value (see Figure VI-6 and Figure VI-7).

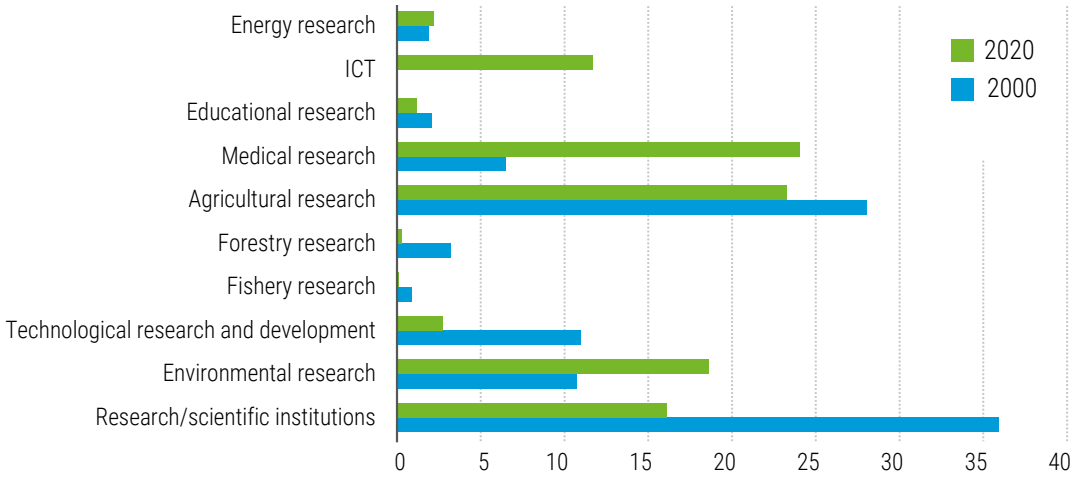
Figure VI 6
ODA for STI by sector, 2000–2021



Notes: 2021 values are projections. Technological research and development, fishery research, forestry research, and ICT do not yet have values for 2021. The series for ICT starts in 2003.

Source: UNCTAD based on data from OECD.[26]

Figure VI 7
ODA by STI category as percentage of total ODA for STI, 2000 and 2020

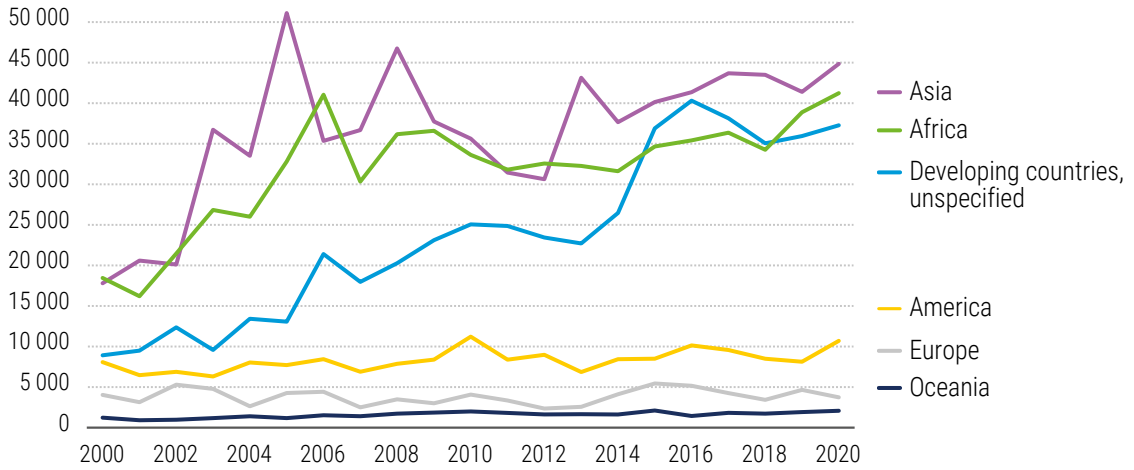


Notes: The series for information and communication technology starts in 2003.

Source: UNCTAD based on data from OECD. [27]

The growth in ODA for STI capacities has been greatest in Asia and Africa, in both percentage and absolute terms (Figure VI-8).[28] Countries in the Americas and Oceania had modest growth.

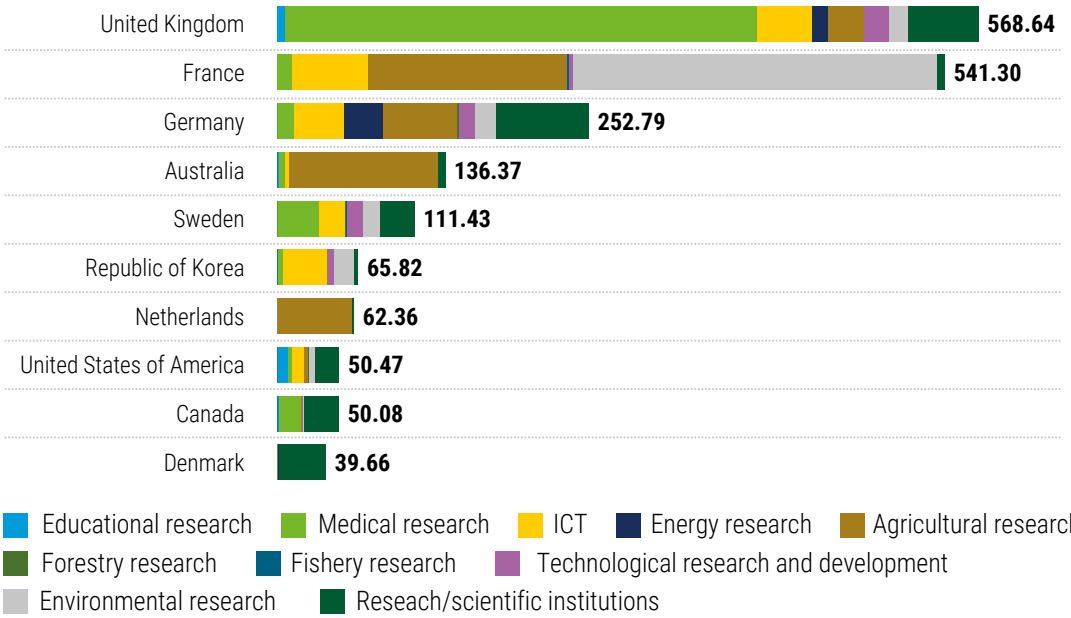
Figure VI 8
Total ODA for STI per region ($ million, 2020 prices)



Source: UNCTAD based on data from OECD.[29]

Most ODA for STI capacities comes from bilateral DAC members – United Kingdom, France, Germany, Australia, Sweden, the Republic of Korea, the Netherlands, the United States, Canada, and Denmark (Figure VI-9).[30] Each, however, has different priorities. In 2020 most of the assistance from the United Kingdom was medical research, while France concentrated more on environmental research, Germany on research/scientific institutions, and Australia on agricultural research.

Figure VI 9
Top 10 donor countries of ODA targeting STI capacities in 2020, $millions, 2020 prices)



Source: UNCTAD based on data from OECD.[31]

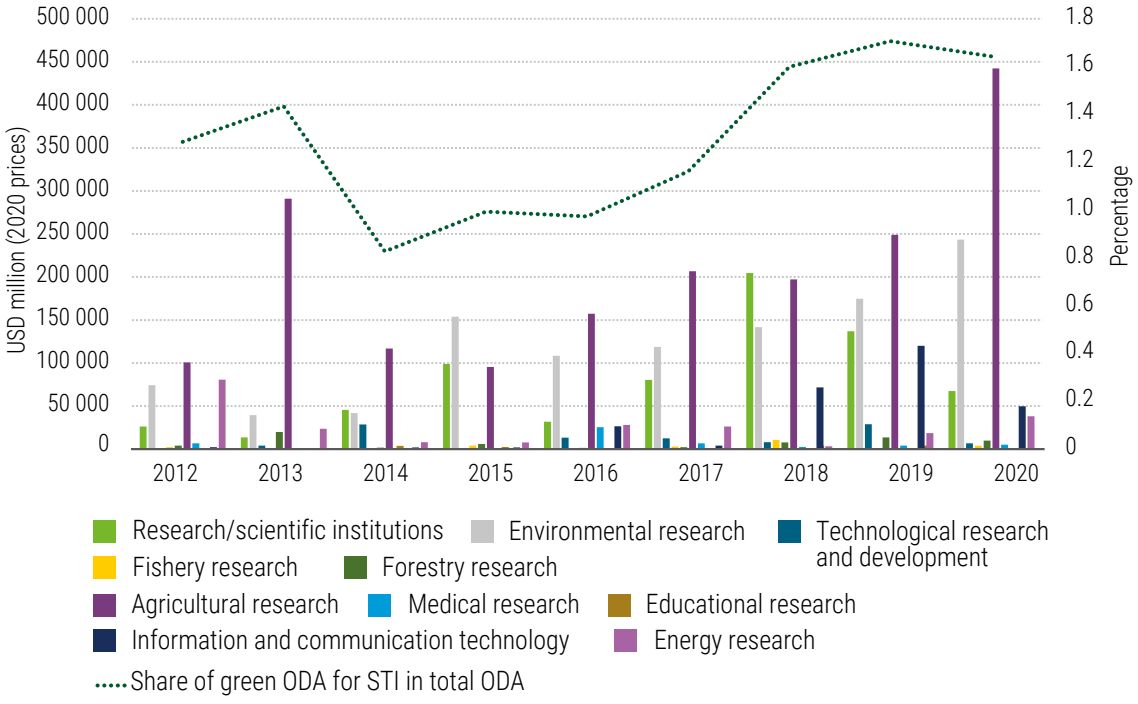
The priorities set for their STI support vary significantly between donors:

- *The United States* – Support from the largest donor is mostly aimed at research, capacity building and innovative approaches to fight the spread of infectious and tropical diseases and prevent maternal and child deaths.
- *The United Kingdom* – In 2013, the United Kingdom pledged to provide 0.7 per cent of its gross national income (GNI) as ODA, and subsequently established new research funds for challenges faced by developing countries – the Newton Fund, the Ross Fund, and the Global Challenges Research Fund which also aim to allow developing countries to take advantage of the high-quality research conducted in the United Kingdom.
- *Sweden* – The research co-operation programme strengthens developing countries' research capacity and finances research projects. The Government's Strategy for research cooperation and research in development cooperation 2015-2021 aims to carry out research on poverty reduction and sustainable development, primarily in low-income countries and regions.
- *Canada* – International STI cooperation is primarily through the Ottawa-based International Research Centre (IDRC), which invests in high-quality research in developing countries, shares knowledge with researchers and policymakers for greater uptake and use, and mobilizes global alliances.
- *Germany* – The country has a long tradition of supporting the technical and vocational education and training systems that can pave the way for green technologies in businesses and societies. In addition, organizations such as the German Academic Exchange Service and Alexander von Humboldt Stiftung provide scholarships for students from developing countries at the postgraduate and post-doctorate levels.

Both the absolute value and the share of green ODA targeting STI capacities as a percentage of total green ODA have been increasing but the absolute values remain low (Figure VI-10).

Figure VI 10

Green ODA targeting STI capacities, 2012-2020 ($ million, 2020 prices)



Source: UNCTAD based on data from OECD.[32]

If developing countries are to achieve the transition to renewable energy sources and low-emission development, they will need more ODA – an issue they are increasing raising in international negotiations. Mongolia for example has committed to increasing its emissions reduction goal by 2030 from 22.7 to 27.2 per cent – if it receives assistance with carbon capture and storage and waste-to-energy technologies.[33] Similarly, Thailand has promised to raise its emissions reduction target from 20 to 25 per cent – if it gets greater access to technology and more financial and capacity-building support.[34]

3. UNITED NATIONS SUPPORT FOR TECHNOLOGY TRANSFER

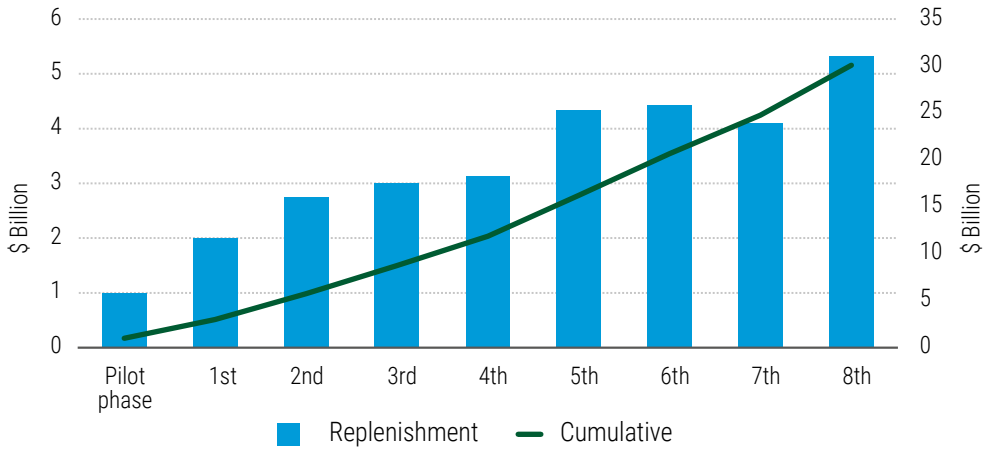
The largest public-sector funding source for transferring environmentally sound technologies (ESTs) is the Global Environment Facility (GEF). Since 1991, financial contributions by donor countries to the several GEF-related trust funds administered by the World Bank have amounted to over $30 billion.[35] The primary source of GEF grants is the GEF Trust Fund.[36]

The GEF supports innovation and technology transfer at critical early and middle stages, focusing on the demonstration and early deployment of innovative options. Its addresses elevated risks associated with innovation, mitigating the barriers of technology transfer and piloting promising approaches.

Since its inception, the GEF has allocated more than $22 billion in grants and blended finance, and mobilized $120 billion in co-financing, for more than 5,000 projects in 170 countries, supplemented by 27,000 community-led initiatives through a Small Grants Programme.[37]

GEF is funded by donor countries and finalized its eighth replenishment in 2022, with 29 donor governments pledging $5.33 billion for the period 2022-2026 – a fivefold increase since the first replenishment round (Figure VI-11). The GEF 7 supported 131 projects in developing countries, with $590 million for the Climate Change Mitigation focal area that is expected to contribute to aggregate emission reductions of more than 1,543 megatons of CO_2 equivalent.[38]

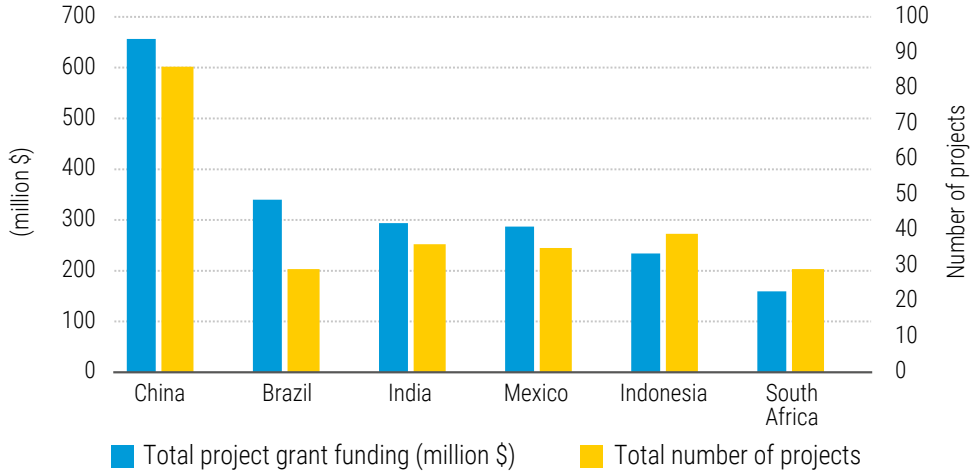
Figure VI 11
Pledge of countries to the GEF of the successive replenishment rounds



Source: UNCTAD based on (Global Environment Facility, 2022).

Since GEF-5, the largest recipient countries of the GEF Trust Fund grants have been China (86 projects, $656 million), Brazil (29 projects, $340 million), India (36 projects, $294 million), Mexico (35 projects, $ 287 million), Indonesia (39 projects, $234 million), and South Africa (29 projects, $160 million) (Figure VI-12). From the pilot phase to GEF7, biodiversity and climate change account for around 25 per cent of the total GEF Trust Fund, while the corresponding share amounts to 10 per cent for international waters, 9 per cent for chemicals and waste and 3 per cent for land degradation.[39]

Figure VI 12
Largest recipients of GEF Trust Fund by number of grants since GEF-5 (2010)



Source: UNCTAD based on (GEFIEO, 2022).

In addition to GEF, within the United Nations System, the UNFCCC has a technology transfer framework covering technology needs and needs assessments, technology information, enabling environments for technology transfer, capacity-building for technology transfer, and mechanisms for technology transfer. Part of this framework is the United Nations Climate Technology Centre and Network (CTCN), which provides technical assistance in response to requests submitted by developing countries via their nationally-selected focal points (Box VI-1). Upon receipt of such requests, the Centre quickly mobilizes its global Network of climate technology experts to design and deliver a customized solution tailored to local needs.

Another United Nations framework for technology transfers is the Addis Ababa Action Agenda (AAAA) which outlines action areas to guide global Financing for Development efforts. The AAAA established the Technology Facilitation Mechanism (TFM) to support the SDGs by encouraging the development, adaptation, dissemination, diffusion and transfer of environmentally sound technologies to developing countries.

In addition, the United Nations system has several programmes to build new capabilities and skills for all national innovation system actors to develop and deploy technologies for greener and more productive production. International cooperation supports tailored programmes supporting countries in their environmental management efforts, including implementing multilateral environmental agreements and providing sustainable energy.

Box VI 1
United Nations Climate Technology Centre and Network (CTCN)

The CTCN delivers five main types of technical support on climate technologies: (1) Technical assessments, including technical expertise and recommendations related to specific technology needs, identification of technologies, technology barriers, technology efficiency, as well as piloting and deployment of technologies; (2) technical support for policy and planning documents, including strategies and policies, roadmaps and action plans, regulations and legal measures; (3) training; (4) tools and methodologies; and (5) implementation plans.

The CTCN does not provide funding directly to countries but instead supports the provision of technical assistance provided by experts on specific climate technology sectors. Technical assistance on climate technologies is provided to developing countries at request, free of charge (with a value up to $250,000), at local, national or regional levels, to academic, public, NGO, or private sector entities, and for a broad range of adaptation and mitigation technologies. Technical assistance is provided at all stages of the technology cycle: from identification of climate technology needs, policy assessment, selection and piloting of technological solutions to assistance for technology customization and widespread deployment.

Source: UNCTAD based on https://www.ctc-n.org/technical-assistance.

B. FOSTERING INTERNATIONAL COOPERATION FOR GREEN INNOVATION

International action for green innovation comes from many sources. It may be the result of businesses seeking greater efficiency and profits, or government action or philanthropy contributing to global public goods. Such fragmentation might be thought to hinder progress but can also be considered an advantage in that it matches the complexity and the scale of what is needed.[40]

Currently, most international support for green innovation relates to specific green products such as energy-efficient transport or fuel-saving improved cooking stoves. Much less is intended to strengthen innovative capacities and national innovation so that developing countries can adapt and adopt green technologies and arrive at their own solutions.

1. ALIGN TRADE WITH THE PARIS AGREEMENT

International trade should be consistent with the Paris Agreement on climate change. Trade rules should, in particular, permit developing countries to protect infant industries so new green sectors can emerge to build cleaner and more productive production. Historically, successful infant industry policies promote new exports so that they cannot just meet local demand but also can reach the necessary economies of scale and provide the proper incentives and discipline to the firms in the infant sector. Governments in developing countries should be able to protect infant industries through selective export subsidies for specific new sectors, local content requirements and tariffs for related imports. There should also be direct and indirect subsidies, investment measures and government procurement that promote domestic products over imported ones. The ability to sequence and manage these interventions is critical to avoid the pitfalls that faced earlier industrial policies in developing countries.[41]

Recent initiatives in developed countries show that these policies are needed even in more technologically advanced countries to build their technological and productive capacities in new sectors that contribute to tackling climate change. For example, in 2022, the United States passed the Inflation Reduction Act, which provides significant funds for climate change mitigation and adaptation, including a $7,500 tax credit for electric vehicles assembled in the United States. [42] Moreover, by 2023, the eligibility criteria of half of these tax credits will require 40 per cent of the minerals of the electric vehicle batteries come from the United States or FTA partners.

While developed economies have the capabilities and economic strength to promote targeted industrial policies for climate action, most developing countries will require the support of the international community. The existential threat of climate change justifies all support for less technologically capable developing countries to build these technological, innovation and productive capacities, including through targeted industrial policies. The Paris Agreement, signed 193 member states and the EU, in articles 9, 10 and 11 enshrines this support for technology development and transfer, capacity building and required finance.[43]

Essential for implementing these Articles is a well-functioning trade system with effective global governance that enables countries to address this pressing global challenge. Current trade rules, however, are not always compatible with the infant industry policies – notably those related to export subsidies and import restrictions. Under WTO rules, governments should design and implement policies that are non-discriminatory among the sources of imported goods and services (most-favoured-nation principle) and between imported and domestic goods and services (and services providers) (national treatment principle). Subsidies should be given only for domestic production, not exports.[44] In the case of agricultural products, subsidies for domestic production are not allowed when they have a distortive effect on trade, unless under prescribed monetary limits as provided for in national schedule (AMS) and under certain allowance. Moreover, developing countries may face additional constraints in WTO+ rules under Regional Trade Agreements like on IPRs.[45]

Previous WTO rules on subsidies used to provide some flexibility. They allowed R&D subsidies and subsidies for regional development and environmental protection, but rules on these subsidies expired in 2000.[46] Article 27 of the Subsidies and Countervailing Measures (SCM) permitted low-income developing

countries to implement export subsidies for a period (eight years from the date of entry into force of the WTO Agreement, in the case of the least developed countries).[47] Although developing countries can still ask for extensions that the WTO Ministerial Conference can approve, the expiry of the initial time limit sets the tone for a less flexible system.

Developed countries have more frequently used the dispute settlement mechanism to raise cases against middle-income developing countries. For example, out of 301 countervailing actions initiated by the United States between 1995 and 2021, 104 were related to measures enacted by China. Other developing countries that cases from the United States refer to are India (39 cases), Türkiye (16), Indonesia (12), Brazil (9) and Viet Nam (8).[48] At the same time, whenever a developing country wins a case against a developed country, its ability to use remedies or retaliate is limited because the developed country often represents a significant export market.[49] Also, the lack of financial resources prevents small developing countries from using dispute settlement mechanisms (DSM).[50]

This pattern is revealed by an analysis of WTO disputes and Subsidies and Countervailing Measures cases (Table VI-7). Developed countries have been the primary users of these mechanisms, raising almost 5 out of every 6 cases. Most cases were against other developed countries or middle-income countries. However, no case was presented against low-income countries.[51] Thus, the current trade regime may constitute a more significant challenge for implementing infant industry policies in middle-income developing countries, not low-income countries.

Table VI 7
Top reporters and exporters in countervailing actions, 1995-2021

Reporting member	Number of cases	Exporters	Number of cases
United States	301	**China**	196
European Union	92	**India**	96
Canada	77	**Republic of Korea**	33
Australia	39	**Indonesia**	30
India	29	**Türkiye**	26
China	17	**United States**	24
Brazil	14	**Viet Nam**	23
South Africa	13	**Thailand**	22
Egypt	12	**Malaysia**	19
Peru	10	**Italy**	16

Note: The total was 651 cases

Source: UNCTAD based on data from https://www.wto.org/english/tratop_e/scm_e/scm_e.htm.

Nevertheless, the WTO has been responding to demands for more sustainable trade. In 2020, 50 WTO members expressed their intention to collaborate, prioritize and advance trade and environmental sustainability discussions through Trade and Environmental Sustainability Structured Discussions (TESSD) between interested WTO Members and dialogues with external stakeholders. In December 2021, WTO members adopted a Ministerial Statement setting out the future work of TESSD agreeing, among other things, to "[i]ntensify [their] work on areas of common interest and to identify concrete actions that participating Members could take individually or collectively to expand opportunities for environmentally sustainable trade in an inclusive and transparent way, consistent with their obligations."[52]

In June 2022, WTO members launched a broader reform process. The intention is to enhance negotiating functions and restore the dispute settlement mechanism, but they could also change the rules in favour of a green transition. In this context, member countries should consider extending the UNFCCC principle of "common but differentiated responsibility and respective capabilities," to trade, investment, and intellectual property rights. This principle could be considered under the mechanism established by the Bali Ministerial Conference to review and analyse the implementation of special and differential treatment provisions through Dedicated Sessions of the Committee on Trade and Development.[53]

Efforts to align trade rules with the Paris Agreement should continue and be strengthened. Some authors have proposed other ways to change the rules to facilitate technological upgrading in developing countries.[54] For example, a rule could be created to require developed countries to meet their commitment of directing 0.7 per cent of their GDP to ODA before they are able to complain against developing countries that use subsidies to promote specific new export sectors. Also, by bringing back the non-actionable subsidies for R&D, regional development and environmental compliance under the now expired SCM.[55]

Meanwhile, countries should continue to seek to develop their infant industries in cleaner sectors under the existing WTO rules. For example, countries with larger domestic markets can implement specific subsidies for production for domestic consumption (since subsidies and local content requirements for exports are prohibited). Thus, these countries could subsidize nascent cleaner sectors focusing on import replacement; for example, for the production of components and parts of domestic solar and wind energy projects. As this production takes root, the capacities for export could be developed with the support of trade facilitation measures. Countries could also provide subsidies through regional development, technological and environmental policies. For example, a policy to promote the establishment of a new regional cluster on green technologies for cleaner production could be framed as WTO-compatible under these rules.[56] Another possible strategy to be followed by developing countries is to subsidize the production of new cleaner sectors and use a stable and competitive exchange rate as an alternative to tariffs. That combination would have the same effect as export subsidies for the priority targeted sectors.[57]

Alternatively, whenever less technologically advanced developing countries identify those rules that prevent their greening efforts, a waiver or some allowance should be explicitly (and more easily) provided by the WTO membership.

The international community should also be innovative and propose new and bold trade mechanisms to support the development of innovation and technological capacity in developing countries for cleaner and more productive production. Any such mechanism should address the supply and demand elements. On the supply side, developed countries can use development assistance to help countries to emulate the production of more advanced countries – to diversify their economies and produce cleaner, more productive and competitive products. On the demand side, developed countries should open their markets to production from latecomer economies.

A challenge that would need to be addressed in such an approach is the identification of products and countries that would benefit from such measures. Some observers point to this identification problem as one of the reasons for the past failure of the WTO efforts on environmental goods and services.[58] Moreover, as seen in Chapter 5, it is possible to find products associated with lower carbon footprints in all sectors and at very disaggregated levels, from primary products to manufacturing. Thus, designing rules that identify these products is challenging, particularly if they rely on government self-assessment. Similarly, the level of technological capacity of a country requires a sophisticated methodology to be assessed. This suggests that a new institutional arrangement would be required at the international level to generate the information to be used in the stipulation of trade rules.

A possible arrangement to pilot this approach would be to create an international programme of guaranteed purchase of tradable green products that can be used for energy transition (e.g., products, parts and components used in renewable energy projects). The programme could be set up so that to participate in it, firms from developed and developing countries should partner in an innovation collaboration arrangement to develop the technological and productive capacities of developing country firms. The

programme could match the complexity of products to be purchased to the technological capacity of the developing country, providing a reasonable "challenge" for countries to build their technological and productive capacities. For example, only countries with low technological capacities could participate in the programme producing the less complex products. More technologically advanced developing countries would have to participate in producing more complex products.

2. REFORM INTERNATIONAL PROTECTION OF IPRS FOR LESS TECHNOLOGICALLY ADVANCED COUNTRIES

More stringent international protection of Intellectual property rights (IPRs) reduces the opportunity for firms to reverse engineer and copy the production they try to emulate. Historically, many countries have caught up primarily by copying existing technologies – as happened in the century after the industrial revolution when other countries sought to emulate Britain. It was also evident from the 1960s when Asian countries such as Japan and the Republic of Korea copied from industries in Europe and the United States.[59] Only some way into the catching-up process did they increase their levels of intellectual protection.

Emulation became more difficult as international protection of IPRs was tightened up – especially from 1994, with the WTO Agreement on Trade-Related Aspects of Intellectual Property (TRIPS) (Box VI-2).[60] This set a much higher bar and has no provisions for differential IP regimes for countries at different levels of technological capabilities – the special and differential treatment provisions only relate to time lags in the implementation of the agreement, which are not linked to any objective measures of technological or productive capacities.[61] A less-stringent IPR regime at the global level (which is unlikely) would increase the opportunities for emulation for less technologically advanced countries.[62]

Box VI 2

Selected elements of the Agreement on Trade-Related Aspects of Intellectual Property Rights (TRIPS)

Flexibility and compulsory licenses

TRIPS Article 31: Where the law of a Member allows for other use of the subject matter of a patent without the authorization of the right holder, such use may only be permitted if, before such use, the proposed user has made efforts to obtain authorization from the right holder on reasonable commercial terms and conditions and that such efforts have not been successful within a reasonable time. A Member may waive this requirement in case of a national emergency or other circumstances of extreme urgency or in cases of public non-commercial use. The scope and duration of such use shall be limited to the purpose for which it was authorized. In the case of semi-conductor technology, it shall only be for public non-commercial use or to remedy a practice determined to be anti-competitive after judicial or administrative process. Any such use shall be authorized predominantly for the supply of the domestic market of the Member authorizing such use.

Transitional periods

TRIPS Article 65.2 to 5: A developing country Member was entitled to delay for a further period of four years the date of application of the provisions of the Agreement.

TRIPS Article 66.1: Given the special needs and requirements of least-developed country Members, their economic, financial and administrative constraints, and their need for flexibility to create a viable technological base, such Members shall not be required to apply the provisions of this Agreement for ten years from the date of application. The Council for TRIPS shall, upon duly motivated request by a least developed country Member, accord extensions of this period. In June 2021, the TRIPs Council agreed to extend the LDC transition period to 1 July 2034.[63]

Technology transfer

TRIPS Article 66.2: Developed country Members shall provide incentives to enterprises and institutions in their territories to promote and encourage technology transfer to least-developed country members to enable them to create a sound and viable technological base.

Technical and financial cooperation

TRIPS Article 67: To facilitate the implementation of this Agreement, developed country Members shall provide, on request and on mutually agreed terms and conditions, technical and financial cooperation in favour of developing and least-developed country Members. Such cooperation shall include assistance in the preparation of laws and regulations on the protection and enforcement of intellectual property rights as well as on the prevention of their abuse, and shall include support regarding the establishment or reinforcement of domestic offices and agencies relevant to these matters, including the training of personnel.

Source: UNCTAD based on (WTO, 1994; Cimoli et al., 2009b)

TRIPS Article 66.2 does oblige developed countries to "provide incentives to enterprises and institutions in their territories for the purpose of promoting and encouraging technology transfer to least developed country members in order to enable them to create a sound and viable technological base." However, although developed countries have reported incentives to their firms and institutions to engage in technology transfer not only to the LDCs but also, in some cases, to developing countries in general, compliance with the Article has been low and difficult to enforce.[64]

Considering the imperative to tackle the existential threat of climate change, the international community should align the international protection of IPRs with the principle of "common but differentiated responsibility and respective capabilities" set out in the UNFCCC. Manufacturers in technologically weak and less-diversified countries should be allowed to imitate the production of more technologically advanced economies. [65] The international IPR system should also allow for tailored IP regimes in which governments manage their IP systems to support climate action and their industrial and technological development strategies, balancing IP regimes to address the needs of different sectors and different stages of development.[66]

The principle that the international trade framework should place sustainable development considerations above commercial objectives has already been demonstrated during the COVID-19 crisis. In 2022, the 12th Ministerial Conference of WTO adopted a Ministerial Decision allowing eligible Members until 2027 to produce and supply vaccines without the consent of the patent holder to the extent necessary to address the COVID-19 pandemic. [67] Similarly, the 2022 WTO Ministerial Declaration on Response to the COVID-19 Pandemic and Preparedness for Future Pandemics,[68] recognized "the role of the multilateral trading system in supporting the expansion and diversification of production of essential goods and related services needed in the fight against COVID-19 and future pandemics, including through identifying opportunities and addressing barriers."

Similarly, countries have used existing WTO mechanisms to try to promote consistency of the trade regime with the climate change agreements. In 2013, Ecuador, for example, proposed a series of actions to use flexibilities in the TRIPS Agreement for environmentally-sound technologies for vulnerable developing countries and least developed countries whose effective adoption and dissemination constitute a matter of "public interest" due to the existential threat of climate change (Box VI-3). The proposal received a mixed reaction; it was welcomed by some countries, while others welcomed the debate but not necessarily the proposals.[69]

Box VI 3
2013 proposals by Ecuador to adapt the Trade-Related Aspects of Intellectual Property Rights

The 2013 proposals by Ecuador in a Communication to WTO's Council for Trade-Related Aspects of Intellectual Property Rights were:

- Reaffirmation of the existing flexibilities in the TRIPS Agreement so that Members use them in connection with ESTs, for example through a declaration addressing flexibilities in the TRIPS Agreement, climate change and access to ESTs;
- Initiation of a review of Article 31 of the TRIPS Agreement to determine which of its provisions may excessively restrict access to and dissemination of ESTs, and particularly its paragraph (f) and the need to include provisions on, as the case may be, the transfer of expertise or know-how to implement compulsory licences;
- Evaluation of the regulation of voluntary licensing and the conditions thereof from the standpoint of the most pressing needs of the most vulnerable developing countries in relation to adaptation to and mitigation of climate change;
- Recognition that adaptation to and/or mitigation of the harmful effects of climate change should be assimilated to the concept of "public interest", with the adoption of a provision authorizing exemption from patentability, on a case-by-case basis, for inventions whose exploitation is vital for the diffusion of ESTs needed for adaptation and/or mitigation of climate change;
- Evaluation of Article 33 of the TRIPS Agreement to establish a special reduction in the term of protection for a patent of [X] years in order to facilitate free access to specific patented ESTs for adaptation and/or mitigation of the effects of climate change because of urgent need in the public interest; and
- Inclusion of a mechanism in the TRIPS Agreement to promote open and adaptable technology licensing for results obtained from research into climate change and ESTs financed through public funds.

In the light of the above points, the application of new flexibilities included in the TRIPS Agreement would be understood to be only in favour of the vulnerable developing countries and least developed countries.

Source: WTO documents online (IP/C/W/585).[70]

3. PARTNERS FOR GREEN TECHNOLOGY

Policymakers are keen to guarantee the benefits of green transformations for national companies and workers, and private actors who strive to protect their intellectual capital through patents and royalties. All of which will inhibit the rapid and widespread diffusion of innovation.

International and national governance of green innovation must deal with these tensions and develop partnerships for common public goods.[71] One ground-breaking model for this philosophy is the Intergovernmental Panel on Climate Change (IPCC). Others are the Paris Agreement of 2015 and the agreements for the Sustainable Development Goals, especially SDG 17 "Partnership for the Goals". As nearly all governments have approved the Paris Agreement and SDGs,[72] this should also be a guiding principle for public promotion of green innovations.

There are also successful examples of collective research whose results belong to all participating countries, particularly in natural sciences, including the European Organization for Nuclear Research (CERN), the International Thermonuclear Experimental Reactor (ITER) and the Square Kilometre Array (SKAO) project (Box VI-4). Similar collaborations can also shape international cooperation for green innovations that equitably incorporate the views and priorities of developing countries.[73]

These collaborations can still however, allow for conflicting views and diverging interests. This can be shown by the current discussion about a global transition towards a "green hydrogen economy". The recent debate about the EU energy "taxonomy" made it clear that countries have different views on what clean energy should be the basis for green hydrogen production. For Germany, the term clean energy should be exclusively reserved for renewables such as wind and solar, while France includes nuclear energy among clean energy sources.

Box VI 4
Examples of partnership-oriented approach to research

International Mega-Science collaborations are driven by a common goal. The founding fathers of CERN, for example, stated that "The spirit from the beginning, was that we are not at CERN to profit; we are there to help to achieve the common objective."[74] ITER similarly unites three continents and 35 nations under one ambition to employ fusion power as a large-scale, carbon-free energy source to build a new Sun on earth. That spirit resonates in SKAO international collaboration to demonstrate the scientific and technological feasibility for peaceful purposes. The knowledge obtained is expected to benefit all humankind eventually.

The common goal and scientific spirit are embodied in mandates or mutual agreements. CERN was example, established in 1954 as result of a Convention signed by 12 founding states in 1953.[75] Today it has 23 Member States, bringing together more than 17,500 people working to discover what the universe is made of and how it works. The ITER Agreement was signed in Paris in 2006 and entered fully into force in 2007 after the members' ratification.[76] Similarly, seven countries signed the SKA Observatory Convention in 2019 in Rome.

To avoid undue influence from any particular member, these collaborations, have been established as intergovernmental organizations (IGOs). For example, the ITER Organization enjoys privileges and immunities on the territories of the seven Members. [77] Likewise, founding members of SKAO came together in Rome in 2019 for the signature of the international treaty establishing the IGO that will oversee the delivery of the world's largest radio telescope.[78]

Funding agencies from Member and Non-Member States of CERN are responsible for the financing, construction and operation of experiments. [79] Members of ITER contribute to the project in-kind resources – components, equipment, materials, buildings, and other goods and services and may recommend staff). But they also provide financial contributions to the organization's budget. [80]

Today, global issues such as the energy crisis, scientific quests, climate change, and sustainable development are too complex to be answered by one nation's experts or facilities alone. International large-scale collaborations engender knowledge sharing, innovation, and economic development. Successful collaborations – such as CERN, ITER, and SKAO – leverage international talent to go beyond what can be done and discovered at smaller scales.

Source: UNCTAD.

4. MULTILATERAL AND OPEN INNOVATION

Most global STI efforts are governed by developed countries and generally reflect their priorities – domestic stakeholders define agendas and priorities of research, financing comes from public and private sources in the country, and usually national companies and societal groups are prioritized.[81]

Countries with different levels of socio-economic development and ecological conditions will set diverse priorities in their R&D agendas. For food security, for example, since food availability is no longer an issue in developed countries, R&D in the agricultural sector has declined, middle-income countries have rising populations and increasing incomes and need R&D on agriculture to further boost productivity.[82] Similarly, in energy research, the industrialized countries are primarily interested in decarbonizing grid-connected energy systems while low-income countries in Africa and Southern Asia need easy-to-roll-out renewable-energy-fed mini-grids. And when it comes to green hydrogen, the main focus of the current debate is on hydrogen to decarbonize the steel industry, while the developing countries might prefer to use green hydrogen to produce ammonia as the basis for nitrogen fertilizer.

The international community can address these priority differences by shifting research for green innovation from the national to the multinational level.[83] A useful model is the Consultative Group on International Agricultural Research (CGIAR), which is internationally financed and located mainly in developing countries (Box VI-5). CGIAR is intensively embedded in multi-stakeholder networks and aims to produce common goods and has contributed innovative solutions for a climate-smart, innovative and socially inclusive agriculture. International organizations and donors could adapt the CGIAR model to other sectors.

Multilateral research can cover the whole value chain, or just a part of it. Research institutions could, for example, bring products or processes close to technology maturity and invite private companies to take

care of rapid deployment. Or they might only take concepts to the laboratory stage or early demonstration projects. The aim should be to combine the strengths of multilateral and publicly funded research with the creativity and endeavours of the private sector.

Multilateral research should be based on open innovation – with all the results available to international experts and knowledge communities, all of whom can contribute to the best possible solutions. Many innovators are already producing open-source designs and technologies, but there is no central repository – which hinders access for producers in developing countries.

In this regard, the Economic and Social Council of the United Nations recently adopted resolution 2021/30 which calls for a centralized repository of open-source technical information as a global stock of knowledge.[84] Such a database would require solid support from UN Member States and agencies. UNCTAD has been disseminating the proposals and seeking ways of implementing the resolution.[85]

Box VI 5
Examples of multilateral modes of research and research cooperation

Consultative Group on International Agricultural Research (CGIAR): CGIAR was formally launched in May 1971 by the World Bank and 16 donors, including governments of industrialized countries and other organizations CGIAR has, since then, become a major player for world agricultural research and a reference in terms of how scientific research can help develop agricultural solutions for the poor.[86] CGIAR is the largest global partnership focusing on "agricultural research for development" particularly in developing countries with a vision to create a "world free of poverty, hunger and environmental degradation". It operates globally through its 15 research centres in close association with "hundreds of partners, including national and regional research institutes (NARIs), civil society organizations, academia, development organizations and the private sector".[87] CGIAR's mandate is to contribute to regional or global public goods and, thus, technologies and knowledge generated are in principle freely transferred of shared. [88]

Global Carbon Capture and Storage (CCS) *Institute:* When the Global CCS Institute was launched in 2009 it had 15 governments and more than 40 companies and industry groups as foundation members. By 2010 membership had increased to 263 members, including 26 national governments. The mission of the Global CCS Institute is to accelerate the roll-out of commercial CCS for a low-carbon future. To achieve this objective, a set of CCS demonstration projects shall be rolled out and capacity building and knowledge sharing are crucial. The role of IPR has been intensely discussed since the institute's formation. While on the one hand, IP rights of partners are respected, the goals are 1) to gather and package non-proprietary information on CCS and make it accessible to all stakeholders, 2) to make IP generated through program activities as widely accessible to members as practical and to make IP jointly generated by the Institute and its partners through Institute activities available in reasonable terms to other Institute activities.[89]

International Energy Agency (IEA) Implementing Agreements: The IEA, an intergovernmental organization, acts as an energy policy advisor to its member countries. Through its work, IEA supports their efforts to ensure reliable, affordable and clean energy for their citizens. The triple goals are energy security, economic development and environmental protection.[90] IEA also provides opportunities for exploring alternative energy and conservation sources through long-term cooperation. One important mode of multilateral cooperation is the IEA Implementation Agreements (IA). By IEA rules and regulations, participation in an IA is to be based on equitable sharing of obligations, contributions, rights and benefits. Patents resulting from work within an IA may be filed in countries as appropriate by the inventing participant. Participants may be required not to disclose information related to these patents for a fixed period.

Source: UNCTAD based on Stamm and Figueroa (2012).

5. ASSESSING TECHNOLOGIES

Most technologies have both positive and negative consequences depending on the local context and on how they are used. Artificial intelligence in agriculture, for example, can enable farmers in developing countries to use much less fertilizer and pesticides. But if it is embedded in IT-powered robots for harvesting fruits and vegetables AI can eliminate the jobs of agricultural workers who are often women.[91] Also, how technologies are assessed regarding their opportunities and risks is often related to the specific value systems of a society and the challenges it faces. For example, the CRISPR-CAS genome editing technology can be used to boost agricultural yields but also raises a number of ethical issues.

A 2018 ruling by the EU court of justice made progress in genome editing technologies depending on bureaucratic procedures and, thus, slowed down the innovation process. Therefore, a decision based on normative considerations from one world region potentially has a significant global impact.[92]

Every country needs to be able to assess the benefits and dangers of each technology according to its own needs, priorities and concerns, but to date, technologies have largely been assessed either from the perspective of the developed countries or of emerging economies such as Brazil the Philippines or Türkiye (Box VI-6).

What is needed however is a more general multilateral system for assessing new technologies such as AI and gene-editing – based on the opportunities and risks they offer to different types of country.[93] UNEP, for example, through the Climate Technology Centre & Network (CTCN) conducted a Technology Needs Assessment in Brazil on the use of Industry 4.0 technologies, particularly on how they can help create a circular economy.[94] UNCTAD is currently carrying out pilot projects involving three African countries to build capacity for technology assessment. It could also consider how developing countries can be systematically supported to use such technologies.

Box VI 6
Technology assessment elements in emerging economies

Brazil – The Government is assessing the country's technological capacity through the project "Evaluation of the Technological Needs to the Implementation of the Climate Action Plans in Brazil" (TNA Brazil). It contributes to the national goals of mitigation of greenhouse gases, taking into consideration Brazil's Nationally Determined Contribution and Brazil's strategy for the Green Climate Fund.[95]

Philippines – DOST-National Research Council of the Philippines (NRCP) is investigating alternative energy sources in the Philippines through the The Clean Energy – ALERT (Alternative Energy Research Trends) programme. This programme is expected to lay out how renewable energy can reduce government's costs, bring jobs to the country, create wealth, expand access to energy for the most vulnerable in poor communities, and foster national energy independence.[96]

Türkiye – The Science and Technology Commission was established to anticipate the future technologies and contribute to the country's 2053 net zero emission target. The objective is to foresee future technologies for adaptation and mitigation, and to enable the country to develop its R&D and innovation capacity. With a multidisciplinary holistic approach, the Commission has held more than 40 online meetings with 97 experts from universities, the private sector, NGOs and public institutions. The outcomes are translated into prioritized RDI topics in TÜBİTAK's R&D, and innovation support programmes.

Source: UNCTAD based on contributions from the Governments of Brazil, the Philippines and Türkiye.

6. REGIONAL AND SOUTH-SOUTH STI

Climate change is a global issue; thus, technological innovations to address this threat might increasingly be generated on the transnational or even global level. However, this is not the case. One indicator is the volume of financial resources spent on R&D. The European Union arguably has most ambitious regional integration programme Horizon Europe on which predicted expenditure over the period 2014-2020 will be about 13 billion but this pales in comparison to EU countries' national spending. In 2020, Germany alone invested more than €15 billion in public R&D.[97]

In developing countries, there is even less regional cooperation on STI for sustainable development. Researchers and investors in the poorer countries have little incentive to work with their regional peers and are more likely to enter research projects with developed countries and emerging economies, which can offer access to world-class research and laboratories as well as computing power. In addition, individual researchers, would prefer to publish in internationally refereed journals and cooperate with researchers from well-known universities in the North.[98]

This is also reflected in the level of South-South cooperation in science and technology, which remains limited. On 15 April 2019, the UN General Assembly adopted a resolution recognising the importance of South-South cooperation to achieve the SDGs, calling for greater support to step it up.[99] The document also serves as an international framework of agreed principles covering the topic. It calls for regional mechanisms to share and strengthen successful science, technology and innovation policies and strategies, explore new opportunities, and promote cross-border and interregional coordination and collaboration between initiatives and research in scientific areas.[100] Moreover, there have been several initiatives in South-South cooperation. In 2020, for example, African governments launched the 10-year Science, Technology and Innovation Strategy for Africa (STISA-2024). But overall cooperation has been limited, even in issues such as climate change in which countries in the same region often face similar problems, as in the Caribbean with the rise in sea level or in sub-Saharan Africa (SSA) with changing patterns of precipitation.

The problem is partly that small and poor countries do not have sufficiently interesting home markets to attract local or international investment in the manufacture of goods related to green innovation. To address this issue, donor 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 (SASSCAL) and the West African Science Service Centre on Climate Change and Adapted Land Use.

For many countries the lack of South-South cooperation is being offset by the arrival of China. Between 1990 and 2018, China's share of total imports in sub-Saharan Africa rose from 1.1 to 16.5 per cent. And markets in China and Africa are being brought close together through the infrastructure of the Belt and Road Initiative. Accompanied by a change in China-SSA trade patterns, shifting from imports of products such as footwear and light manufactured to more sophisticated and capital-intensive goods, China is now the most significant source for machines and electronics for the region.[101]

And compared with investment from developed countries China seems to be more effective in promoting technological progress in Africa. [102] This could be because there are smaller technological gaps between enterprises in China and those in Africa which eases the transfer of technology. Moreover, many Chinese investors are very active in transferring technology-related knowledge to their staff in Africa, generally through on-the-job training rather than classroom-type training.[103] This often refers to small Chinese companies operating in Africa's domestic markets.

Nevertheless, the evidence for such technology transfer is limited and mixed.[104] Some studies indicates that Chinese companies are involved in more traditional styles of technology transfer, for smooth implementation of investment projects, when it is cheaper to employ a local contractor than to fly in staff from the home country.[105]

More technologically advanced developing countries should step up and strengthen efforts to promote regional and South-South cooperation for green innovation.

7. A MULTILATERAL CHALLENGE FUND "INNOVATIONS FOR OUR COMMON FUTURE"

Successful innovation systems create multiple incentives for companies and entrepreneurs to develop their own ideas and transfer them to practice. Many industrialised countries use business plan competitions or competition-based incentives for innovation. These inject dynamism to the business sectors and help reconfigure innovation systems. However, most developing countries lack the financial or management capacities to develop similar incentives. In addition, in the spirit of this chapter, innovation challenges should best be implemented, not on the national level, but internationally.

This Report proposes therefore a multilateral challenge fund "Innovations for our common future." The name echoes the 1987 report of the World Commission on Environment and Development (WCED), "Our Common Future", which embraced environment and development as one single issue. Funded by

international organizations donors and international philanthropy, the fund would mobilize creative thinking and stimulate innovations that could respond to many global challenges. The governance mechanism could be similar to the Intergovernmental Panel on Climate Change (IPCC) with its own executive committee, technical support units and with a secretariat.

The next step would be to design a global green innovation competition. It could draw, for instance, on the international donors experienced in this area. The criteria for assessing projects would be the extent to which they incorporate North-South and South-South and Triangular STI cooperation for green innovation.

1 Hultman et al., 2012

2 Hultman et al., 2012, IMF, 2022; WEF, 2022

3 Pandey, Coninck, et al., 2022

4 Khor, 2012

5 UNCTAD, 2014b

6 Kirchherr and Urban, 2018

7 Blicharska et al., 2017

8 Blicharska et al., 2017: 22

9 For a significant period (1975-2017) patents were extracted from a database of the Cooperative Patent Classification (CPC). Green technologies were conceptualized as comprising technologies 1) in climate change mitigation and adaptation and 2) in systems that integrate technologies related to power network operation and ICTs in this area.

10 This office is considered to have very rigorous procedures and, thus, patents granted there can be seen as a "proxy" for quality.

11 EPO, 2013

12 The rather sophisticated methodology of OECD-DAC to collect and disseminate aid data permits to estimate the percentage of ODA addressing international environment goals, written down in Conventions on Climate Change, Biodiversity, Desertification, etc. OECD, 2019.

13 IEA, 2022a

14 *Foreign Affairs*, 2022

15 Michaelowa and Namhata, 2022

16 The OECD's Development Assistance Committee (DAC) monitors ODA flows to developing economies that target the objectives of the Rio Convention on (i) biodiversity, (ii) climate change, and (iii) desertification, besides climate change adaptation, added in 2010. However, reporting Rio markers became mandatory only in 2006, with provider coverage varying across the years.

17 OECD, 2022

18 OECD, 2018b: 4

19 OECD, 2022

20 OECD, 2022

21 OECD, 2022

22 OECD, 2022

23 OECD, 2022

24 OECD, 2022

25 Rijsberman, 2021

26 OECD, 2022

27 OECD, 2022

28 The share of ODA targeting STI capacities as a percentage of total ODA per year has also increased for unspecified developing countries (15.24 per cent in 2000 and 26.65 per cent in 2020, after reaching a peak of 30.12 per cent in 2016).

29 OECD, 2022

30 There are, however, some exceptions. For example, for most years between 2001 and 2020, multilateral ODA constituted the main source of ODA targeting ICT.

31 OECD, 2022

32 OECD, 2022

33 Kosolapova, 2020

34 Ibid.

35 Global Environment Facility, 2022

36 The GEF also administers the Least Developed Countries Fund (LDCF), the Special Climate Change Fund (SCCF), the Nagoya Protocol Implementation Fund (NPIF), the Capacity-Building Initiative for Transparency (CBIT) Trust Fund and Adaptation Fund.

37 Global Environment Facility, 2022

38 Global Environment Facility, 2022

39 GEFIEO, 2022

40 Pandey, Coninck, et al., 2022

41 See for example Lall, 2004; Wade, 2015; UNCTAD, 2016.

42 U. S. Congress, 2022

43 United Nations, 2015

44 According to the Agreement on Subsidies and Countervailing Measures articles 2 and 3: Specific subsidies to certain enterprises or sectors, contingent on export performance or use of domestic over imported goods, are not allowed. Subsidies that have objective criteria or conditions governing the subsidy eligibility are considered not specific and, therefore, allowed. The criteria or conditions must be clearly spelt out in law, regulation, or another official document to be capable of verification. However, if the subsidy is used by a limited number of certain enterprises, or predominantly used by certain enterprises, it could be considered specific.

45 Cimoli et al., 2009a; UNCTAD, 2018c

46 Lee, 2019

47 WTO, 2022

48 UNCTAD calculations based on WTO, 2022

49 Lee, 2019

50 The DSM is blocked in practice given the ongoing vacancies of Appellate Body. See WTO, 2022

51 WTO, 2022

52 WTO, 2022

53 WTO, 2022

54 See for example Akyuz, 2009; Cimoli et al., 2009; Lee, 2019

55 Lee, 2019

56 Lee, 2019

57 Rodrik, 2007; Bresser Pereira, 2010; Lee, 2019

58 See, for example, WTO, 2012

59 Chang, 2002; Reinert, 2008; Lee, 2019

60 Cimoli, Coriat, et al., 2009

61 UNCTAD, 2007

62 Freire, 2021a

63 WTO, 2021

64 Moon, 2008

65 As proposed by Chang 2020

66 E.g. as suggested in Cimoli et al. 2009

67 WTO, 2022

68 WTO, 2022

69 For example, in the meeting of the Council on 10-11 October 2013, Ecuador's proposal was welcomed by Bolivia, China, Cuba, India, Indonesia, , but not by Canada, the European Union, Japan, New Zealand, Switzerland and the United States.

70 WTO, 2013

71 Pandey, Coninck, et al., 2022

72 UNFCCC, 2023; United Nations, 2015

73 Blicharska et al., 2017; Stamm, 2022

74 Engelen and Hart, 2021

75 CERN, 2008

76 ITER, 2022

77 Official Journal of the European Union, 2006

78 SKAO, 2022

79 CERN, 2022

80 ITER, 2022

81 Stamm et al., 2012.

82 Pardey et al., 2016.

83 These cases have been analyzed in more detail in an international research project under the umbrella of the OECD (2012).

84 ECOSOC, 2021

85 UNCTAD, 2021a

86 Fabre and Wang, 2012: 45

87 Pandey, Coninck, et al., 2022

88 Fabre and Wang, 2012

89 OECD, 2012

90 Stamm and Figueroa, 2012: 132-133

91 Stamm, 2022

92 Ibid.

93 Ibid.

94 ASDF, 2020

95 Ministério da Ciência, Tecnologia e Inovações, 2022

96 National Economic and Development Authority, 2019

97 Destatis, 2023

98 See, for instance, Blicharska et al., 2017

99 UN, 2019

100 UNOSSC, 2022

101 Darko et al., 2021

102 Hu et al., 2021; A study of firm-level data (Hu et al. 2021) and a meta-study of more than one hundred sources (Calabrese and Tang, 2022).

103 Calabrese and Tang, 2022.

104 Oya and Schaefer, 2019, 2019, Weng et al., 2019, Calabrese and Tang, 2022: 12.

105 For example, Kirchherr and Matthews, 2018, and Oya and Schaefer, 2019