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Policy issues for science, technology and innovation: mainstreaming inclusive technology and innovation policies that leave no one behind

Mainstreaming inclusive technology and innovation policies that leave no one behind

Note by the secretariat

Summary

Technology and innovation have helped to achieve an unprecedented level of economic growth in Asia and the Pacific. They have also expanded access to basic opportunities and services and offered means to address environmental concerns. However, not everyone has been able to benefit from such opportunities.

Harnessing technology and innovation to achieve the Sustainable Development Goals and leaving no one behind requires promoting not only more technologies and innovations but also more inclusive ones.

The Asia-Pacific region hosts some of the more transformative efforts to use technology and innovation for inclusive development. Just a few examples include the grass-roots movement driving community-led innovation to address local social and economic needs in India, small entrepreneurs earning a better living by trading online in Indonesia, women furthering scientific careers in Malaysia, research addressing social problems in the Republic of Korea, frontier technologies enabling better care for older persons in Japan, and technology transfer enabling affordable access to clean energy in rural areas of Tajikistan.

Most inclusive innovations are developed by firms, entrepreneurs, grass-roots innovators and development organizations. However, public policies are still required. Left on their own, valuable inclusive technologies and innovations may not flourish, reach scale or diffuse throughout society.

The present document contains information on approaches adopted by Governments in Asia and the Pacific to support inclusive technologies and innovation. It also contains highlights of key issues for promoting inclusive innovations that require further consideration: building political support for an inclusive innovation agenda; managing trade-offs between economic, social and environmental objectives; setting priorities and resourcing them adequately; developing greater understanding of policies that support inclusive innovation; and monitoring and evaluating the impact of these policies.

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The Committee may wish to share national experiences, including good practices and lessons learned, in promoting inclusive technology and innovation policies that leave no one behind. The Committee is invited to reflect on policy priorities to ensure that technology and innovation contribute to inclusive societies and markets. The Committee is also invited to indicate what support may be required, such as training, research or advisory services, from the secretariat to promote inclusive technology and innovation.

I. Introduction

1. Technology and innovation provide immense opportunities for society, the economy and the environment. They have the potential to increase the efficiency, effectiveness and impact of efforts to meet the Sustainable Development Goals.

2. In the 2030 Agenda for Sustainable Development,[1] Governments committed to using technology as a critical means of implementation. Member States have also pledged to leave no one behind in their efforts to achieve sustainable development.

3. Technology and innovation, together with the opportunities provided by trade and investment for capital accumulation and productive transformation, have helped to achieve an unprecedented level of economic growth in Asia and the Pacific, enabling several countries to catch up with developed nations. They have also expanded access to basic opportunities and services – such as education, health and energy – and offered means to address environmental concerns.

4. However, not everyone has benefited from such opportunities. Income and wealth inequalities are on the rise in the Asia-Pacific region and globally. The region's combined income inequality, measured by the Gini coefficient, has increased by more than 5 percentage points in the last 20 years.[2] Least developed countries and countries with special needs have not been able to build technological capabilities and are lagging further behind. Rural communities, women, persons with disabilities, and other vulnerable and low-income groups are often unable to make full use of technologies and innovation.

5. Harnessing technology and innovation to achieve the Sustainable Development Goals and leave no one behind requires promoting more technologies and innovation, particularly the more inclusive ones, that address the needs of lower-income and vulnerable groups.

6. The Asia-Pacific region hosts some of the most transformative efforts to use technology and innovation for inclusive development. Just a few examples include the grass-roots movement driving community-led innovation to address local social and economic needs in India, small entrepreneurs earning a better living by trading online in Indonesia, inclusive businesses providing affordable access to health care in India, women furthering scientific and technological careers in Malaysia, research programmes addressing social problems in the Republic of Korea, frontier technologies addressing the needs of an ageing population in Japan, digital identification platforms enabling

[1] General Assembly resolution 70/1.

[2] *Inequality in Asia and the Pacific in the Era of the 2030 Agenda for Sustainable Development* (United Nations publication, Sales No. E.18.II.F.13).

financial inclusion in India and technology transfer enabling affordable access to clean energy in rural areas of Tajikistan.

7. This present document contains a review of key concepts related to inclusive technology and innovation policies and a sample of public initiatives that have supported inclusive technology and innovation in the Asia-Pacific region. It is not a comprehensive review but a starting point for discussions on the opportunities that Governments need to encourage, enable and emulate for more inclusive innovation.

II. Key concepts and approaches

A. Inclusive innovation

8. Inclusive innovation comprises, in its broadest sense, initiatives that serve the welfare of lower-income and excluded groups. The concept of inclusive innovation encompasses diverse, contested and often competing perspectives.[3] Two broad perspectives can be used to outline inclusive innovation: (a) innovations for the poor or pro-inclusive innovation, a simpler and market-based perspective that defines inclusive innovation as innovation that promotes the creation of products and services that are specifically designed to meet the needs of low-income or excluded groups; and (b) innovation by the poor, or grass-roots innovation, a more complete notion of development and inclusion that defines inclusive innovation as innovation that is carried out by low-income or excluded groups.[4] In practice, inclusive innovation develops within a continuum of these contrasting perspectives. The framing of the inclusion challenge has implications for the choice of policy priorities and of policy instruments to be used.

9. Inclusive innovation includes both technological innovations – for example, the redesign of a portable electrocardiograph costing a fraction of a standard one – and non-technological innovations – such as the reorganization of service delivery to make heart surgery more affordable to low-income groups.

B. Leaving no one behind

10. Leaving no one behind[5] means ending absolute poverty but also reducing inequalities among individuals and groups and ensuring that those who have been left behind (in absolute and relative terms) can catch up with those making progress. It means prioritizing and fast-tracking action for the furthest behind, including youth, persons with disabilities, older persons and indigenous peoples, as well as women and the poor. It recognizes that explicit and proactive attempts are needed to put those left behind first. It requires, for example, identifying those left behind, understanding their needs, focusing policies on places in which left behind groups live, promoting inclusive economic growth and reducing inequality in all its forms.

[3] Mario Pansera and Richard Owen, "Framing inclusive innovation within the discourse of development: insights from case studies in India", *Research Policy*, vol. 47, No. 1 (February 2018), pp. 23–34.

[4] Organization for Economic Cooperation and Development (OECD), "Innovation policies for inclusive development: scaling up inclusive innovations" (Paris, 2015).

[5] Elizabeth Stuart and Emma Samman, "Defining 'leave no one behind'", Briefing note (London, Overseas Development Institute, 2017).

C. Social, industrial and territorial inclusiveness

11. Inclusiveness has a social dimension (ensuring women, low-income groups, persons with disabilities, older persons and other vulnerable groups are included), an economic dimension (ensuring that micro-, small and medium-sized enterprises can fully participate in economic activities) and a geographic dimension (reducing disparities within and between countries).

III. Arguments for inclusive technologies and innovations

12. Promoting inclusive technologies and innovations makes sense for multiple reasons. First, inclusive innovation can support more resilient economies by enabling broad-based growth. Second, it promotes social welfare and social justice by increasing opportunities to make goods and services available to low-income and other marginalized groups and by enabling marginalized groups to take part in innovation activities.

13. Inclusive innovations and technologies provide a broader productive base and additional opportunities for economic growth. For example, the Spark Plan of China, implemented between 1986 and 2015, has promoted economic development in rural areas through the transfer and diffusion of technologies and knowledge. With an average annual budget of $70 million, the programme has stimulated the development of local agricultural and other industries in rural areas. The Spark industrial belt has encompassed 114,000 companies and a total labour force of 12.3 million.[6]

14. Inclusive technologies and innovations are critical to enhance social welfare and social justice and to address inequalities in access to goods and services. Frugal innovations[7] in health care are expanding health services to a wider population. Narayana Health is a chain of hospitals in India providing high-quality, affordable care. Its business model combines innovative technology with a highly efficient delivery system to optimize productivity and minimize costs. As a result, the average cost of open-heart surgery is less than $2,000, whereas the same procedure in the United States of America would cost $100,000. Inclusive financial innovations, such as the Aadhaar digital identity programme in India, have greatly expanded financial inclusion. However, technology and innovation can exacerbate inequality and the exclusion of marginalized segments of the population.[8] More inclusive approaches to the development of technologies help to redress this by ensuring that the benefits of technologies are more evenly spread across societies.

IV. Why are public policies needed to promote inclusive technologies and innovations?

15. Most inclusive innovations are developed by firms, entrepreneurs, grass-roots innovators and development organizations. However, public policies are still required to address market, systemic and transformational failures that prevent the emergence and diffusion of inclusive technologies and innovations. Left on their own, valuable inclusive technologies and innovations may not flourish, reach scale or diffuse throughout society.

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[6] OECD, “Innovation policies for inclusiveness – policy cases: Spark plan: People’s Republic of China” (2017).

[7] The term frugal innovations refers to innovations that reduce the complexity and cost of goods and services and their production or delivery.

[8] *Inequality in Asia and the Pacific*.

16. Inclusive innovation policies can help to address market failures by providing resources and incentives to develop and adopt inclusive technologies, by reducing the risks associated with their development and adoption. In Tajikistan, public policies are providing an enabling regulatory environment for the diffusion of small-scale renewable energy technologies.

17. Public policies can help to bring about inclusive innovations by enabling learning and joint action between different stakeholders and by intermediating between formal and informal systems of innovation. For example, the National Innovation Foundation of India has boosted grass-roots innovations by facilitating the documentation of grass-roots innovations and traditional knowledge, linking informal knowledge systems with formal scientific systems and supporting knowledge networks.

18. Public policies are also crucial in harnessing the direction of innovation towards addressing societal challenges (including poverty, inequality and climate change) and enabling transformational changes. For instance, Japan is explicitly harnessing frontier technologies to address major national challenges such as an ageing population.

19. Inclusive innovation policies are a valuable instrument to support inclusive development. They complement other policy instruments – such as taxation and education policies or rural infrastructure development programmes – to support social, economic and regional inclusion. As taxation policies and public investments are limited in providing social welfare and public goods and services, inclusive technology and innovation policies offer additional and complementary opportunities to sustain inclusive development.

V. Inclusive technology and innovation policies in Asia and the Pacific

20. Inclusive technology and innovation have been supported through a myriad of approaches in Asia and the Pacific and can be grouped in to four areas: (a) strategic approaches that provide direction to the development of technology and innovation; (b) the promotion of inclusive technologies and innovations (for example, promoting appropriate technologies); (c) inclusive growth approaches that promote industrial inclusion; and (d) strategies targeted at removing the barriers that particular groups, such as women and persons with disabilities, face as producers and consumers of technology and innovation. The following subsections contain more information on these approaches.

A. Strategic approaches

21. The first type of approach is a strategic approach. This is when a government promotes an inclusive national science, technology and innovation policy, supports a mission-oriented strategy to address a complex societal challenge (such as financial inclusion) or promotes the inclusive appraisal of technological alternatives (to consider the economic, social and environmental implications of emerging technologies on different groups). Governments can support strategic approaches that provide direction to the development of technology and innovation, allocate resources and make decisions on how outcomes are evaluated.

1. Inclusive national science, technology and innovation policies

22. Policymakers can mainstream the inclusive perspective in national science, technology and innovation policies and promote inclusive technologies and innovation in a holistic manner. Mainstreaming inclusiveness means establishing inclusive outcomes as well as processes in science, technology and innovation policy formulation.

23. Countries have adopted inclusive outcomes in their national science, technology and innovation policies to differing degrees. Often they have focused on inclusive growth outcomes (promoting, for example, the innovation capacities of smaller firms), but they have also included specific objectives for geographic inclusiveness (fostering innovation in rural areas), gender inclusion or investing in research to address domestic challenges.

24. In its Fifth Science and Technology Basic Plan (2016–2020), the Government of Japan seeks to promote inclusive innovation in several areas, including increasing dialogue between society and science, technology and innovation actors; promoting a smart society; promoting diversity and career mobility in science, technology and innovation and in particular improving women's career prospects in these areas; and promoting innovation systems that contribute to regional revitalization.

25. The Plan represents a major shift in the Government's policy, towards addressing both economic and social challenges, and seeks to contribute to sustainable and inclusive development in Japan and abroad. An ageing society, a shrinking population and the loss of public confidence in science are driving this policy shift.

26. For example, the Plan includes the concept of a "super-smart society" (or "society 5.0") where cyberspace and physical space will be highly integrated through new technologies such as artificial intelligence, robotics, the Internet of things, big data and network technologies. In this vision, technology and innovation will improve the quality of life for all citizens regardless of their age, gender, language or region. For example, artificial intelligence and robots would provide enhanced nursing care to an ageing population, and public transportation in rural areas would improve thanks to the use of autonomous taxis and buses.

2. Mission-oriented approaches

27. Mission-oriented policies are a set of complementary policies and measures aiming to address complex societal challenges, such as the achievement of financial inclusion or switching to a renewable energy system. Mission-oriented policies guide changes in the direction of technological systems, focus on the diffusion of technologies and, to achieve their objectives, seek the development of both radical and incremental innovations.[9]

28. Governments can support system-wide transformations through public investments, policies and procurement. The role of government in this regard is not only as a market fixer but a market maker. These mission-oriented approaches require leadership from the top, long-term investments, and

[9] Mariana Mazzucato, "Mission-oriented innovation policy: challenges and opportunities", IIPP Working Paper, No. 2017-01 (London, Institute for Innovation and Public Purpose, University College, London, 2017).

comprehensive and coherent supply-and-demand-side policies that support the development and adoption of technologies.

29. A number of Governments in the Asia-Pacific region have successfully introduced mission-oriented policies to promote technologies that bring services to the poor on a large scale.

30. For example, in India, the stack technology platform based on the Aadhaar digital identification system has enabled the financial inclusion of 1.2 billion people. The Aadhaar project is a government-led, technology-based financial inclusion system. It uses a unique identification number (based on biometric and demographic data) linked to a mobile phone number, a low-cost bank account and an open mobile platform. The combination of those elements enabled public and private banks to establish an open and interoperable low-cost payment system that is accessible to everyone with a bank account and a mobile phone. More than 338.6 million beneficiaries have now received direct benefit transfers, saving the Government $7.51 billion over three years.[10]

3. Inclusive appraisal of technological alternatives

31. The development and application of new and emerging technologies poses a number of ethical dilemmas that require understanding of their cost-benefit and economic, social and environmental implications for different groups, decisions on if or how to proceed with their development and considerations of what alternative solutions are possible. Stakeholders often have divergent values and interests regarding the development of new technologies. For instance, synthetic biology[11] – the convergence of life sciences technologies (for example DNA recombination) with other fields such as engineering, computational technology and nanotechnology – offers new opportunities to address major development challenges. Synthetic biology enables, for example, the production of artemisinin, an active ingredient required to treat a lethal type of malaria. Before, artemisinin could only be sourced from the sweet wormwood plant, and its natural cultivation cycle caused lags in supply and price volatility. Synthetic biology provides a more reliable source of artemisinin, but it may also have an impact on the livelihoods of farmers cultivating the crop in developing countries and on biodiversity.

32. Inclusive technology appraisals enable various stakeholders, including potential users, to assess the social, economic and environmental impact of new and emerging technologies and of alternative options and to decide which options, not necessarily technological, best serve their needs.

33. One of the objectives of the Fifth Science and Technology Basic Plan (2016–2020) of Japan is to deepen the relationship between society and science and technology by addressing citizens' loss of confidence in science following the nuclear power incident caused by the great east Japan earthquake and cases of research fraud.

[10] India, "New innovation approaches to support the implementation of Sustainable Development Goals", statement to the Commission on Science and Technology for Development of the United Nations, twentieth session, Geneva, 10 May 2017.

[11] Friedrich Soltau, "The promise of synthetic biology for sustainable development", brief for the *Global Sustainable Development Report* (GSDR) *2015 Edition*. Available at https://sustainabledevelopment.un.org/content/documents/5468Syn_biology_draft_brief_rev6.pdf.

34. The Plan states that society should be making decisions on ethically or legally contentious issues, such as genetic testing, regenerative medicine and artificial intelligence. It further states that the Government needs to provide a suitable forum for formal or informal communication with the various stakeholders and undertake research on the ethical, legal and social issues with the participation of different social and natural sciences disciplines. Accordingly, the Government must forecast the social benefits and costs of the new technology, as well as its unintended uses, and provide a framework for implementation that balances advantages and disadvantages. The Plan also promotes the formulation of ethical guidelines to guide leading-edge research.

35. Also envisaged in the Plan is the promotion of research on scientific methods for appropriately predicting, evaluating and making decisions based on scientific grounds, for producing technology assessments that comprehensively analyse the impacts of science and technology, and for formulating and implementing regulations, as well as researching ways to manage transitions between social systems.

36. Technology appraisals are an expensive endeavour. To address this limitation and ensure that technology assessments look at the social, economic and environmental impact of emerging technologies and of alternative options, the Action Group on Erosion, Technology and Concentration (ETC Group), a civil society organization, proposes the establishment of regional technology assessment platforms in Asia and the Pacific to enhance technology assessment capacity in developing countries. These platforms would ensure the full and informed participation of marginalized groups in discussion on relevant technology issues.

B. Promoting inclusive technologies and innovation

37. The second type of approach is the promotion of inclusive technologies and innovation, including through research programmes on social problems, appropriate technologies, grass-roots innovations and the transfer of technology to support inclusion.

1. Establishing public research programmes focused on addressing social problems

38. Governments can fund research programmes on social problems that specifically seek solutions to development problems. The Republic of Korea,[12] for example, has dedicated specific resources for multi-departmental research projects addressing priority social problems. Research projects to solve social problems are driven by demand instead of supply and require shifting processes. They require, for instance, joint planning and implementation across different research departments as well as more intense participation by civil society and citizens. In this context, one of the main roles of the government is to establish platforms that enable various stakeholders to effectively participate in the planning and implementation of the activities. Research programmes on social problems, such as on mission-oriented strategies, focus on addressing a social challenge but have a more limited scope as their emphasis is primarily on research.

[12] *Innovative Financing for Development in Asia and the Pacific: Government Policies on Impact Investment and Public Finance for Innovation* (United Nations publication, Sales No. E.17.II.F.23).

2. Sustaining the development and adoption of appropriate technologies

39. It is commonly argued that appropriate or intermediary technologies, namely small-scale, labour-intensive technologies that are simple and affordable, are more relevant for economically poor countries or communities and for inclusive growth paths. For example, in the early nineteenth century, Robert Owen, a manufacturer, sought to develop small mills instead of large-scale mills, in order to empower the workforce and support small communities.[13] E.F. Schumacher, in his seminal book *Small is Beautiful: A Study of Economics as if People Mattered*,[14] argued for intermediary technologies, that is, for simpler technologies that are easier to understand, maintain and repair, that fit more easily into unsophisticated environments and are less vulnerable to unforeseen situations. The notion of appropriate technologies has evolved from being concerned only with the development of appropriate technologies to also being concerned with its deployment. Nowadays, this philosophy underlies efforts to develop and diffuse technologies such as off-the-grid solar panels and mechanical water pumps.

40. The Government of Indonesia has a policy that aims to empower rural communities and small firms through appropriate technologies. The policy is led by the Ministry of Villages, Disadvantaged Regions Development and Transmigration and implemented in collaboration with several ministries, national agencies and local governments. It aims to support economic growth and regional development using appropriate technologies developed by universities and public research institutions.[15]

41. The policy has been supported for nearly two decades; a presidential instruction was adopted in 2001 and two subsequent regulations were adopted (in 2010 and 2017).[16] The main elements include identifying needs for appropriate technology, especially among rural communities and micro-, small and medium-sized enterprises in specific locations; establishing technology service centres at the district level; encouraging universities, public research institutions and technology centres to develop appropriate technologies that respond to community needs; financing the development and diffusion of those technologies; providing technical assistance; and encouraging grass-roots innovations through creativity and innovation contests at the community level.

42. The promotion of appropriate technologies requires policy support that is context appropriate. The Government of Indonesia uses diverse approaches to respond to diverse settings, but this diversification has reduced opportunities for synergies. Weak technology adoption capacities in rural communities are a limiting factor in the diffusion of appropriate technologies.

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[13] Joanna Chataway, Rebecca Hanlin and Raphael Kaplinsky, "Inclusive innovation: an architecture for policy development", Innovation Knowledge Development Working Paper, No. 65 (Milton Keynes, United Kingdom, Open University, 2013).

[14] (London, Blond & Briggs, 1973).

[15] Based on inputs provided by Indonesia's focal point for the Subcommittee on Science and Technology Infrastructure and Resources Development of the Association of Southeast Asian Nations.

[16] Indonesia, Presidential Instruction No. 5 on empowering rural communities through the implementation and development of appropriate technology (2001); Ministry of Home Affairs Regulation No. 20 on community empowerment through management of appropriate technology (2010); and Ministry of Villages, Disadvantaged Regions Development and Transmigration Regulation No. 23 on the development and implementation of appropriate technology in rural natural resource management (2017).

43. The Government of Indonesia has sought to enhance the economic capacity of rural areas by promoting appropriate technologies that are relevant to community needs. Several lessons can be drawn from these experiences: communities need to be involved in the planning, implementation and evaluation of the technologies; technical and non-technical assistance is required; and the coordination of policies across different sectors is indispensable to support appropriate technologies in rural areas.

3. Supporting grass-roots innovation

44. The grass-roots innovation movement, similar to the appropriate technologies movement, supports relevant technologies for communities, however, it focuses on supporting the community to develop their own technologies and knowledge and in recognizing their knowledge. It also values other forms of innovation (for example, educational) beyond technological ones. By placing communities at the centre and sourcing traditional, indigenous knowledge, it allows for innovations to be suited to the local context. Grass-roots innovations are "networks of activists and organizations generating novel bottom-up solutions for sustainable development; solutions that respond to the local situation and the interests and values of the communities involved".[17] Hence, grass-roots innovations are generated by local communities, rather than by the government or the private sector. Grass-roots innovations are often based on the knowledge and experience embedded in local communities, outside the formal institutions of science, education and research[18] and are commonly developed through experimentation, learning by doing and improvisation by trials.[19] The driving force behind grass-roots innovations is often to meet a social need.[20]

45. Some of the key challenges in supporting grass-roots innovations include accessing appropriate financing and funding; identifying genuine grass-roots innovations; connecting to formal institutions and the wider community; and accessing the supply chain and opportunities for business development.[21] Policies which seek to create a supportive system for grass-roots innovations may consider measures and institutional frameworks that address these challenges.

46. India is a notable example of a country in which grass-roots innovations are part of the national innovation system.[22] The Honey Bee Network, established in 1989, is a key organization within the grass-roots innovation movement in India. The Honey Bee Network, like its namesake, seeks to cross-pollinate ideas and promote the sharing of knowledge between communities.

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[17] Gill Seyfang and Adrian Smith, "Grassroots innovations for sustainable development: towards a new research and policy agenda", *Environmental Politics,* vol. 16, No. 4 (July 2007), pp. 584–603.

[18] Ibid.

[19] Ashok Jain and Jan Verloop, "Repositioning grassroots innovation in India's S&T policy: from divider to provider", *Current Science*, vol. 103, No. 3 (August 2012), pp. 282–285.

[20] Mokter Hossain, "Grassroots innovation: a systematic review of two decades of research", *Journal of Cleaner Production*, vol. 137 (November 2016), pp. 973–981.

[21] Adrian Smith, Mariano Fressoli and Hernán Thomas, "Grassroots innovation movements: challenges and contributions", *Journal of Cleaner Production*, vol. 63 (January 2014), pp.114–124.

[22] Anil K. Gupta, "Innovations for the poor by the poor", *International Journal of Technological Learning, Innovation and Development*, vol. 5, No. 1/2 (2012), pp. 28–39.

A key pillar of its work is to acknowledge and protect the intellectual property rights and contributions of the poor. A number of formal institutions were set up to complement its work, including the Society for Research and Initiatives for Sustainable Technologies and Institutions, a voluntary organization established in 1993, which provides advocacy support as well as financial and technological support to grass-roots innovators. In addition, the Gujarat Grass-roots Innovations Augmentation Network, established in 1997, acts as a type of incubator, linking innovation, investment and enterprise. The Honey Bee Network is an intermediary organization that actively scouts for innovations among local communities, helps to build trust and links grass-roots innovators to more formal institutions.[23] This is particularly important as formal and institutional science can play a role in validating and building on the innovations of people at the grass-roots level.[24]

47. Drawing on the experiences of the Honey Bee Network, the National Innovation Foundation was established in 2000 as an autonomous institute under the Department of Science and Technology to strengthen grass-roots technological innovations and traditional knowledge and to expand the policy and institutional space for grass-roots innovators.[25] The Foundation works to build a register of grass-roots innovations; protect property rights; set up incubators to transform innovations into viable business opportunities; and disseminate innovations on a commercial and non-commercial basis.[26] With the support of the Honey Bee Network, the Foundation has documented more than 225,000 grass-roots innovations from more than 585 districts in India.[27] The Foundation has also filed more than 500 patents in the United States of America and in India on behalf of grass-roots innovators.[28]

48. Fostering grass-roots innovations requires recognizing their value but also addressing the challenges faced by grass-roots innovators. In 2003, the National Innovation Foundation and the Small Industries Development Bank of India established a micro-venture capital fund for grass-roots innovations, which has provided funding to more than 180 grass-roots innovators. The Grass-roots Technological Innovation Acquisition Fund, established in 2011, provides financial incentives for the pooling and diffusion of grass-roots innovations.

4. Technology transfer to support inclusion

49. International technology transfer enables access to existing technologies and takes place through multiple channels, including technology licensing, trade, foreign direct investment and the international movement of experts. Technology transfer requires that recipients, typically firms, are able to identify needs and relevant technologies and to adopt and adapt them to the local context. In least developed countries and other countries with special needs, where the technological capabilities of local firms are limited, international cooperation often plays a major role in supporting not only technologies that serve the needs of disadvantaged communities (such as access to clean and affordable energy by rural communities) but also in

[23] Anil K. Gupta, “Innovations for the poor by the poor”.

[24] Anil K. Gupta, “Tapping the entrepreneurial potential of grassroots innovation”, *Stanford Social Innovation Review* (summer 2013), pp. 18–20.

[25] www.nif.org.in/aboutnif.

[26] Anil K. Gupta, “Innovations for the poor by the poor”.

[27] www.nif.org.in/aboutnif.

[28] Anil K. Gupta, “Innovations for the poor by the poor”.

building the technological, market and regulatory elements that enable the diffusion of the inclusive technology.

50. Small-scale hydropower generation solutions are generally implemented in run-of-river schemes or with existing water infrastructure and have the capacity to generate up to 1 MW of electricity. While their capacity to generate electricity is small, they are particularly effective in providing clean energy to rural areas where the population is sparse and electricity demand weak.[29] They require smaller investments and can generate income opportunities in rural areas. Moreover, in contrast to large-scale hydropower installations, they have limited environmental impact. Scaling up access to small-scale hydropower is, therefore, a relevant example of an inclusive technologies and innovation strategy.

51. The Government of Tajikistan, with the support of the United Nations Development Programme (UNDP), has embarked on a comprehensive programme to accelerate the development of small-scale hydropower generation.[30] The programme seeks to remove legal barriers to the broader use of small-scale hydropower, encourage technology transfer related to small-scale hydropower generation, build capacities and develop a market around this technology. The programme links a technology import-based development programme to local actors, including universities, local government institutions and firms.

52. It was carried out in collaboration with, among others, the Ministry of Energy and Water Resources, the Ministry of Economic Development and Trade, the national energy company, municipal authorities, district and regional water management departments, equipment suppliers and construction companies, communities, non-governmental organizations and local training providers.

53. To effectively transfer technologies and support integrated rural development, the programme was designed to build technological capacity and the necessary legal, policy and market elements. The programme has trained local technicians on technical and planning matters and on the operation and maintenance of small-scale hydropower facilities. For instance, technical universities are providing training to 100 students on an annual basis.

54. The Government of Tajikistan has passed laws to support the development of small-scale hydropower. A law on energy efficiency and energy saving, adopted in 2013, established a national renewable energy sources and energy efficiency trust fund. At the policy level, the Ministry of Energy and Industry endorsed three documents providing strategic guidance on the use and scaling up of renewable energy sources and energy efficiency. A national programme for the development of renewable energy sources and the construction of small hydropower plants for the period 2016–2020 was adopted in 2015.

[29] *The Least Developed Countries Report 2017: Transformational Energy Access* (United Nations publication, Sales No. E.17.II.D.6).

[30] For more information see www.tj.undp.org/content/tajikistan/en/home/operations/projects/environment_and_energy/technology-transfer-and-market-development-for-shp-in-tajikistan.html (accessed 18 May 2018); and Economic Commission for Europe, *Innovation Performance Review of Tajikistan* (United Nations publications, Sales No. E.16.II.E.6).

55. A power purchase agreement for buying electricity from individual power producers was signed by the national energy company, providing a precedent for future individual power producers looking to sell their excess power to the national electricity grid, which should help market development and confidence building.

C. Promoting inclusive growth

56. A third type of approach is inclusive growth approaches that promote inclusive businesses (businesses that include the poor as clients, employees or owners) and industrial inclusion (when micro-, small and medium-sized enterprises can fully participate in economic activities).

1. Promoting inclusive business

57. Inclusive businesses are those whose models include the poor on the demand side as clients and customers and on the supply side as employees, producers and business owners at various points in the value chain.[31] Low-income groups are the largest socioeconomic group but the poorest in resources. Inclusive businesses see opportunities in these markets, for example, with strategies that provide large-scale, low-cost and low-margin products. Inclusive businesses promote inclusion as they expand access to goods, services and income-generating opportunities for low-income groups.

58. The Government of the Philippines is championing the promotion of inclusive business as a strategy to achieve inclusive, innovation-led growth and has introduced a number of initiatives. The first step was the development of an accreditation system for inclusive business models to distinguish them from other types of investment.[32] It also put in place a number of financial incentives and capacity-building programmes to encourage inclusive businesses. For example, the 2017–2019 Investment Priorities Plan provides fiscal incentives for companies with inclusive business models in agribusiness and tourism; the 2017 Sagip Saka Act provides tax incentives to private companies that buy agricultural produce directly from smallholder farmers and fishers; and the "Go local!" initiative supports products produced by the country's small firms through incubation, marketing and branding.[33]

2. Empowering smaller firms to innovate

59. Innovation in the formal economy is inclusive when micro-, small and medium-sized enterprises have the capacities and opportunities to successfully participate in and benefit from innovation. These enterprises often may have more limited awareness of why innovation is important for their business or how to innovate. Smaller firms also have fewer human resources to innovate and financial resources to risk and more limited access to knowledge institutions.

60. Many Asian countries have actively promoted industrial inclusiveness and innovation activities in micro-, small and medium-sized enterprises through policies that seek to address the barriers to innovation. For instance,

[31] UNDP, *Barriers and Opportunities at the Base of the Pyramid: the Role of the Private Sector in Inclusive Development* (Istanbul, August 2014).

[32] Asian Development Bank, "Accreditation of inclusive business: pioneering IB policy in the Philippines", *Inclusive Business*, 12 February 2016.

[33] UNDP, *New Horizons: How Inclusive Business is Helping Achieve the SDGs in the Philippines* (Manila, 2017).

SPRING Singapore, the enterprise development agency of Singapore, established a comprehensive set of instruments to support innovation activities among local small and medium-sized enterprises. SPRING Singapore provides financing (in the form of innovation vouchers, grants and loans) for these enterprises to innovate. Recognizing that innovation and learning often happen in interaction with other organizations, SPRING Singapore has also promoted collaboration between small and medium-sized enterprises and other small and medium-sized enterprises, industry partners and large organizations.[34]

61. In terms of financing, the Innovation and Capability Vouchers provide small amounts of funding (up to 5,000 Singapore dollars) for small and medium-sized enterprises to procure research and development and other services to improve capacity in innovation, productivity, human resources and financial management. The Capability Development Grant finances up to 70 per cent of a small and medium-sized enterprise's qualifying project in order to enhance the enterprise's capabilities and productivity.

62. In terms of supporting inter-firm collaboration, the Collaborative Industry Projects programme supports collaborations between enterprises and industry partners (for example, trade associations and chambers of commerce) to address common industry-specific business challenges, by financing up to 70 per cent of a small and medium-sized enterprise's qualifying costs for projects in which a consortium of at least three small and medium-sized enterprises participate. Similarly, the Partnerships for Capability Transformation programme supports collaborative projects between large organizations (large firms or government entities) and local small and medium-sized enterprises in certain areas.

3. Enabling the participation of small firms in the digital economy

63. The expansion of information and communications technology (ICT) and its application to the economy, in particular the development of online platforms, is revolutionizing the way in which entrepreneurs and firms conduct business. Small entrepreneurs can now source information and customers online, place orders online, and even sell their products domestically and abroad using online platforms. To do business online, firms must have affordable and reliable access to ICT, be able to rely on a legal environment that recognizes online transactions and have access to an efficient transport network and online payment systems. Additionally, small firms are often confronted with further challenges. Many micro-, small and medium-sized enterprises are not familiar with the technological and marketing skills required to do business online, do not have access to financial resources to move their business online and are not ready to face competition online.

64. In Indonesia, Rumah Kreatif BUMN is an ambitious government programme to build the capabilities of small and medium-sized enterprises to commercialize their goods and services online. The programme is supported by state-owned enterprises that gather, train and support small and medium-sized enterprises. The programme provides enterprises with training, market access and access to financing through three stages: Go Modern (online registration, product standardization and brand management training), Go Digital (training on digital applications, social media and product automation) and Go Online (training on website creation, listing on Blanja.com, and

[34] Jue Wang, "Innovation and government intervention: a comparison of Singapore and Hong Kong", *Research Policy*, vol. 47, No. 2 (March 2018), pp. 399–412.

marketing and inspiration to grow further).[35,36] Blanja.com is a state-owned open marketplace that offers Indonesian firms the opportunity to trade online and has the largest product listing in the country. As of April 2017, more than 482,000 small and medium-sized firms have used Go Modern, 21,577 have used Go Digital and 10,133 have used Go Online.[37]

D. Removing barriers to participation and making technology and innovation activities more inclusive

65. The fourth type of approach refers to strategies targeted at removing the barriers that particular groups, such as women and persons with disabilities, face as producers and consumers of technology and innovation.

1. Supporting girls and women in science, technology, engineering and mathematics careers

66. For technology and innovation to benefit men and women alike, women must be able to participate in, benefit from and decide on technological and innovation activities. The active involvement of women in the design and development of technologies is fundamental if technological innovation is to respond to their needs. For instance, in 2014, a mobile firm released a health application that could monitor a comprehensive set of health metrics – including blood-alcohol content – but which initially failed to track menstruation.[38]

67. Women are not represented equally in scientific, technological and innovation sectors as professionals and decision makers. Gender parity remains elusive among researchers. The gender gap widens with each step up the ladder of the research system. So while women represent 53 per cent of graduates worldwide, only 28 per cent of researchers are female. The gap is not related to a country's level of development. In Asia and the Pacific, the Republic of Korea and Japan have some of the lowest proportions of female researchers, 18 and 15 per cent, respectively,[39] while Malaysia, the Philippines and Thailand have all achieved gender parity. The gender gaps are sector specific; for example men are underrepresented in health while women are strongly underrepresented in engineering and in ICT. Talent shortages in certain job families, notably those requiring digital skills, are a strong incentive for the private and public sectors to support increasing participation of women in scientific and technological careers.

[35] Wirawan Agahari, "Digital Economy and Inclusive Development: Insights from Indonesia", PowerPoint presentation, 11 and 12 April 2018. Available at https://diodeweb.files.wordpress.com/2018/04/diode18man-agahari-digital-economy-and-inclusive-development-in-indonesia.pptx.

[36] Jakarta Globe, "TelkomGroup Encourages Go Global Through E-Commerce Training and Online Marketing at Blanja.com", 22 September 2017. See http://jakartaglobe.id/advertorial/telkomgroup-encourages-go-global-e-commerce-training-online-marketing-blanja-com/.

[37] Rumah Kreative Kreatif BUMN, Lokasi RKB. Available at http://rkb.id/lokasi#page-4 (accessed 7 May 2018).

[38] World Economic Forum, "The tech industry needs more women. Here's how to make it happen", 9 November 2017.

[39] United Nations Educational, Scientific and Cultural Organization (UNESCO), *UNESCO Science Report: Towards 2030 – Executive Summary* (Paris, 2015).

68. The impact of frontier technologies on women is likely to be different than it is on men. Artificial intelligence algorithms are reproducing, even exacerbating gender and racial bias in various ways: gender bias in the data sets used to train artificial intelligence systems are being reproduced and systems providing personalized information (for example, social online platforms) are feeding information that reinforces user biases.[40] In terms of employment, women will likely benefit less from new job opportunities in frontier technologies given gender differences in fields of study.[41] Women are already a minority in jobs and in decision-making positions in science and technology-related occupations. For instance, in the software and information technology services industry, women represent only 27 per cent of employees and 19 per cent of leadership hires.[42]

69. Closing the gender gap in scientific and technological careers involves building balanced educational foundations, fixing the leaking pipeline in scientific research careers and rebalancing gender asymmetries in engineering and information technology industries.

70. The Government of Malaysia has a long history of supporting a gender balance in science and technology education and has introduced policies promoting greater workforce diversity. As a result, the overall number of women researchers is close to parity, although in the private sector only 30 per cent of researchers employed in 2013 were women.[43]

71. In order to become a developed country by 2020, the Government of Malaysia, in 2010, set a national goal of producing 1.3 million specialists in scientific and technological fields by the year 2020. Promoting women's interest in science, technology, engineering and mathematics studies is one vehicle to achieve that goal.

72. Participation of girls in scientific and technological studies has improved gradually over four decades due not to a specific strategy but to the inclusion of gender considerations in key national policies in the areas of education, economy, and science and technology.[44]

73. Since the 1970s, the Government of Malaysia has adopted a 60:40 enrolment policy to ensure that 60 per cent of the students, both in secondary and higher education, are enrolled in science. Under this policy, students that score an A or B in science and mathematics at the lower secondary assessment are automatically placed in the scientific stream at the upper secondary level. This policy has facilitated the selection of students that have the necessary aptitude and has contributed the most to increasing the participation of girls in science and technology education.

74. The objective of this policy has proved difficult to achieve. The Malaysia Education Blueprint 2013–2025 seeks to encourage further interest

[40] Kristian Hammond, "5 unexpected sources of bias in artificial intelligence", 11 December 2016; European Political Strategy Centre, European Commission, "The age of artificial intelligence: towards a European strategy for human-centric machines", EPSC Strategic Notes, No. 29 (2018); and World Economic Forum, "AI has a gender problem. Here's what to do about it", 16 April 2018.

[41] OECD, *The Pursuit of Gender Equality: An Uphill Battle* (Paris, 2017).

[42] World Economic Forum, *The Global Gender Gap Report 2017* (Geneva, 2017).

[43] UNESCO, *UNESCO Science Report*.

[44] This section draws largely on UNESCO, "Sharing Malaysian experience in participation of girls in STEM education", In-Progress Reflection, No. 3 (Paris, 2016).

in science and technology by promoting teaching and learning approaches that stimulate higher-order and design thinking skills; awareness within the school community; and the use of ICT in teaching and learning. The second and third implementation phases have specific objectives on reducing gender gaps in students' achievements, which for Malaysia means focusing on boys who leave school early or have low results, as girls consistently outperform boys at every level of education.

75. Science and technology professional bodies, such as the Academy of Sciences Malaysia or the Malaysian Institute of Chemistry, are also encouraging science and technology education for all. Awareness has been raised in government ministries and private sector organizations on the different and unique capabilities that women bring to the workplace. A biennial Women in Science, Technology and Innovation Forum has been institutionalized in collaboration with UNESCO.

76. Gender inclusiveness is also considered in the selection of pedagogies and the design of scientific curricula. Most female role models in science and technology in Malaysia took science or technology courses or chose their careers based on their interest in exploring and doing experiments. Pedagogies supporting these approaches are now encouraged. Specific rules were made regarding the gender of members of the panels of experts invited to develop various curricula, in addition to other gender components of curricula development (for instance, ensuring that illustrations in text books are gender responsive).

77. The Government has aimed to increase the number of women participating in the labour force and, more recently, the quality of their participation by promoting women in decision-making positions.[45]

2. Promoting assistive technologies for persons with disabilities

78. Persons with disabilities are often at a disadvantage when trying to use ICT. Access to assistive devices and related support services is a precondition for persons with disabilities to optimize their level of independence in daily life and to live in dignity.

79. The Incheon Strategy to "Make the Right Real" for Persons with Disabilities in Asia and the Pacific guides the third Asian and Pacific Decade of Persons with Disabilities, 2013–2022. The Strategy set 10 priority goals, including enhancing access to the physical environment, public transportation, knowledge, information and communication (Goal 3), and its specific targets include enhancing the accessibility and usability of information and communications services (target 3.C) and halving the proportion of persons with disabilities who need but do not have appropriate assistive devices or products (target 3.D).

80. A 2018 report assessing the progress of the Incheon Strategy indicates that, of the 14 Governments that provided information, more than one third of persons with disabilities, approximately 7.5 million people, had no access to the required assistive devices.[46]

[45] Malaysia, Economic Planning Unit, Prime Minister's Department, *Tenth Malaysia Plan 2011–2015* (Putrajaya, 2010).

[46] Economic and Social Commission for Asia and the Pacific (ESCAP), "Inequality of opportunity in Asia and the Pacific: education", Social Development Division Working Paper Series (ST/ESCAP/2817).

81. Several elements are required for persons with disabilities to benefit from assistive technologies. These elements include awareness; advice and assessment of needs to identify personal technology; provision of assistive technology with a clear system of funding; training in the use of assistive technology for professionals and for persons with disabilities; technical support to implement customized and personalized assistive technologies; availability of accessible digital content; research and development; and the implementation of relevant policies (such as the right to accommodation, anticipation and redress).

82. Governments can actively encourage the availability, through regulation and soft measures, of these elements in a coordinated and coherent manner.

83. Recent research conducted in five developing countries, including Malaysia and Pakistan, suggests that there is a gap between the policies in place and the experience of access to assistive technologies.[47]

84. This research found weaknesses in all five countries and found that most countries had inadequate systems for providing and supporting assistive technologies. Common weaknesses were related to awareness, advice, provision, training, support, and availability of accessible digital content, while the areas of greater strength were policy and research and development. The research also indicates clearly that the provisions made for different forms of disability vary considerably.

85. Persons with disabilities have sought to address weaknesses in the ecosystem through their own networks and activities, and the use of social media and messaging is providing the basis for increased awareness and decision-making. Research indicates that there is an underlying trend of users self-determining solutions. This user-led model reduces the cost of provision significantly and offers opportunities for governments to invest in sustaining and strengthening emerging networks with information and resources.

86. Technologies implemented on mobile and portable devices dominated provision. This suggests that additional innovative methods of service delivery could expand and enhance the ease of access to technology for persons with disabilities. The use of open licence solutions has supported the localization of assistive technologies and helped to address language and cultural differences.

VI. The Commission's work on inclusive technology and innovation policies

87. The secretariat conducts research and analysis, promotes intergovernmental dialogues, and builds capacities in the areas of science, technology and innovation policies.

88. In order to support member States' pledge to leave no one behind and the commitments contained in Commission resolution 74/11 to maximize the positives of science, technology and innovation and to minimize the possible negatives, the secretariat is establishing a new programme on inclusive technology and innovation policies.

[47] Based on a preliminary assessment of research findings, as shared by Mr. Akber Gardezi, Inter Islamic Network on Information Technology, based at COMSATS University, Islamabad (11 May 2018). The research was conducted in Jordan, Malaysia, Pakistan, Qatar and Tunisia.

89. The programme will bring additional strategic expertise to member States and enhance the Commission's work on science, technology and innovation policies by filtering through an inclusive lens its existing work on research, capacity-building and dialogue on science, technology and innovation policies (for example, by examining the implications of frontier technologies for low-income and other marginalized groups). It will also build upon and contribute to the secretariat's work on social development, such as poverty and inequality, women's empowerment and gender equality, and inequality or disability-inclusive development.

90. The programme will support Governments across the region in their efforts to design and implement inclusive technology and innovation policies by offering advisory services to those wishing to promote more inclusive innovation, conducting research and providing a platform for expert and policy discussions.

VII. Conclusion

91. It is possible to formulate technology and innovation policies that support more inclusive development. Supporting inclusive technology and innovation poses a number of questions that require further exploration, analysis and deliberation by policymakers and stakeholders.

92. The first issue is how to put inclusiveness high on the political agenda so that the needs of disadvantaged communities are given due consideration in science, technology and innovation policies and, subsequently, how to reconcile economic growth objectives with inclusion objectives.

93. Inclusion outcomes are often loosely defined in national science, technology and innovation policies. How can vague inclusion outcomes be translated into specific inclusion objectives in technology and innovation strategies and plans?

94. A third technology and innovation policy issue is prioritizing among multiple inclusion needs. Given that resources are limited, on which vulnerable groups should science, technology and innovation policies focus? How should priorities be decided? In which areas (for example, women in scientific and technological careers, frontier technologies, inclusive growth, grass-roots-based development) can technology and innovation policies have a greater impact in promoting inclusion?

95. Different perspectives (inclusive economic growth versus social justice) and diverse, even contradictory, options (from bottom-up to top-down approaches) can support inclusive innovation. How much attention and resources should be dedicated to the different approaches?

96. A variety of policy instruments encourage inclusive technologies and innovations, including enabling regulatory environments, supportive public procurement policies, focused research programmes, financial support and incentives, and establishing supportive institutions and programmes. Which is the right policy mix in each context?

97. Finally, traditional technology and innovation indicators are not adequate for recognizing the value and shortcomings of inclusive innovation and technology initiatives. How can policymakers and other stakeholders monitor and evaluate inclusive innovation and technology policies when traditional indicators (for example, expenditure in research and development, productivity growth) are not relevant?

VIII. Issues for consideration by the Committee

98. The Committee may wish to discuss the issues raised in the present document and share experiences and lessons learned with regard to inclusive technology and innovation policy.

99. Given the large number of avenues to support inclusive innovations and of policy issues requiring further exploration, member States are invited:

(a) To identify priority inclusive technology and innovation policy issues that ESCAP should explore in more detail;

(b) To indicate areas of inclusive technology and innovation policies that are being considered and may require support from the secretariat in the form of training, research or advisory services to guide the development of inclusive technology and innovation policies;

(c) To suggest areas for cooperation on inclusive technology and innovation policies to support shared prosperity.