79th Commission Session

ASIA-PACIFIC COUNTRIES WITH SPECIAL NEEDS DEVELOPMENT REPORT 2023

Strengthening Regional Cooperation for Seamless and Sustainable Connectivity

ESCAP
Economic and Social Commission for Asia and the Pacific

*The shaded areas of the map indicate ESCAP members and associate members.**

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Foreword

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Seamless and sustainable connectivity is essential to overcoming development challenges and improving living standards in the least developed countries, landlocked developing countries and small island developing States of Asia and the Pacific, given their economic size and geographic location.

The recent COVID-19 pandemic, geopolitical tensions and economic headwinds amplified existing gaps in access to sustainable transport, energy and telecommunication services; freight disruptions led to delays and increased transport costs, especially in the landlocked developing countries and small island developing States that are dependent on these links; and supply irregularities and price shocks raised energy security concerns in fuel-importing countries. Faced with global crises, governments furthermore redirected public resources to cushion their immediate impacts on its people, rather than invest in connectivity.

Connectivity, through seamless and sustainable transport, energy, and telecommunications infrastructure and systems, however, drives long-term development while mitigating the effects of climate change and natural disasters; integration of multimodal transport that includes rail could promote decarbonization while improving regional supply chains; expansion of electricity grids, could accelerate the cost-efficient deployment of renewable energy; and enhanced digital connectivity could lead to improved access to climate adaptation solutions.

Regional cooperation to strengthen these links is key for this transition. By highlighting how policymakers can leverage the transformative power of connectivity, this report calls for a collective push for the improved well-being of our citizens through the attainment of the Sustainable Development Goals.

As we approach the midpoint of the implementation of the 2030 Agenda for Sustainable Development, building a sustainable, inclusive and resilient future for all is more important than ever.

Executive summary

Sustainable development in Asia and the Pacific is contingent on progress made by countries in special situations, which include least developed countries (LDCs), landlocked developing countries (LLDCs), and small island developing States (SIDS), and comprises more than half of the countries in the region. Unfortunately, the COVID-19 pandemic, geopolitical tensions and persistent economic challenges have hindered their progress.

This report highlights the crucial role of connectivity in transport, energy, and information and communications technology (ICT) for achieving sustainable development and a low-carbon, resilient economy. This is unique because the focus of the report is on the role of connectivity in addressing climate change and building resilience, with attention placed on countries in special situations in Asia and the Pacific, while considering synergies across the three sectors.

Connectivity in transport, energy and ICT is crucial not only for promoting socioeconomic development but also for addressing climate change and increasing resilience to disasters. Improved multimodal transport connectivity, for example, can reduce trade costs, enhance efficiency and competitiveness of doing business, and allow for the use of more environmentally friendly modes of transport. The benefits are especially pronounced for the Asia-Pacific LLDCs and SIDS, which are at a disadvantage because of their lack of direct coastal access and geographical distance from international markets, respectively. Similarly, ICT connectivity can help countries with a small population and limited natural resources achieve economies of scale and access innovative solutions for climate resilience and adaptation. Greater energy connectivity can also boost energy security and accelerate the deployment of renewable energy, thereby promoting a green energy transition. Sustainable connectivity is particularly important for countries in special situations given their vulnerability to climate impacts and the long-term benefits of moving towards a low-carbon and climate-resilient world.

The significance of connectivity for LDCs, LLDCs and SIDS is well-recognized in the global programmes of action that the international community has created to support the development of these countries. For instance, the Doha Programme of Action for Least Developed Countries for the Decade 2022−2031 prioritizes infrastructure development in transport, energy and ICT. The Vienna Programme of Action for Landlocked Developing Countries for the Decade 2014−2024 highlights the need for cooperation with transit countries to enhance connectivity in these sectors. The SAMOA Pathway (2014−2024) emphasizes the importance of infrastructure availability and quality in SIDS.

Despite the clear benefits of connectivity in transport, energy and ICT, the countries in special situations lag far behind what other countries in the region have managed to achieve. Indeed, LLDCs and SIDS remain among the least connected countries in terms of transport connectivity, and unfortunately, the gaps with other developing countries are not narrowing. Mobile broadband Internet is, on average, three times more expensive in the countries in special situations than the regional average. LLDCs are finding it difficult to trade energy with their neighbours and must often connect far-flung communities, while SIDS have focused on developing energy resources and microgrids locally.

Improving connectivity in countries in special situations is challenging due to several long-term structural factors. For instance, LDCs and LLDCs that rely on low-value primary products and SIDS with narrow economic bases are affected by high transport costs due to remoteness to major international markets and often rugged terrains. In addition, there is an unbalanced modal split in transport operations across countries, a persistent shortage of quality infrastructure, and gaps in operational and procedural connectivity.

One of the critical barriers to seamless connectivity in these countries is the lack of cooperation on interoperability and digitalization. Harmonization and digitalization of international transport procedures are essential to overcome operational and procedural connectivity gaps in countries in special situations. Energy connectivity also faces challenges due to the complex sociotechnical systems of electric power grids that require harmonized operational, planning, regulatory, and financial procedures across borders. While some initiatives are under way to address these challenges, most remain in the study stage and require implementation.

The impacts of climate change present a considerable challenge to connectivity in countries in special situations. For instance, frequent adverse climate events threaten maritime connectivity in SIDS, causing damage to port infrastructure and increasing maintenance costs. Coastal erosion and increased sedimentation levels in harbours negatively affect shipping channels, while cyclones put ports at great risk. LDCs and LLDCs are also highly vulnerable to climate change. Two examples of this are the constant exposure to rising temperatures which result in the deterioration of road surfaces, bridge joints and rail tracks and are often of low quality to begin with, and flash floods or landslides that cause damages to all modes of transportation.

The recent polycrisis of the pandemic, geopolitical tensions and a slowing global economy have further exacerbated challenges faced by countries in special situations. Additional cross-border controls and disruptions in, for instance, freight transit transport have led to increased delays and costs. These have been compounded by growing energy security concerns. The polycrisis has also demonstrated the importance of ICT connectivity, particularly in crisis response, remote working and learning, and the provision of health-care services. For example, in countries with large rural populations, such as LDCs, and those with geographically dispersed populations, such as SIDS, ICT connectivity played a vital role in ensuring access to essential services.

At the same time, the polycrisis has unlocked new opportunities for sustainable freight and digitalization of infrastructure services. For instance, while the pandemic has limited and disrupted the supply of maritime transport services, it has increased the demand for rail freight services. Moreover, disruptions to the traditional transport corridors between Europe and China have increased the need for alternative corridors, some of which transit LLDCs in North and Central Asia. In the wake of the pandemic, many LDCs and LLDCs adopted measures to digitalize transport operations, including simplifying customs procedures and cargo clearance processes to gain access to emergency medical and other essential supplies quickly. In terms of ICT connectivity, the pandemic has boosted investment and expedited policy formulation. Further unlocking digitalization advances could expedite seamless and sustainable connectivity within and between these countries.

The long-term downward trends of the cost of renewable energy and heightened costs and volatility of non-renewable energy prices amid the polycrisis could accelerate the transition to a low-carbon economy. Renewable energy resources, such as solar and wind power, are becoming increasingly cost-effective for electric power generation. These sources of energy present great potential in sparsely populated areas. Consequently, power transmission must be central to efforts to bring renewable energy to the region's cities and towns.

Going forward, it will be crucial to coordinate regional efforts aimed at strengthening the development of transport corridors that promote decarbonization and enhance resilience. Upgrading railway infrastructure corridors, especially for the region's LDCs and LLDCs along the non-traditional transport corridor between China and Europe, plays an important role. Multimodal transport corridors that include rail transport can provide competitive long-distance connections if delays at borders are reduced and cross-border interoperability is ensured. They can also contribute towards the decarbonation of regional supply chains, given the lower emissions generated by rail transport. In SIDS, pledges, such as the Clydebank Declaration for Green Shipping Corridors, which is aimed at establishing green shipping, could boost resilient and sustainable port development and maritime connectivity.

Integrating climate resilience into transport infrastructure and asset creation is an urgent national task. In many LDCs and SIDS, the integration process has, however, been hampered by capacity constraints, resource gaps and inadequate access to technology. A multi-step approach, including assessment of sectoral climate vulnerabilities, identification of priority transport assets at high risk, investments for improving resilience and technical cooperation at the regional level, should be considered.

Harmonizing existing operational, planning, financial and regulatory procedures is at the core of greater energy connectivity. One way to harmonize operational procedures is to adopt grid codes and technical standards that are compatible across borders and directly support the integration of variable renewable energy resources. To harmonize planning procedures, integrated model-based software can be used to help assess the total costs of energy systems and create the basis for long-term, multilateral collaboration.

To reap the benefits of energy connectivity, flexible trading that responds to grid operating conditions is essential. This would require a harmonized regulatory framework at the subregional level, which, in turn, requires cooperation among national regulators and a common vision to implement cross-border multilateral trading arrangements. For countries in special situations, credible development plans and road maps would help harmonize regulations and procedures for energy connectivity efforts to move from the study stage to the implementation stage.

While SIDS in Asia and the Pacific may not be able to pursue cross-border power trade through grid interconnections, collaboration and regulatory harmonization are still required to increase transparency and lower the costs of investment by allowing joint supply chains to service these States.

New technologies, geospatial data and smart solutions can enhance the resilience of countries in special situations. Promising options for the Asia-Pacific countries in special situations include adopting scientific monitoring and reliable fibre-optic cables, improving Internet redundancy through low Earth orbit satellite technologies, especially during and after natural disasters, and promoting affordable, efficient and quality Internet connectivity through Internet exchange points. Access to funding and technical assistance for these new technologies is of paramount importance. Additionally, port digitalization can enable resilient and sustainable maritime connectivity for SIDS.

Overall, **connectivity must be placed within the larger context of cross-cutting issues common to transport, energy and ICT,** as there are significant opportunities to maximize synergies across the three sectors, particularly through co-deployment and management. For instance, advances in the electrification of transport will have far-reaching implications for energy by increasing demand for electricity. Similarly, the co-deployment of electric power and ICT infrastructure has great potential to transform the development of local renewable energy resources in SIDS, just as high rates of variable renewable energy penetration require ICT-enabled real-time measurement, operation and control systems.

Pursuing smart and cost-effective solutions is crucial to accelerate progress towards the Sustainable Development Goals, especially in countries in special situations where access to financial resources is often limited. Leveraging the transformative power of transport, energy and ICT connectivity to unlock synergies and respond swiftly to climate change is, therefore, a strategy that policymakers should pay heed to. This, however, requires greater institutional capacities of national stakeholders, including regulators and policymakers, and a strategic vision to collaborate regionally. Reaping the social, economic, and environmental benefits of connectivity initiatives also requires more bilateral and multilateral efforts, including through South-South cooperation.

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Contents

Explanatory notes

Analyses in the report are based on data and information available up to the end of March 2023.

Groupings of countries and territories/areas are defined as follows:

- **ESCAP region:**
  - Members [49]: Afghanistan; Armenia; Australia; Azerbaijan; Bangladesh; Bhutan; Brunei Darussalam; Cambodia; China; Democratic People's Republic of Korea; Fiji; Georgia; India; Indonesia; Iran (Islamic Republic of); Japan; Kazakhstan; Kiribati; Kyrgyzstan; Lao People's Democratic Republic; Malaysia; Maldives; Marshall Islands; Micronesia (Federated States of); Mongolia; Myanmar; Nauru; Nepal; New Zealand; Pakistan; Palau; Papua New Guinea; Philippines; Republic of Korea; Russian Federation; Samoa; Singapore; Solomon Islands; Sri Lanka; Tajikistan; Thailand; Timor-Leste; Tonga; Türkiye; Turkmenistan; Tuvalu; Uzbekistan; Vanuatu; and Viet Nam;
  - Associate members [9] – American Samoa; Cook Islands; French Polynesia; Guam; Hong Kong, China; Macao, China; New Caledonia; Niue; and Northern Mariana Islands.
- **Least developed countries** (LDCs) [11]: Afghanistan; Bangladesh; Bhutan; Cambodia; Kiribati; Lao People's Democratic Republic; Myanmar; Nepal; Solomon Islands; Timor-Leste; and Tuvalu.
- **Landlocked developing countries** (LLDCs) [12]: Afghanistan; Armenia; Azerbaijan; Bhutan; Kazakhstan; Kyrgyzstan; Lao People's Democratic Republic; Mongolia; Nepal; Tajikistan; Turkmenistan; and Uzbekistan.
- **Small island developing States** (SIDS) [22]:
  - ESCAP member States [15]: Fiji; Kiribati; Maldives; Marshall Islands; Micronesia (Federated States of); Nauru; Palau; Papua New Guinea; Samoa; Singapore; Solomon Islands; Timor-Leste; Tonga; Tuvalu; and Vanuatu;
  - Associate members [7]: American Samoa; Cook Islands; French Polynesia; Guam; New Caledonia; Niue; and Northern Mariana Islands.
- **Countries with special needs/countries in special situations** [37]: LDCs, LLDCs and SIDS.
- Developing ESCAP region – ESCAP region, excluding Australia, Japan and New Zealand.
- Developed ESCAP region – Australia, Japan and New Zealand.
- Pacific – American Samoa; Australia; Cook Islands; Fiji; French Polynesia; Guam; Kiribati; Marshall Islands; Micronesia (Federated States of); Nauru; New Caledonia; New Zealand; Niue; Northern Marina Islands; Palau; Papua New Guinea; Samoa; Solomon Islands; Tonga; Tuvalu; and Vanuatu.
- Due to the limited availability of data, associate members of ESCAP are excluded from the analysis in the report unless otherwise indicated.
- For the purposes of this report, Singapore is not considered to be a small island developing State because of its high level of development and high-income status, and for simplicity of analysis.

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References to dollars ($) are to United States dollars, unless otherwise stated.

Acronyms

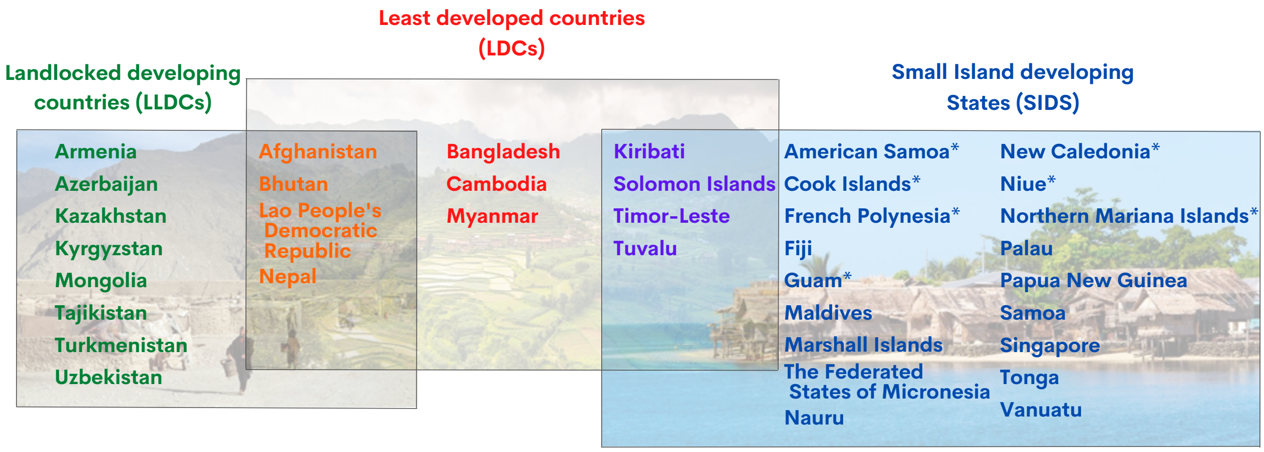
ADB	Asian Development Bank
AERN	ASEAN Energy Regulatory Network
AP-IS	Asia-Pacific Information Superhighway initiative
APCICT	Asian and Pacific Training Centre for Information and Communication Technology for Development
APG	ASEAN Power Grid
ASN	Alcatel Submarine Networks
ASEAN	Association of Southeast Asian Nations
CAREC	Central Asia Regional Economic Cooperation Program
BIMSTEC	Bay of Bengal Initiative for Multi-Sectoral Technical and Economic Cooperation
CAREM	Central Asia Regional Electricity Markets
CASA-1000	Central Asia-South Asia power project
COP26	United Nations Climate Change Conference in Glasgow
DART	Deep-Ocean Assessment and Reporting of Tsunamis
ESCAP	Economic and Social Commission for Asia and the Pacific
ECTS	electronic cargo tracking system
GEIDCO	Global Energy Interconnection Development and Cooperation
GDP	gross domestic product
GNI	gross national income
HVDC	high-voltage direct current
ICT	information and communications technology
IPT	Independent Power Transmission
IEA	International Energy Agency
IMO	International Maritime Organization
IRADe	Integrated Research and Action for Development
ITF	International Transport Forum
ITU	International Telecommunication Union
IXP	international Internet exchange points
JICA	Japan International Cooperation Agency
LDC	least developed country
LEO satellite	low Earth orbit satellite
LLDC	landlocked developing country
LTMS-PIP	Lao People’s Democratic Republic, Thailand, Malaysia and Singapore Power Integration Project
NAPSI	Northeast Asia Power System
NEARPIC	North-East Asia Power Interconnection and Cooperation

OHRLLS	United Nations Office of the High Representative for the Least Developed Countries, Landlocked Developing Countries and Small Island Developing States
OPERA	Office of Pacific Energy Regulators Alliance
PCI	Productive Capacities Index
PPP	public-private partnership
PV	photovoltaics
SAARC	South Asian Association for Regional Cooperation
SAREP	South Asia Regional Energy Partnership
SARI/EI	South Asia Regional Initiative for Energy Integration
SCADA	supervisory control and data acquisition
SDG	Sustainable Development Goal
SIDS	small island developing State
SMART cables	Science Monitoring and Reliable Telecommunications cables
UNCTAD	United Nations Conference on Trade and Development
UNDP	United Nations Development Programme
UNESCO-IOC	United Nations Educational, Scientific and Cultural Organization-Intergovernmental Oceanographic Commission
UNICEF	United Nations Children's Fund
USAID	The United States Agency for International Development
WMO	World Meteorological Organization

Introduction

The United Nations classifies 37 economies in Asia and the Pacific as least developed countries (LDCs), landlocked developing countries (LLDCs) or small island developing States (SIDS) (figure 1). Collectively referred to as "countries with special needs" or "countries in special situations", they are marked by inherent structural weaknesses, such as geographic remoteness from seaports or major sea routes, lack of scale economies, and high vulnerability to climate change, disasters and environmental degradation. As a result, these countries remain greatly underrepresented in the region's economy, accounting for just 3 per cent of the gross domestic product (GDP) and trade in goods and services, while making up more than one half of ESCAP member States and associate members.[1]

Figure 1 List of Asia-Pacific countries with special needs



Source: ESCAP.
Note: Asterisks (*) indicate associate members of ESCAP.

Seamless and sustainable connectivity can address some of the structural weaknesses of the countries in special situations, while strengthening economic development and resilience, and promoting climate action. For example, improved multimodal transport connectivity can lower trade costs, enhance the efficiency and competitiveness of doing business, and allow the use of more environmentally friendly modes of transport. The benefits are especially pronounced in the LLDCs and SIDS of Asia and the Pacific, which are at a disadvantage because of their lack of direct coastal access or geographical distance from international markets. Similarly, improved digital connectivity can help countries in special situations, especially those with a small population and few natural resources, achieve economies of scale, while fostering access to innovative business as well as climate resilience and adaptation solutions. Economies of scale can also be achieved through greater energy connectivity, which, in turn, increase energy security, accelerate cost-efficient deployment of renewable energy and facilitate the green energy transition. The long-term benefits of seamless and sustainable connectivity will be particularly large for countries in special situations, given their vulnerability to current and future climate impacts and the sustainable development dividends from moving towards a low-carbon and climate-resilient world. Box 1 shows how seamless and sustainable connectivity has been featured in global programmes of action for LDCs, LLDCs and SIDS as a critical element to achieving sustainable development.

Box 1: Transport, energy and information and communications technology connectivity in global programmes of action for least developed countries, landlocked developing countries and small island developing States

Providing seamless and sustainable connectivity is a critical, shared challenge many countries in special situations face. It has been repeatedly recognized as one of the key priorities in the programmes of action for LDCs, LLDCs, and SIDS.

The Doha Programme of Actions for the Least Developed Countries for the Decade 2022−2031[2] underscores the importance of infrastructure development in transport, energy and ICT as one of its six priorities. It includes a target to expand and upgrade national and cross-boundary transport connectivity. Concerning energy connectivity, the Programme highlights the need to strengthen regional cooperation to promote innovation and support regional cross-border power grid connectivity. It also highlights the key role of Governments in reinforcing energy interconnections, connecting regional energy markets and increasing energy security at the regional and global levels. To enhance ICT connectivity, the Programme calls for strong international cooperation to support investment in ICT infrastructure and sets out a target to expand ICT connectivity to bridge the digital divide.

The Vienna Programme of Action for Landlocked Developing Countries for the Decade 2014−2024[3] explicitly highlights the need for close cooperation with transit countries to enhance connectivity in transport, energy and ICT as one of the eight priority areas. It underscores the urgency of infrastructure development, especially in transport, energy and ICT, and highlights the importance of regional connectivity for transport systems, promotion of cross-border energy trade and energy transit, and enhancement of ICT networks. It further emphasizes the significance of intermodal connectivity in transport and the need to promote operational connectivity through the harmonization, simplification and standardization of rules and documentation pertaining to transport.

The SIDS Accelerated Modalities of Action (SAMOA) Pathway 2014−2024[4] highlights several ways to increase the availability and quality of infrastructure in transport, energy and ICT. While the SAMOA Pathway does not explicitly recognize connectivity as a priority, enhancing connectivity is embedded throughout the agenda. For example, it refers to adequate transport, energy and ICT infrastructure networks as key components of sustained economic growth. The SAMOA Pathway also emphasizes the importance of enhanced access to energy, upgraded transport infrastructure and increased use of ICT infrastructure.

The COVID-19 pandemic and the crisis in Ukraine have further highlighted the importance of connectivity as they have amplified pre-existing gaps in access to transport, energy and telecommunication services. For instance, freight transport disruptions have led to long delays and increased costs, significantly affecting LLDCs and SIDS. These challenges have been compounded by growing energy security concerns in net fuel-importing countries. Digital connectivity has become essential because of its critical role in crisis response, remote working and learning, and the provision of health-care services, especially in countries with large rural populations, such as LDCs, and those with a geographically dispersed population, such as SIDS.

Due to persisting connectivity gaps and disruptions, several regional cooperation initiatives have been introduced to foster seamless and sustainable connectivity. Among them are the Regional Road Map on Power System Connectivity: Promoting Cross-border Electricity Connectivity for Sustainable Development, the action plan for implementing the Asia-Pacific Information Superhighway initiative, covering 2022−2026, and the Regional Action Programme for Sustainable Transport Development in Asia and the Pacific (2022−2026)[5]. In addition, Asia-Pacific Governments continue to boost their transport, energy, and digital connectivity by focusing more on reducing environmental costs and addressing climate change.

Considering the large and persistent financing gaps in countries in special situations and the limited time left to achieve the Sustainable Development Goals (SDGs), synergies must be sought between regional cooperation initiatives, with the urgency of an effective climate change response at the core of such efforts. For example, digitalization efforts through the Asia-Pacific Information Superhighway initiative can reduce overall costs of ICT infrastructure development through the co-deployment of ICT and transport infrastructure or other best practices. Transport networks and energy corridors, which are part of economic sectors that account for more than two thirds of all carbon emissions, can be designed to help global, regional and subregional decarbonization efforts.

At the same time, national-level actions need to be synchronized with and benefit from regional cooperation measures and initiatives. In this regard, there is an urgent need to develop coherent and mutually reinforcing development strategies and policies for national connectivity, under which the three broad sectors, transport, energy and ICT, are integrated. Policy and institutional reforms are needed to streamline the roles and responsibilities of multiple national agencies working in the connectivity sphere. Parallel to that, when taking every opportunity to digitize the construction and operations of connectivity infrastructure, and the delivery of associated downstream services, States must pay heed to decarbonizing transport operations and increasing renewable energy generation.[6]

It is against this background that the report examines the role of transport, energy and digital connectivity as a catalyser of sustainable development in the countries in special situations. The report provides examples of how regional cooperation on seamless and sustainable connectivity can facilitate a long-term transformation towards a net-zero emissions future. This is especially important given that the halfway mark of implementation of the 2030 Agenda has been reached.

The rest of the report is organized as follows: Chapter 1 presents a survey of the state of transport connectivity in Asia-Pacific countries in special situations and gives highlights of opportunities and challenges against the background of the pandemic, geopolitical turmoil and the climate crisis; the focus of chapter 2 is on seamless and sustainable connectivity in the electric power system and the role it can play in supporting sustainable development; Chapter 3 contains an outline of the trends in digital connectivity for Asia-Pacific countries in special situations and a detailed discussion on the potential for more affordable and resilient ICT connectivity in these countries; and in the concluding chapter, the main points are tied together, by suggesting four broad areas for regional cooperation, before bringing the report to a close.

ENDNOTES

1. Of the 53 member States and 9 associate members of ESCAP, 30 member States and 7 associate members belong to at least one of these three country groups.
2. General Assembly resolution 76/258, annex.
3. General Assembly resolution 69/137, annex II.
4. General Assembly resolution 69/15, annex.
5. See ESCAP/78/15/Add.2.
6. In a similar vein, in the annex, the importance of building domestic productive capacities to realize the benefits of seamless and sustainable connectivity is highiighed. An analysis of the UNCTAD Productive Capacities Index (PCI) points to an urgent investment need for transport infrastructure in LLDCs and for the expansion and modernization of the ICT infrastructure in all Asia-Pacific countries in special situations.

Chapter 1

Regional cooperation for sustainable transport connectivity

Improving transport connectivity in Asia and the Pacific can only be achieved by tackling one of the greatest development challenges of the region, namely closing long-standing connectivity gaps affecting countries in special situations. This entails addressing a range of development issues because countries in special situations comprise a diverse group of countries, LDCs, LLDCs and SIDS. Furthermore, the challenge must be reviewed in the context of recent global and regional shocks, such as the COVID-19 pandemic and the geopolitical challenges in Europe, which have significantly undermined transport connectivity.

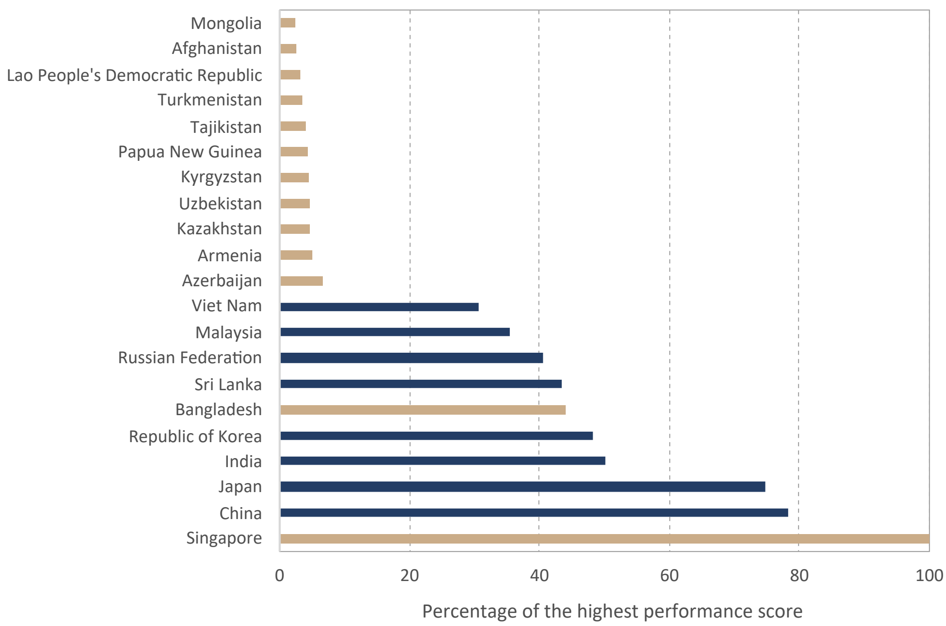
The objective of this chapter is to examine the state of transport connectivity in countries in special situations over the past decade and highlight the enduring disruptions associated with the COVID-19 pandemic, heightened geopolitical tensions and the urgency of the climate change response. In the chapter, ways to transition to more efficient and sustainable transport connectivity in countries in special situations are examined, conditions for such a transition are identified and the role of regional cooperation is explored. The chapter concludes with an outline of regional actions to enhance sustainable transport connectivity in countries in special situations.

1.1. Current transport connectivity landscape

Countries in special situations in Asia and the Pacific have the lowest levels of transport connectivity in the region – some of them are among the least connected countries in the world.

Various global indices used to measure efficiency of transport connectivity clearly show the persistent connectivity challenges of LLDCs and LDCs. The Logistics Performance Index of the World Bank, the Liner Shipping Connectivity Index of the United Nations Conference on Trade and Development (UNCTAD), and the freight connectivity index of the International Transport Forum (ITF) reveal that landlocked countries are consistently among the weakest performers.[7] The ESCAP transport connectivity index, which includes components covering freight transport by air, road, rail and maritime and logistics, shows that ten LLDCs among the 33 Asia-Pacific countries analysed fare especially poorly (figure 1-1). The findings underline the connectivity disadvantages of LLDCs as a group compared to their coastal peers with direct port access.

Figure 1-1 ESCAP transport connectivity index, as a percentage of the highest performer's score, for selected Asia-Pacific countries

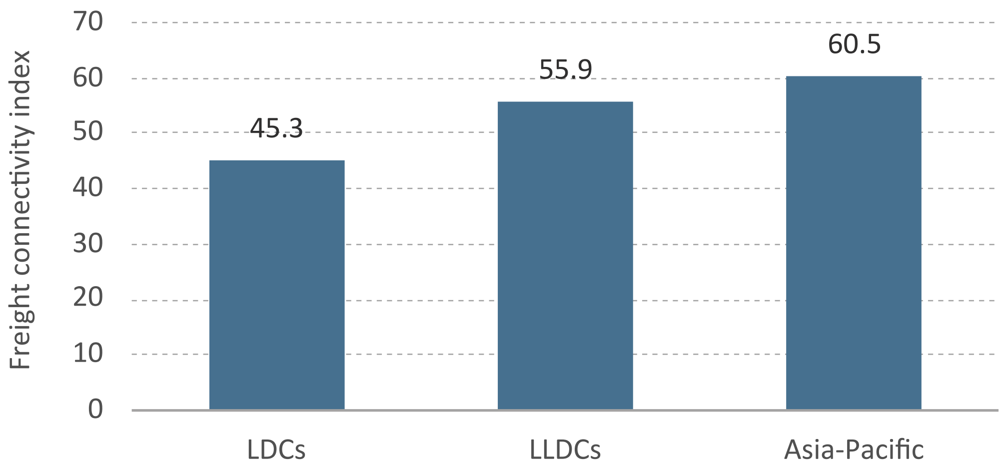


Source: ESCAP (2019d).

Note: The brown bars represent countries in special situations, and the blue bars represent other selected countries in Asia and the Pacific.

The global transport connectivity indices expose the persisting divide between LLDCs, LDCs and the rest of Asia (figure 1-2).

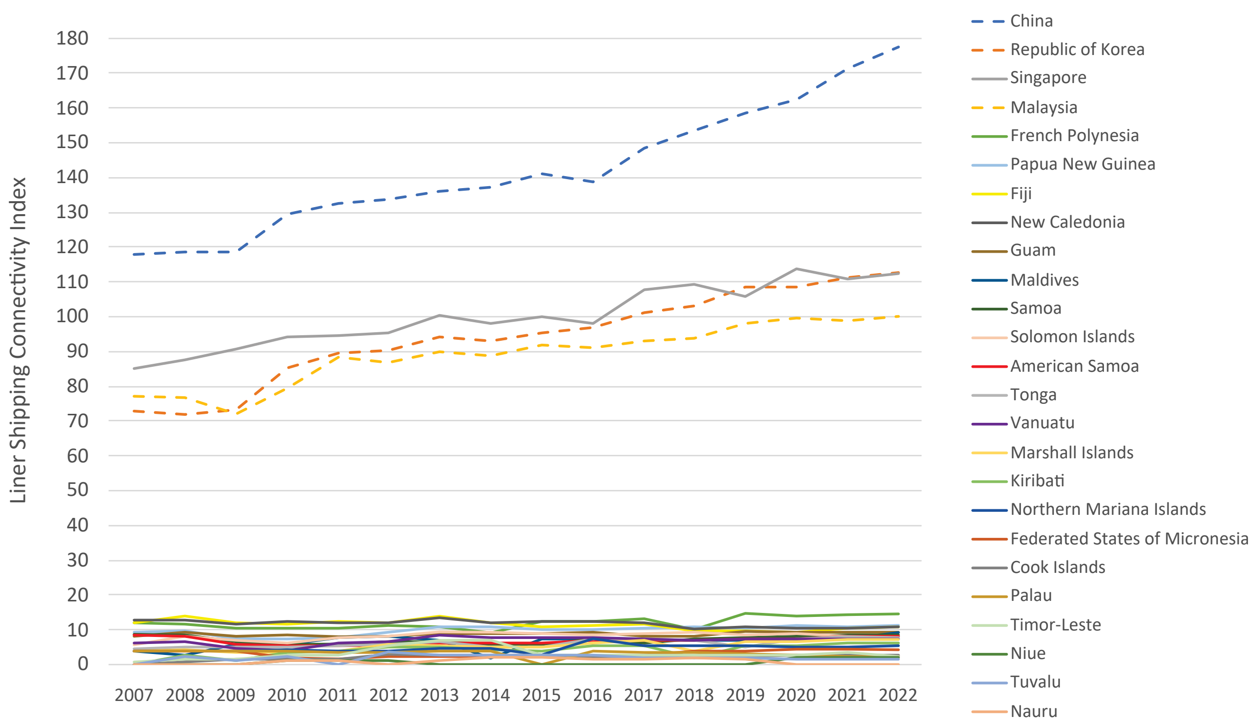
Figure 1-2 Freight connectivity levels in Asia and the Pacific, 2021



Source: ITF (2019).
Note: The index scores were updated for 2021 using the latest data available.

A similar situation is prevailing in Pacific SIDS, including in three LDCs, as is shown by indices measuring maritime transport connectivity. Overall, connectivity levels are low among these island States. The most populated among them – Papua New Guinea, Fiji and Solomon Islands – also display the highest level of connectivity (figure 1-3).

Figure 1-3 Maritime connectivity levels in selected States in Asia and the Pacific as measured by the Liner Shipping Connectivity Index



Source: UNCTADstat. Available at http://stats.unctad.org/LSCI (accessed on 15 February 2023).
Note: The solid lines represent SIDS, and the dashed lines represent other selected countries in the region.

A thorough understanding of transport connectivity gaps and the economic nature of transport links, which differ greatly depending on the geography of countries in special situations, is important to gauge countries' needs and the role of transport connectivity in the structural transformation of their economies.

A. Landlocked developing and least developed countries in Asia

There are twelve LLDCs in the Asia-Pacific region. Seven of them are in the North and Central Asia region (Armenia, Azerbaijan, Kazakhstan, Kyrgyzstan, Tajikistan, Turkmenistan and Uzbekistan). The other LLDCs in the region are Afghanistan, Bhutan and Nepal in South Asia; the Lao People's Democratic Republic in South-East Asia; and Mongolia in East and North-East Asia. Four of the Asian LLDCs (Afghanistan, Bhutan, Nepal and the Lao People's Democratic Republic) are also LDCs. The other LDCs of the region are Bangladesh, Cambodia and Myanmar.

The economic structure and trade of these Asian LLDCs and LDCs have the following peculiarities:

- Their main exports are low-value primary products, which are highly sensitive to transport costs. Imports are high value-added goods that require fast transport connections.

- Agricultural exports and imports require short or predictable transport time and special infrastructures, such as cold storages. The perishable nature of most of these products calls for reliable transport and logistics support systems.

- Crude oil tends to be transported by pipeline, so existing infrastructure must be reliable or special tanker services are required if transported by rail or sea.

- The countries face the challenge of moving from low- to higher-value manufacturing for which cost-effective access to global markets is vital.

Typically, trading carried out by LLDCs and LDCs is oriented towards large markets or neighbouring countries. For instance, India and Pakistan together account for more than 80 per cnt of exports from Afghanistan; and India is the largest trading partner of Bhutan and Nepal. Similarly, the Lao People's Democratic Republic mainly trades with Thailand; Mongolia with China; LLDCs in the North and Central Asia subregion with the Russian Federation, Türkiye or the Islamic Republic of Iran. This pattern persists because most of the exports of LLDCs and LDCs are primary goods, such as minerals, metal ores and agro-based products, which are processed in nearby large countries for value-addition and further export. Because of their limited capacities, LDCs and LLDCs often do not have their own competitive industries. Better transport connectivity is key to making their domestic industries more viable.

Cross-subregional trade involving LLDCs and LDCs remains modest. To illustrate, the value of merchandise exports from Central Asia was $88 billion in 2021, while imports reached $80 billion in the same year. Most exports were destined for Europe (43 per cent of the total), followed by East and North-East Asia (25 per cent), and Western Asia and Northern Africa (9 per cent). Similarly, Europe was the dominant source of the region's imports (48 per cent of total imports), followed by East and North-East Asia (29 per cent), and Western Asia and Northern Africa (6 per cent). Though geographically close, economies in South and South-West Asia and South-East Asia were not among the main trading destinations for the countries of Central Asia. One reason for this is a lack of viable transport connections. Better connections could induce greater trade in fertilizers, metals, grains, chemical products and textiles between countries in North and Central Asia and countries in South-East Asia.[8]

The economic development of LLDCs and LDCs critically depends on their structural transformation from an overreliance on primary goods to higher value-added manufacturing and trade.[9] The development of the transport sector is key to this transformation. However, transport connectivity of LLDCs and LDCs in Asia is complicated by a raft of systemic factors:

- An unbalanced modal split in transport operations, manifesting in the dominant position of road transport in domestic and international freight transport operations;
- A persistent shortage of quality infrastructure, manifesting in missing links and substandard quality of the road and rail transport infrastructure;
- Operational connectivity gaps, resulting from a lack of harmonization, facilitation and digitalization of international transport procedures;
- Extensive unrealized transit potential, due to the above-mentioned factors, and insufficient bilateral and multilateral cooperation.

B. Small island developing States and least developed countries in the Pacific[10]

Small island developing States, including the three Pacific LDCs, are typically far from their major trading partners and rely on imports of most goods, including fuels, construction materials, vehicles and foodstuffs. Their economic base is narrow and their trade volumes are low. As a result, the vessels that service SIDS tend to be small or medium in size and run on an infrequent basis.

Maritime development of SIDS is shaped by small, isolated, and geographically disbursed populations, a narrow economic base, high vulnerability to external shocks and vulnerable economies, and heavy reliance on imports. In practice, this results in the following:

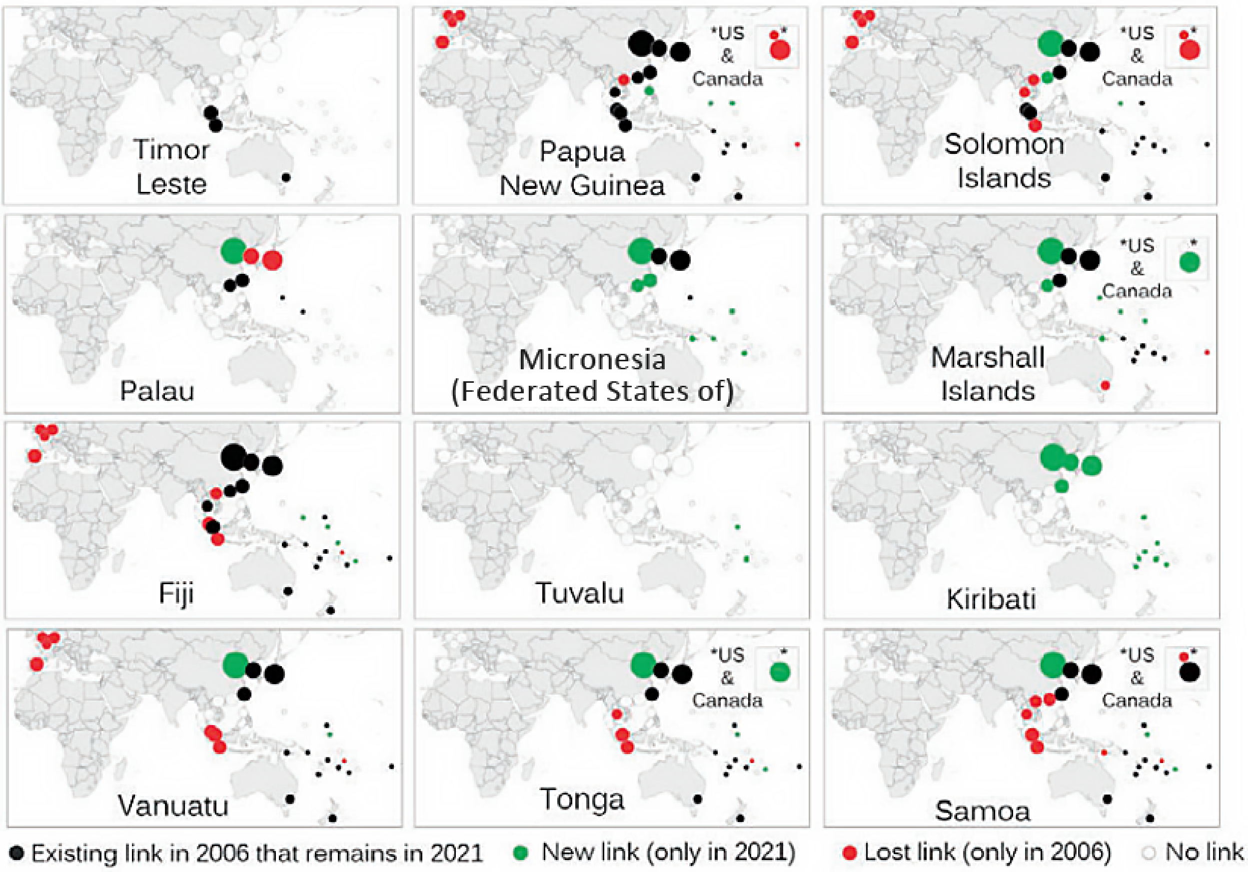
- Low trade volumes. Oceania accounts for less than 0.2 per cent of global shipping cargo;
- Higher import than export volumes. This imbalance results in high rates of empty container returns;
- Use of small, multi-purpose vessels with ship-mounted cranes. The equipment is scaled to the volume and type of cargo; at most port facilities, they are small and have no shore cranage;
- Widely varying quality of port facilities and inadequate funding for operations and maintenance;
- Natural monopolies in most port services. This is because, in many cases, low cargo volumes do not support more than one supplier.

As it is well known, transport connectivity is low among Asia-Pacific SIDS. Papua New Guinea, Fiji and Solomon Islands are the best-connected countries in this grouping (figure 1-4). Their relatively large market size makes them more attractive for maritime companies, which use them as transhipment bases. Only some SIDS are served by North-South shipping routes, which link Australia and New Zealand with East Asia and North America. Guam, located in the northern part of the ocean and Fiji, located in the southern part of the ocean, are the two regional hubs. Overall transport connectivity among SIDS has improved since the mid-2000s, but in most cases, it has stagnated or declined since 2013. Over the period 2006–2021, some Pacific SIDS were not served directly by shipping lines, while others faced significant variations in shipping services. For some States, the transport connectivity has improved slightly because of the deployment of larger vessels and more regular schedules. Others have been challenged by reduced capacity and fewer services (figure 1-4).

Maintaining frequent vessel connections is an ongoing challenge for SIDS. Low cargo volumes and trade imbalances keep transport costs high. Papua New Guinea and Fiji are the SIDS with the most port calls. The Federated States of Micronesia and Kiribati recorded the lowest number of port calls by container ships between 2018 and 2021. During the same period, containership port calls declined in most SIDS, except Papua New Guinea, Solomon Islands and the Marshall Islands.

The trade competitiveness of SIDS in the Asia-Pacific region is negatively affected by the poor quality of port infrastructure, low connectivity and low frequency of shipping services. These conditions trigger a vicious cycle of port congestions and high logistics costs. Freight rates for export and import cargo are often elevated due to additional handling surcharges incurred at congested ports. In addition, Pacific SIDS only have connections with a limited number of trading partners and most direct connections are with small ports within the region.

Figure 1-4 Direct links of selected small island developing States, 2021 compared with 2006



Source: Lifted from page 40 of UNCTAD and ESCAP (2022).

Notes: The size of the circles represents the number of vessel calls. A direct link exists between two States if a same vessel calls at ports in both countries.

The connectivity of SIDS in Asia-Pacific continues to suffer because of the following:

- A low frequency of shipping services;
- Lack of redundancy of shipping services and port facilities. In many Pacific islands, there is only one international port with sufficient capacity, adequate wharf length, depth of water in channels and berths to allow international ships to call directly;
- High transport costs relative to the value of shipped goods;
- Vulnerable transport networks. Ports in SIDS and shipping services are vulnerable to disruptions by natural disasters, pandemics, and macroeconomic and fuel price shocks;
- Poor domestic transport connectivity aggravated by the rapid urbanization of capital cities, the depopulation of outer islands and regulations curbing the involvement of international firms in domestic trade.

1.2. Recent developments in transport connectivity

The recent global and regional economic disruptions − ranging from the COVID-19 pandemic to heightened geopolitical turmoil − have had a strong negative impact on the countries in special situations in Asia and the Pacific. The effects of these events may fundamentally change the trade and transport connectivity of these countries.

A. Impact of the COVID-19 pandemic

Until 2020, Eurasian and Asian transport connectivity developed favourably in most countries involved in trade between Asia and Europe, including LLDCs in North and Central Asia. Growing inland freight transit volumes spurred the development of transport infrastructure. In addition, many countries linked up to international transport operations and began using new transit connections.

This trend ended with the COVID-19 pandemic. New macroeconomic realities emerged. First, supply shocks became the defining feature of the economic downturn as production was hit, borders were closed, and food and energy prices rose sharply. This was unlike other recent economic recessions, which were marked primarily by a decline in credit, stocks and demand. Second, spending on transport and logistics fell and became more fragmented. There was no coherent policy to support infrastructure or transport operators and governments focused their efforts on domestic interventions rather than regional cooperation. These largely uncoordinated policy responses have slowed the restoration of trade.

In the wake of the first waves of the pandemic, shipping costs rose dramatically. Transport costs surged amid rising freight volumes between Asia and Europe and an acute lack of capacity at major Asian ports. Between March 2020 and May 2021, the Shanghai Containerised Freight Index rose more than 300 per cent. The same index for shipments to Europe jumped approximately 500 per cent. The World Container Index, which is compiled by Drewry (n.d.), a maritime research consultancy, surged more than 300 per cent during the same period.

Not only did freight rates climb to unprecedented heights, but shipping times also increased. The blockage for six days in March 2021 of the Suez Canal, after the grounding of the container ship Ever Given, led to a major disruption of trade between Europe, Asia and Middle East.

For Asian LLDCs and LDCs, major impacts of the pandemic on the transport sector were higher costs and reduced funding for transport infrastructure. Because of the limited operation or closure of the retail trade, warehouses became overcrowded and importers struggled to accommodate shipments. For the duration of much of the pandemic, just-in-time logistics turned into just-in-case logistics. The volatility in cargo flows affected all countries, including those with direct port access. Naturally, inland freight handling facilities and service providers in landlocked countries experienced even greater challenges in setting freight rates and adhering to delivery time schedules.[11]

Similar pandemic-related impacts were observed in SIDS, including the Pacific LDCs. Estimates had predicted early on that these economies would be hit the hardest by rising freight rates and the associated surge in import prices and inflation. UNCTAD (2021) projected that SIDS would, with a delay of one year, experience a 24 per cent hike in import prices − double that of the predicted rise in the global average, and that soaring freight rates would trigger a steep rise in consumer prices in small, import-dependent economies. This was consistent with the finding that the pass-through of higher shipping costs to inflation tends to be significantly larger in small economies that depend heavily on imported goods (Carrière-Swallow and others, 2023). In short, the COVID-19 pandemic, among other factors, hurt transport connectivity and reduced infrastructure funding, especially in LDCs, LLDCs and SIDS.

For countries in special situations, guarding against future shocks critically depends on ensuring more reliable and predictable access to gateway ports for transshipments (especially in the case of LLDCs), and, in the case of SIDS, improved port infrastructure and maritime services. The latter group of countries would greatly benefit from an upgrading of their port facilities to enable access of larger feeder vessels serving nearby maritime hubs.

B. Impact of the European geopolitical crisis on transport connectivity in countries in special situations

The Eurasian geopolitical crisis, which came on the heels of the pandemic, exacerbated the global economic slowdown. The combined effects on global trade and transport have been significant, resulting in lower trade volumes and increased transportation costs and time, and disruptions to the movement of goods across borders. The impact has been particularly marked in LLDCs in North and Central Asia, where transport connectivity has been hit by sanctions imposed on the Russian Federation and other disruptions to trade. The commodities that were most affected were the main exports of North and Central Asian countries, such as oil, metals, fertilizers, agricultural products and grains (ESCAP, 2023).

As a result of restrictions on the use of land and airspace of the Russian Federation, the transport of goods between Asia and Europe has shifted from the most efficient and established links to other routes, especially the “Middle Corridor”, which is a developing land and sea freight route between Europe and China (table 1-1). One of the key features of transport along the Middle Corridor is a high number of border crossings and rail-to-sea transshipments. This adds up to two weeks in transportation time relative to the traditional Dostyk-Brest and the Trans-Siberian routes. Alternative routes can only pick up a fraction of the trade: the Northern Corridor via the Russian Federation and Belarus accounts for more than 80 per cent of the China-Europe trade. The Middle Corridor can handle just 5 per cent of total traffic between Europe and Asia. Another key impact of the geopolitical crisis has been the disruption to nascent trade links whose development is necessary to unlock the export potential of LLDCs. An analysis of transport corridors, especially between Europe and Asia, is presented below.

Table 1-1 Changes, constraints and opportunities of selected transport corridors

	Type	Commodities:	Prospects and opportunities:	Challenges:
Trans-Caspian International Transport Route (TITR, Middle Corridor)	Multimodal	Exports of high value-added metal products and oil to European countries: imports by Central Asian countries and transit of containerized China-Europe goods trade; access to Black Sea ports for North Central Asia links with South Asia and South-East Asia	Sharp increase in transportation volumes due to a shift from the northern route in the short term Prioritization of the route by European freight market participants	Lack of a development strategy Absence of a unified and interconnected system of operational management Lack of a "one-stop shop" system for users (unlike the Northern Route) Lack of coordination and linkage of multimodal transport solutions, including their interchangeability Significant infrastructure constraints Development plans significantly underestimate traffic volumes
Kazakhstan – Turkmenistan – Islamic Republic of Iran (KTI)	Railway	Oil, grains, and agricultural products	Significant increase in the transportation volumes, mainly oil and other exports from Kazakhstan by sea to South-East Asia and Africa Prioritization of the route by Russian freight market participants	Lack of a unified and interconnected operational management system Low transparency of the business system
Kazakhstan – Uzbekistan – Islamic Republic of Iran – Türkiye (Southern route)	Railway	Intraregional trade in North and Central Asia, transit of containerized goods China – European Union, metals exports to the European Union, grains exports to Western Asia	Increased transportation volumes due to a shift from the northern route. Prioritization by the European freight market participants	Lack of a unified and interconnected operational management system Low managerial competence in some segments of the route Uncoordinated tariff policy of railway administrations of Kazakhstan and Uzbekistan
Kazakhstan – Uzbekistan – Islamic Republic of Iran motorway	Road	Export of grain, non-ferrous metals and high value-added products to the Middle East, Africa and South-East Asia	Increased transportation volume Ease of organizing road transport compared to railway transport No need for large new infrastructure investments	Lack of a corridor management system and transport safety guarantees Border delays

Source: ESCAP (forthcoming).

In conclusion, because of the ongoing European geopolitical crisis, some LLDCs in the Asia and Pacific region are faced with new risks to their established supply chains. At the same time, the situation has highlighted existing and new opportunities to improve transport connectivity of these countries. Along with economic diversification, new international transport corridors play an increasingly important role in the economic development of LLDCs.

C. Climate change response

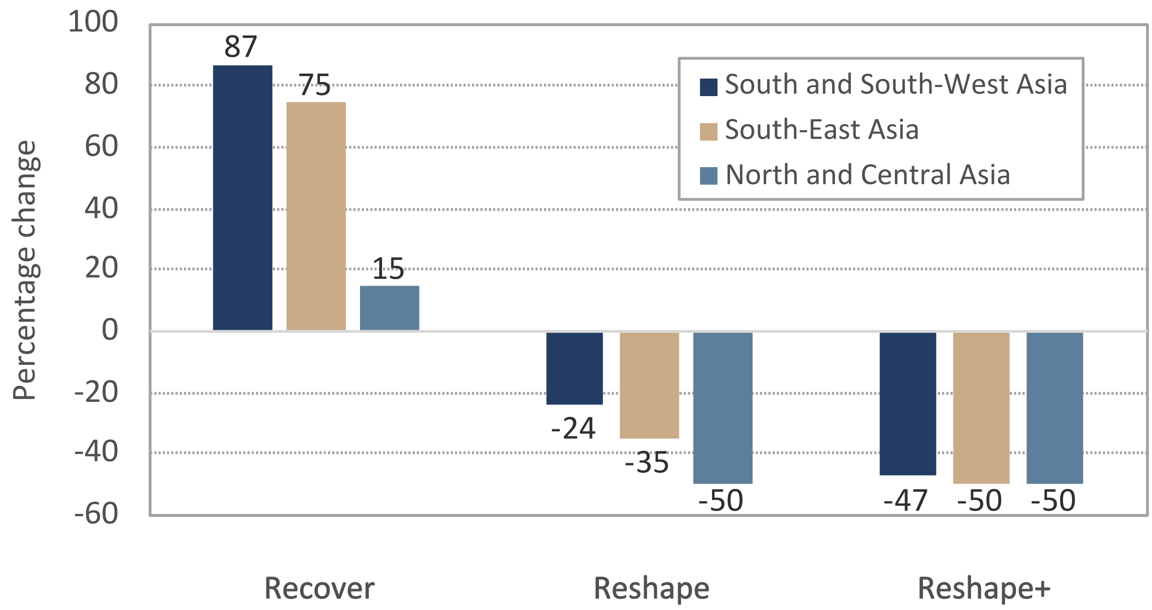
Pandemic-induced supply-chain disruptions, rising geopolitical tensions and a crisis in world energy markets have made the need to move towards a low-carbon future even more urgent. In Asia and the Pacific, climate change threats are especially severe in countries in special situations and concern the transport sector. The most prominent example is SIDS, whose maritime connectivity is under threat by more frequent adverse climatic events. Natural disasters regularly disrupt their supply chains and limit access to potable water, fuel, food and medicine. Governments must build up ample stocks of necessary goods because when a disaster hits, freshwater sources are often contaminated, crops are destroyed and the power supply is disrupted. In many SIDS, however, the transport network does not lend itself to rapid stock building. Furthermore, severe weather or seismic events can disrupt operations of ports. To illustrate, in Nauru, phosphate exports were suspended for eight months after the mooring system was damaged in a ship berthing accident (Nauru, 2015).

Rising sea levels will hit SIDS the hardest. In most of these small and remote States, nearly all major infrastructure and settlements are concentrated in coastal areas vulnerable to rising water levels, storm surges and flooding. The effects of climate change are likely to damage port infrastructure, push up maintenance costs, impede port operations and create more dangerous working conditions. Another challenge is coastal erosion and its impact on shipping channels and sedimentation levels in harbours. Cyclones, which are occurring more frequently than in the past, have put ports at greater risk. In these locations, containers, typically stacked 4 or 5 high at port, now need to be stacked only 3 high. The change reduces the risk of storm damage, but it is costly (ESCAP, 2022a).

Landlocked developing countries and LDCs are particularly vulnerable to climate change impacts that affect their road networks, which are often of low quality to begin with. For example, the quality of the Asian Highway routes is the lowest in North and Central Asia, as only 16 per cent of the entire routes consist of primary and class-I roads (ESCAP, 2019d). Climate change could affect transport infrastructure through long-term gradual or incremental changes in weather patterns and damage caused by sudden extreme weather events. For instance, constant exposure to rising temperatures leads to a gradual deterioration of paved road surfaces, bridge joints and rail tracks, while flash floods or landslides can damage all modes of transportation. In many Asia-Pacific countries, especially in LDCs and SIDS, climate resilience is poorly integrated into transport infrastructure planning and asset creation due to capacity constraints, resource gaps and inadequate access to technology. A study conducted by ESCAP on developing climate resilient transport infrastructure in Kazakhstan (Chepelianskaia and Sarkar-Swaisgood, 2022) highlighted the need for a multi-step approach that includes an assessment of sectoral climate vulnerabilities, the identification of priority transport assets at risk, targeted investments for improving resilience and technical cooperation at the regional level.

In the era of the climate crisis, improvements to transport connectivity in countries in special situations must go hand-in-hand with addressing climate risks and impacts. An analysis of freight and passenger traffic in selected Asian subregions carried out by ESCAP, which is used by ITF (2022a, 2022b, 2022c), projects a sharp rise in greenhouse gas emissions under the "business-as-usual" scenario. It also highlights the tremendous opportunities for transport decarbonization. Under the scenario with the most ambitious decarbonization policies (Reshape+), emissions from the non-urban freight sector in South and South-West Asia, South-East Asia and North and Central Asia may decline by as much as 50 per cent by 2050, despite surging freight volumes (ITF, 2022a; 2022b; 2022c).

Figure 1-5 Estimated change in non-urban freight's carbon dioxide emissions between 2015 and 2050, by scenario (percentage change)



Sources: ITF (2022a, 2022b, 2022c).

1.3. Turning crisis into opportunity; the future of sustainable transport connectivity

Three recent crises, the COVID-19 pandemic, geopolitical disorder and a slowing global economy, have led to a restructuring of international trade and transport links in Asia and the Pacific. Trade volumes have declined and the structure of goods traded between different subregions has changed. In LLDCs, especially those in the North and Central Asia subregion, which acts as a key bridge for trade between Europe and Asia, the recent crises have pushed up trade costs, lowered trade volumes and led to a reduction in public revenue. At the same time, the post-COVID era has created opportunities for developing a more sustainable freight sector in countries in special situations and strengthening cooperation among Asia-Pacific subregions, including the following:

- The development of alternative connections and economic corridors to increase the resilience of existing transport and trade links;
- Opportunities to participate in the development of nascent international transport corridors that have become more attractive as a result the crisis;
- Development of transport and trade links based on the needs of countries in special situations, not historical links,
- A boost to exports thanks to changes in the structure of traded goods.

Above all, the ongoing restructuring of global and Eurasian trade has highlighted the importance of timely, inexpensive, and resilient transport links and reliable supply chains. Key steps towards making transport connectivity of countries in special situations more sustainable and resilient are the following:

- Support current countries in special situations' connectivity initiatives;
- Strengthen international transport corridor development involving countries in special situations;
- Increase the use of international rail transport in Asia;
- Build on the pandemic-induced momentum for transport facilitation and digitalization;
- Promote resilient and sustainable maritime connectivity in the Pacific.

A. Supporting ongoing country in special situations' connectivity initiatives

Despite major global economic challenges, LLDCs in Asia have implemented several connectivity projects that focus on building new infrastructure, enhancing existing infrastructure or initiating new transport services. The main projects are summarized in the table below.

Table 1-2 Examples of the current projects involving countries in special situations in the period 2020–2022

No.	Region	Country	Types of projects: (1) new construction and capacity enhancement	Types of projects: (2) new services (operations)	Impact on connectivity*
1	North and Central Asia	Azerbaijan	2020 – Work on rebuilding a disused railway, which allows North–South trains to bypass the Baku conurbation started		**Transit**
2				2021 – Twice-weekly container block train service from Baku to Mersin and Istanbul launched	**Transit**
3				2021 – The new Caspian Sea train ferry in Azerbaijan, operated by Azerbaijan Caspian Shipping Co, entered into service. It links Baku with Kuryk in Kazakhstan and Turkmenbashi in Turkmenistan.	**Transit**
4		Kazakhstan	2021 – Double-track and electrify the line from the Alakol area to Dostyk on the Chinese border started		**Export and import links**
5		Uzbekistan	2020 – Electrification of the 331-km-long railway ring in the Ferghana Valley is completed		**Export and import links**
6				2021 – Special trains for tea and tea products launched between China and Uzbekistan	**Export and import links**
7				2022 – New intermodal service from Japan to Uzbekistan via China and Kazakhstan launched	**Export and import links, transit**

No.	Region	Country	Types of projects: (1) new construction and capacity enhancement	Types of projects: (2) new services (operations)	Impact on connectivity*
8	South-East Asia	Lao People's Democratic Republic	2021 – The 418-km-long railway linking Vientiane and the town of Boten on the Chinese border formally opened		**Export and import links, transit**
9			2022 – The Vientiane South freight transhipment yard opened		**Export and import links, transit**
10				Nippon Express Co (China) launched a multimodal freight service using rail between Kunming in China and Vientiane in the Lao People's Democratic Republic, and lorries from Vientiane to Thailand and other ASEAN countries	**Export and import links, transit**
11		Myanmar		2021 – First trial shipment completed on a sea, road and rail freight corridor linking Chengdu in China with the Indian Ocean via Myanmar (the route provides China with a route to and from South and South-East Asia. which avoids eastern ports of China)	**Transit**
12	South Asia	Afghanistan		2020 – First Islamic Republic of Iran to Afghanistan freight train launched	**Export and import links**
13			2021 – Line from Aqina on the border with Turkmenistan to the northern Afghan town of Andkhoy inaugurated		**Export and import links**
14				2021 – Shipment of Chinese commercial and transit goods from Urumqi via Uzbekistan to the border town of Hairatan by rail	**Export and import links, transit**
15		Bangladesh	2022 – Construction of a new rail link between Akhaura (Bangladesh) to Agartala (India) completed	2021 – Oxygen Express train carrying liquid medical oxygen launched by the Indian Railways	**Export and import links**
16				2021 – Regular freight services between Haldibari in India and Chilahati in Bangladesh restarted after a hiatus of 56 years	**Export and import links**

Source: ESCAP (forthcoming)

Most of the above-mentioned new transport projects connected LLDCs in the east-west direction between Asia and Europe. The focus was on expanding well-established trunk lines and establishing better links with transit countries. This should help to establish better links for landlocked States and contribute towards more efficient Eurasian transport flows. Meanwhile, Governments in the region are mulling new connections with the potential to change the continent's transport landscape and the economic prospects of LLDCs. This shift has in part been driven by the realization that, in times of conflict, alternatives to well-established transport routes are vital.

B. Strengthening international transport corridor development

The crises over the period 2020–2022 affected transport connectivity in countries in special situations. Some of the transport connections that had previously been the most economical are being substituted by new, less efficient connections. There, however, is a silver lining here: the disruptions to old transport structures may end up boosting transport connectivity in these countries. In the light of these new economic and geopolitical realities, governments should review their transport strategies, including corridors and multimodal routes that once looked unviable.

To date, most of the international corridors linking the subregions of Asia are not fully developed. "Hard" and "soft" transport policy measures, namely physical improvements to infrastructure and other incentives that make users switch transport modes, are needed. In addition, current transport infrastructure development often does not take into account the structure and volumes of future trade. In South and South-West Asia, most cross-border transport projects are planned unilaterally or bilaterally, and largely disregard regional transport concerns. Recent bilateral transit-trade treaties between Bhutan and Nepal, respectively, with India, is one such example. Another barrier to more seamless connectivity is the lack of cooperation on regular transport links and intersubregional interoperability.

The environmental impact of transport corridors has been gaining greater attention in recent years to the point that it is now essential in the development, upgrading and operation of infrastructure. Multimodal solutions often offer great benefits to transport users, service providers and the local community. Designed properly, they can be reliable and cost-effective and make freight operations more environmentally friendly.

Supporting mechanisms of transport corridor management and the implementation of multilateral transport agreements is a key priority of the work of ESCAP on transport and is part of the Regional Action Programme for Sustainable Transport Development in Asia and the Pacific (2022–2026)[12]. As part of this effort, the secretariat has analysed management and other relevant agreements of several transport corridors in the region with the objective to design possible institutional arrangements for one or more of the examined transport corridors (ESCAP, 2019b). ESCAP has also identified critical factors for the "success" of transport corridors and supported multilateral cooperation.

Recommended actions for regional cooperation on transport corridors include the following:

- Promote multilateral agreements on commodity flows and infrastructure projects to ensure improved regional transport connectivity that benefits countries in special situations;

- Launch a monitoring programme of transport corridors that affect countries in special situations to assess their efficiency and operations and can be used for project certification;

- Expand efforts that help simplify border crossing formalities and enhance seamless data interchange and electronic interoperability along transport corridors.

The proposed actions can be coordinated through the platform for the regional cooperation on intermodal transport, set under the Intergovernmental Agreement on Dry Ports. During its fourth meeting in June 2021, the Working Group on Dry Ports, which consists of representatives of ESCAP member States, considered the need for an online data collection tool for intermodal transport corridors and requested ESCAP to explore the development of such a tool.[13]

Box 1-1: An example of a recent development of a transport corridor coordination mechanism in the Asia-Pacific: KTI Railway Corridor

The Economic and Social Commission for Asia and the Pacific, together with the Economic Cooperation Organization (ECO) and with financial support extended by the Islamic Development Bank, implemented a project from 2019 to 2021 to assess the possibilities of the commercialization of a North-South railway corridor that passes along Kazakhstan, Turkmenistan and the Islamic Republic of Iran (KTI) from 2019 to 2021.

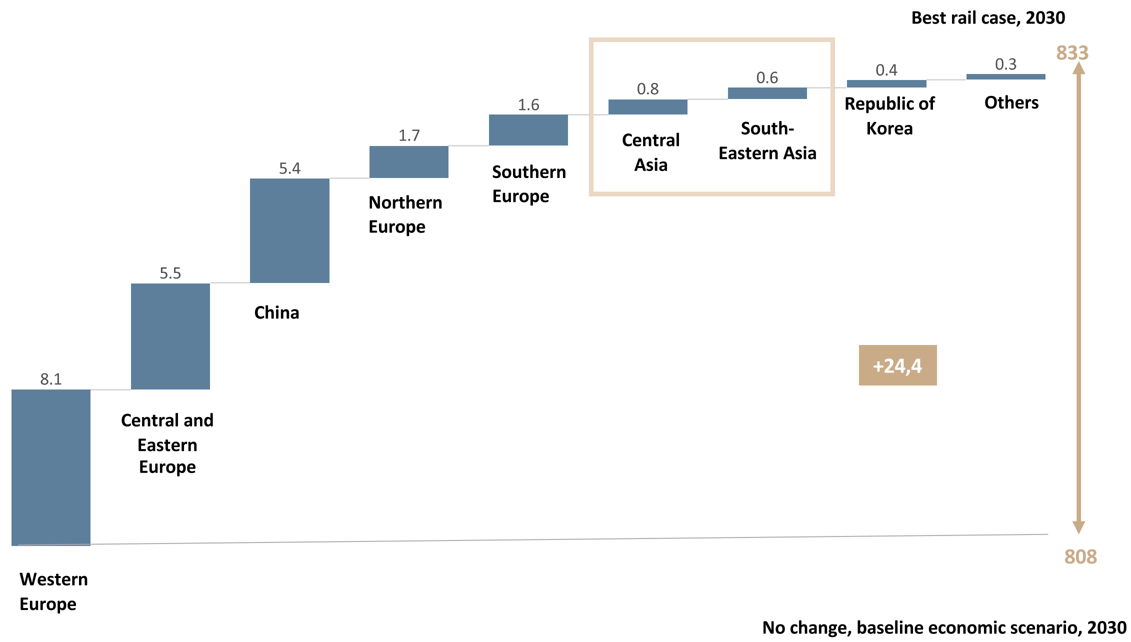
The KTI railway corridor runs east of the Caspian Sea and was completed in the end of 2014. It consists of approximately 940 km of which a 142 km section is in Kazakhstan, a 700 km section is in Turkmenistan, and a 100 km is in the Islamic Republic of Iran.

Under the project, the railway administrations of the three countries signed a memorandum of understanding on the implementation of the KTI rail freight corridor in November 2021. The memorandum establishes a permanent working group as the corridor management mechanism to increase collaboration among the stakeholders to attract freight to the corridor by addressing physical and non-physical barriers as well as developing a marketing strategy for the rail corridor.

C. Increase the use of international rail transport in Asia and beyond

Due to past and present connectivity shocks, rail transport has gained in importance for the region's LLDCs and LDCs. Railways can provide competitive long-distant connections if delays at borders are cut, and technical and digital cross-border interoperability is ensured. A recent study on the development of Eurasian corridors indicated that railway corridors can greatly benefit other subregions, even if they are not part of the corridor (this is notably the case in Central Asia and South-East Asia) (International Union of Railways, 2020). As part of the study, the status quo of rail transport was compared with a best-case scenario. The latter assumes a transit time of seven days for the Trans-Siberian railways, reduced waiting time at border crossings and e-interoperability across Eurasian borders, and a 20 per cent cut in tariffs.

Figure 1-6 Modelled impact of rail transit enhancement on the subregion in Eurasia



Source: International Union of Railways (2020).

Under the best-case scenario, which assumes that infrastructure development is largely financed by the main exporting economies in Asia and Europe, transport costs for LLDCs fall below the pre-pandemic level. The study illustrates, among other issues, the important role cross-border procedures, digitalization and interoperability play in making railways a success. In practice, there is plenty of room for improvement. National authorities and rail companies in Asia and the Pacific have, in recent years, shortened waiting times at the border by scrapping onerous procedures, improving infrastructure and removing some so-called soft constraints. This, notwithstanding time lost at border crossings, remains a key barrier to seamless international railway connectivity. Other barriers are outdated railways interaction interfaces, lacking pre-arrival information, onerous customs procedures and intrusive border checks.

Going forward, three issues must be addressed with great urgency:

- **Establishing interoperability of infrastructure.** Infrastructure and technical procedures along international transport corridors must be harmonized to enable seamless cross-border movement and lower transportation costs. Progress on this front requires intensive regional and international collaboration.

- **A common consignment note.** There should be one document accompanying goods, ideally in digital format, to ensure seamless and efficient international operations. In North and Central Asia, infrastructural and operational interoperability are partially addressed by the Eurasian Economic Commission, but the Commission does not include all countries in the region. In South-East Asia, the Association for Southeast Asian Nations (ASEAN) secretariat and other stakeholders have yet to tackle this issue.

- **Improved e-interoperability.** Common parameters for digital railway solutions are critical for smooth international transportation. Achieving this outcome is possible without making changes to national transport systems. However, e-interoperability requires close international cooperation and sufficient institutional capacity at the country level.

The Intergovernmental Agreement on the Trans-Asian Railway Network provides the basis for the advancement of regional cooperation on rail connectivity. Its working group, which is open to all ESCAP member States, is an important institutional mechanism, which aims to resolve operational difficulties and improve the quality of regional rail infrastructure.

Box 1-2: Post-COVID-19 transport links in South and South-West Asia: the case of India-Bangladesh rail connectivity and implications for Bhutan and Nepal

To expedite the import of food and medical supplies during the COVID-19 pandemic, Bangladesh opened three new railway border crossings with India, raising the number of active border crossing points between the two countries to five.

Bilateral rail freight traffic more than doubled to 3.7 million metric tonnes in the past two fiscal years (2020/21 to 2021/22). Bangladesh Railways, the State-run transportation agency, earned record transit revenue as a result. At the same time, the revival in rail freight has reduced road congestion, and cut lead times and the use of fossil fuels. Rail freight operations continue to suffer, however, from capacity limitations of rail-based dry ports or cargo handling facilities, onerous customs procedures and shortcomings with regard to data exchange and digitalization.

Most freight moves across the Bangladeshi border at the Indian state of West Bengal. In the eastern part of the country, the development of railways is set to lay the foundation for the shortest and most convenient route between the port of Chittagong and Nepal and Bhutan. Similarly, the Radhikapur-Birol and Haldibari-Chilahati routes between India and Bangladesh, not far from the Siliguri corridor, which is the only land bridge between the north-eastern states of India and the rest of the country, can become transit points for cargo to and from Bhutan and Nepal. In sum, ongoing railway development can play an essential role in solving the connectivity challenges of many of the poorly connected countries.

D. Locking in the facilitation and digitalization advances

There is an opportunity to lock in and build on the recent reforms in digitalization and transport facilitation. Improvement of cross-border procedures, greater interoperability and digitalization offer an enormous potential to further reduce transport costs and increase trade volumes, especially for LDCs, LLDCs and SIDS. In the wake of the COVID-19 pandemic, most Asia-Pacific countries, including countries in special situations, took various steps to simplify customs procedures and cargo clearance processes to help them access emergency medical and other essential supplies (table 1-3).

Table 1-3 Examples of transport facilitation and digitalization measures in landlocked developing countries and least developed countries

Afghanistan	In coordination with neighbouring Pakistan and the Islamic Republic of Iran, the Government of Afghanistan arranged for the clearance of essential goods and medical supplies through select border crossing points. This followed temporary pandemic-related closures of critical border stations.
Bangladesh	The Government exempted medical equipment from duties and taxes and essential goods were given priority in custom clearance. Documentation for goods imports from China can be submitted in digital form; similar digitalization is under consideration for other countries. Transit facilities for goods to Bhutan remained operational.
Bhutan	A special counter was opened to deal with custom documentation for imports of essential goods from India.
Cambodia	Measures to facilitate cross-border logistics during the pandemic include allowing the swapping of containers and changing of trucks at the border.
Armenia	Conclusion of agreements with Georgia and the Russian Federation regarding a green corridor for cargo of Eurasian Economic Union countries, namely the allocation of a separate cargo area for Armenian goods across the border in Georgia and at the Russian Federation border crossing point, Verhniy Lar.
Azerbaijan	The Government prioritized the quick and smooth movement of goods required in the fight against COVID-19. A transit corridor for freight vehicles was established.
Myanmar	Introduction of special arrangements, such as exemptions for the importation of all pharmaceuticals and raw materials and reduction of container and general cargo storage and handling charges at ports, as well as the launching of online licensing systems.
Nepal	The authorities formed a quick response team at the customs headquarters to expedite clearance processes at all custom offices with the aim of clearing essential goods in less than two hours. The submission of paper documents at ports is no longer mandatory; digital copies are accepted.
Kazakhstan	As of 15 April 2020, road transport carriers no longer need to carry paper permits. Verification is carried out electronically, as are almost all railway-related processes. The system allows customers to pay fees and fines online. In addition, National Company Kazakhstan Temir Zholy, the national railway company of Kazakhstan, abolished fines, fees and charges associated with the carriage of goods for the duration of the pandemic-induced state of emergency.

Kyrgyzstan	The authorities cancelled the requirement for trucks to carry special permits to speed up the movement of goods. A green corridor was established for all freight vehicles transporting medicines and essential goods. In the wake of the pandemic, Kyrgyz Temir Zholu, the State-run transportation company, waived fees and penalty charges for storing cargo on container sites and on wagons at railway stations. It also slashed transportation costs for coal exporters by 30 per cent on certain parts of the rail network.
Uzbekistan	Uzbekistan Railways, the State-run rail carrier, launched a software programme for processing and providing preliminary electronic information to customs authorities for goods transports. In addition, it applied a 30 per cent discount on the transportation of all goods transported through Uzbekistan to and from the south of Kyrgyzstan.

Source: ESCAP, Asia-Pacific countries' COVID-19 policy responses, online repository, 2021. Available at https://hdl.handle.net/20.500.12870/3499.

While the pandemic accelerated a move towards port digitalization and smart ports in Asia and the Pacific, the number of SIDS in the region with digitalized information and operation systems remains low. SIDS in the Pacific are, however, increasingly interested in port digitalization, which can improve the connectivity and help countries develop ports that can handle general cargo, bulk, and liquid goods in addition to containers.

Facilitation and digitalization reforms of particular interest to countries in special situations also include the use of new technologies and smart solutions in road and rail transport, the digitalization of rail operations and upgrading of transit regimes in LLDCs and LDCs.

Box 1-3: Incremental reforms and the use of technology to overhaul transit systems in landlocked developing countries: the case of transit facilitation for Nepal

Cross-border cargo movements in South Asia have long been marred by infrastructural and procedural bottlenecks, principally arising from manual transhipments and inspections at land customs stations. For transit trade involving LLDCs, these delays are costly and discourage trade. However, a string of recent reforms and new technologies have delivered notable benefits.

One of the first attempts to make the movement of cargo more seamless in South Asia was the piloting of an electronic tracking system under the ESCAP Secure Cross Border Transport Model between the Indian port city of Kolkata and the Bhutanese border town of Phuentsholing in 2014−15. While the system has not yet been introduced on a commercial scale, steps have been taken to introduce an electronic cargo tracking system (ECTS) along the India-Nepal transit corridor. India and Nepal first eased cross-border frictions with the establishment of a dry port at the Nepali town of Birgunj in 2004. The port was later linked by rail with the Indian town of Raxaul, making it possible to haul containers from Kolkata to Nepal. A few years later, India amended customs clearance procedures to allow pre-arrival clearance for transit cargo on the route.

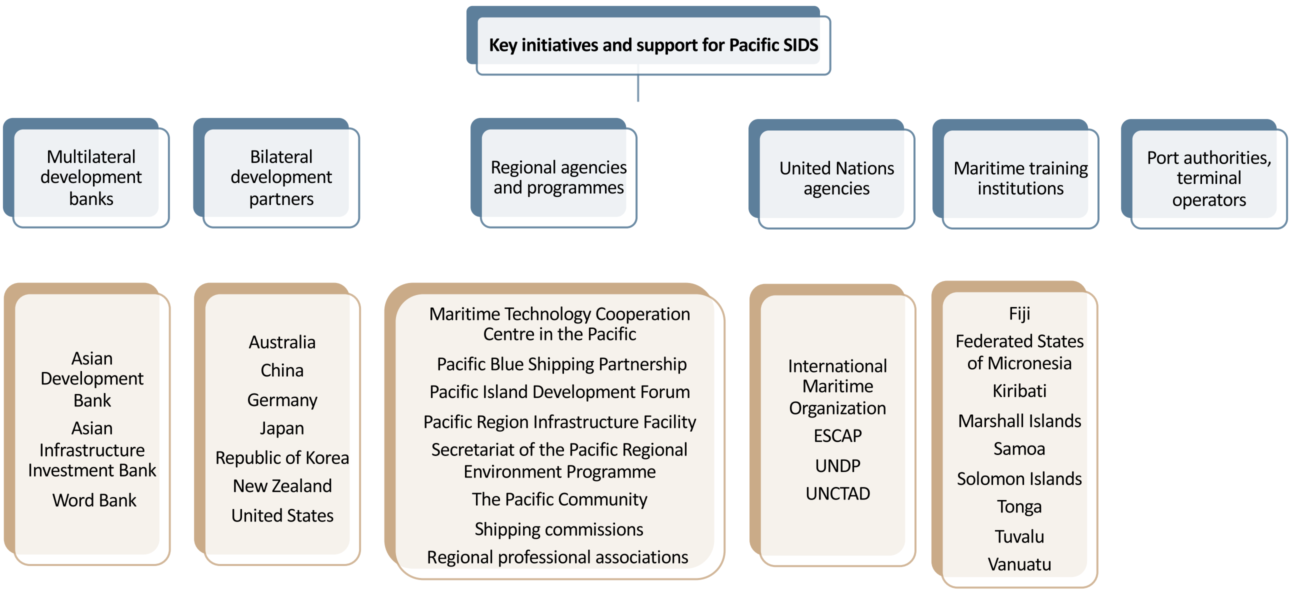
These incremental steps helped facilitate the use of ECTS transhipment procedures for Nepal-bound third country consignments from Visakhapatnam port in the Indian state of Andhra Pradesh in 2018. They enabled seamless transhipments of containers by using geographic information systems, radio frequency identification tracking, e-seals and monitoring software to avoid multiple inspections. The first such container train carrying transit containers from Kolkata port to Birgunj was flagged off in early 2019, cutting transit time in half. Furthermore, in 2021 the India-Nepal Rail Services Agreement of 2004 was amended to permit wagons owned by private operators and the State-owned Nepal Railway Company to service transit containers. Finally, India opened a dedicated terminal for the handling of transit containers for Nepal at the port of Kolkata.

These step-by-step reforms and corresponding upgrades to railway infrastructure have significantly improved transport connectivity in Nepal. The landlocked South Asian country now surpasses its regional peers in terms of the efficiency regarding cross-border transport systems.

E. Promoting resilient and sustainable maritime connectivity in the Pacific

Many issues must be tackled to bring about the sustainable maritime connectivity of the Pacific SIDS. Among them are the low frequency of shipping services, underdeveloped port facilities, high cost of international transport relative to the value of goods traded and vulnerable transport networks. Some of these barriers are not amenable to change through policy. The list of potential actions to improve connectivity, however, is long. It includes, among others, strengthening regional network integration and coordination; fostering domestic connectivity and port infrastructure development; improving border security; and reducing marine pollution. The support SIDS need ranges from financing and improved institutional and legal frameworks to imparting skills and developing capacities. Several domestic and international institutions support maritime connectivity initiatives aimed at supporting SIDS (figure 1-7). Many of them are working through regional programmes (ESCAP, 2022c).

Figure 1-7 Policy areas for enhancing the maritime connectivity of the Pacific small island developing States



Source: Adapted from section 4 of ESCAP (2022c).

The Regional Action Programme for Sustainable Transport Development in Asia and the Pacific (2022–2026)[14] pledges to assist SIDS in meeting transport challenges and strengthening their resilience to economic shocks. Governments, with the support of ESCAP, have identified opportunities for strengthening regional cooperation. Supporting so-called green shipping initiatives is an area that deserves special attention. This support is key because SIDS in the Pacific have limited financial and human resources and depend heavily on imported (non-renewable) energy. Another problem is that environmental regulations are not enforced. This occurs, for instance, when port authorities in SIDS do not enforce rules when inspecting foreign ships. Even so, as underscored during the Fourth Pacific Regional Energy and Transport Ministers' Meeting, held in Apia from 18 to 20 September 2019, the climate-vulnerable Pacific subregion can be a hub for international climate change research and a focal point for debates centring on conservation and resource management.

A recent initiative in which several SIDS took part is the Clydebank Declaration on Green Shipping Corridors, signed at United Nations Climate Change Conference (COP 26), held in Glasgow, Scotland, from 13 October to 13 November 2021. Green shipping corridors refer to shipping routes on which vessels use low- or zero-emission fuels and employ the latest technology to cut greenhouse gas emissions to zero by 2050. The first such agreement was reached by the authorities of the Los Angeles port in the United States of America and the Chinese port of Shanghai. The second was struck between the Maritime and Port Authority of Singapore and the Port of Rotterdam Authority. The joining of more ESCAP member States of this or similar green shipping initiatives, would be an important step towards the decarbonization of maritime transport in the region.

Box 1-4: Green Shipping Corridors Initiatives

Background: At COP26, a total of 24 countries signed the Clydebank Declaration, pledging to act collectively to demonstrate the viability of multiple green shipping corridors by 2025.

Concept: The idea of green shipping corridors is to facilitate early and rapid adoption of fuels and technologies that, on a life-cycle basis, deliver low or zero emissions, putting the marine sector on a path to full decarbonization. To support the establishment of green shipping corridors, signatories must contribute to efforts aimed at achieving decarbonization and net-zero emissions by ensuring that fully decarbonized fuels or propulsion technologies do not add additional greenhouse gas emissions to the global system through their life cycle, including production, transport and consumption.

Signatories: Australia, Belgium, Canada, Chile, Costa Rica, Denmark, Fiji, Finland, France, Germany, Ireland, Italy, Japan, the Marshall Islands, Morocco, Netherlands (Kingdom of the), New Zealand, Norway, Palau, Singapore, Spain, Sweden, the United Kingdom and the United States.[a]

The role of ESCAP: The secretariat supports a gradual roll-out of green shipping corridors in Asia and the Pacific by promoting decarbonized fuels and propulsion technologies of ships on major routes in conjunction with efforts by the International Maritime Organization (IMO) to reduce greenhouse gas emissions from ships.

[a] The underlined countries are ESCAP member States.

1.4. Conclusion

Despite recent advances in infrastructure and operational development, a series of external shocks has undermined transport connectivity in countries in special situations. The COVID-19 pandemic and heightened geopolitical turmoil have slowed progress towards achieving SDGs. At the same time, the crises have unlocked new momentum for structural reforms of the transport sector. Going forward, governments and regional and global institutions should prioritize the following actions to make countries in special situations' transport connectivity resilient and more sustainable:

- Support the ongoing connectivity initiatives in countries in special situations;
- Strengthen the development of international transport corridors involving countries in special situations;
- Scale up the use of railways;

- Build on the pandemic-induced momentum for transport facilitation and digitalization;

- Promote resilient and sustainable maritime connectivity in the Pacific.

A more comprehensive and evidence-based approach to closing transport connectivity gaps would help make freight transport operations in countries in special situations more environmentally friendly. Better regional cooperation is essential; efforts of these countries related to connectivity must be better aligned with the wider sustainability agenda. Furthermore, South-South cooperation should be strengthened, and further efforts must be made to help them maximize the wider economic, environmental and social benefits of their connectivity initiatives and international transport corridors. The institutional mechanisms to support these efforts are already in place: intergovernmental transport agreements and the Regional Action Programme for Sustainable Transport Development in Asia and the Pacific (2022−2026)[15] can help build the path towards more sustainable transport connectivity of countries in special situations in Asia and the Pacific.

ENDNOTES

7 For a recent exposition of connectivity challenges of LLDCs in the Asia-Pacific region based on comparisons of various global indicators, see ESCAP (2022d).
8 For more details, see ESCAP (forthcoming).
9 For more details, see ESCAP (2019a).
10 This section draws on ESCAP (2022c) and UNCTAD and ESCAP (2022).
11 Some reports show that, as maritime transportation serves a derived demand, coping measures by the global shipping industry to adjust with post-COVID-19 shocks to cargo flows through ports have caused further disruptions to transhipment flows to and from hinterlands served by gateway ports. See, for instance, Notteboom, Pallis and. Rodigue (2021).
12 See ESCAP/78/15/Add.2.
13 See ESCAP/DP/WG/2021/4.
14 See ESCAP/78/15/Add.2.
15 See ESCAP/78/15/Add.2.

Chapter 2

Regional cooperation for energy connectivity

This chapter focuses on seamless and sustainable connectivity in the electric power system, and the role it can play to support sustainable development. Energy connectivity can help countries make progress towards several SDGs. Most relevant in this regard is the goal of ensuring access to affordable, reliable and modern energy services for all (Goal 7). In addition, energy connectivity can support progress towards realizing SDGs related to poverty, education, gender equality, jobs, cities and climate action (Goals 1, 4, 5, 8, 11 and 13, respectively).

Power system connectivity can improve access to energy, which is essential for education, health care and economic development. The Asia-Pacific region has made progress towards achieving universal energy access, but large gaps remain. This is especially true for the region's LLDCs and SIDS. In Cambodia, for example, 14 per cent of the population lacks access to modern energy resources. In Vanuatu, this share is 33 per cent as of 2022 (ESCAP, 2022e). For some LLDCs, the best way to connect hard-to-reach communities is to tap into the electricity resources from a neighbouring country via cross-border energy trade. For SIDS, as cross-border power system connectivity is usually not economically viable, regional collaboration on standards or sharing of best practices can spur the deployment of more affordable microgrids. In any case, widening access to modern energy resources brings tremendous benefits, including, among them, greater engagement of children in education, entrance of women into the labour force and small business development.

Power system connectivity can also play a key role in mitigating climate change by reducing greenhouse gas emissions through the deployment and integration of renewable energy resources. For example, in the Asia-Pacific region, many LLDCs have ample hydroelectric resources or the potential to develop them. Hydroelectricity can be a key supplier of flexible power generation and support the integration of other renewable energy sources. To illustrate, through the exchange of power across borders, hydropower generated in the Lao People's Democratic Republic could balance the generation from solar photovoltaics (PVs) in neighbouring Thailand. Similarly, hydropower in Nepal could make it easier for India to meet its ambitious targets for solar and wind power.

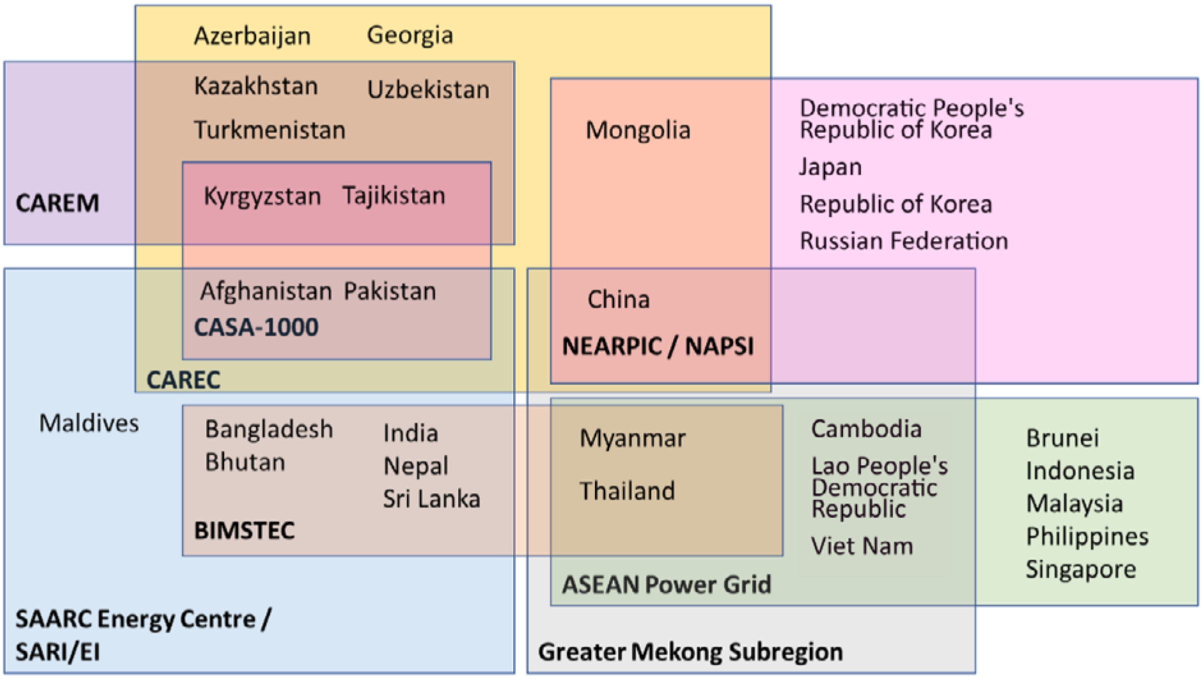
Well-developed power system connectivity puts countries that are rich in renewable energy resources in a good position to develop projects for export, and thus boost, public revenue and foreign exchange earnings. For example, the development and cross-border trade of the vast renewable energy resources of the Gobi Desert would raise export revenue in Mongolia, create jobs and help decarbonize the domestic energy sector.

Unquestionably, power system connectivity can play a powerful role in making economies more sustainable. Ultimately, however, this is a tool that must be used properly for it to accelerate progress towards achieving SDGs. To address this issue, ESCAP member States in 2021 endorsed the Regional Road Map on Power System Connectivity,[16] which promotes cross-border electricity connectivity for sustainable development. The road map outlines a vision, general principles and strategies to foster cross-border power system connectivity in the region. The solutions to overcome barriers to sustainable power system connectivity presented in this chapter mirror and build on the strategies of the road map.

2.1. Power systems connectivity initiatives

Institutional mechanisms for regional or subregional collaboration on power system connectivity and related issues are in place in the Asia-Pacific region (figure 2-1). Most of them include LDCs and LLDCs. In some cases, countries are part of more than one initiative. Subsequent sections of this chapter present a closer look at selected initiatives that operate across or in specific subregions of the Asia-Pacific region.

Figure 2-1 Selected power system connectivity initiatives in the Asia-Pacific region



Source: ESCAP (2022e).

Notes: CAREM, Central Asia Regional Electricity Markets; CAREC, Central Asia Regional Economic Cooperation Program; CASA-1000, Central Asia-South Asia Power Project; SAARC, South Asian Association for Regional Cooperation; SARI/EI, South Asia Regional Initiative for Energy Integration; BIMSTEC, Bay of Bengal Initiative for Multi-Sectoral Technical and Economic Cooperation; NEARPIC, North-East Asia Power Interconnection and Cooperation; NAPSI, Northeast Asia Power System Interconnection.

A. Central Asia

The Central Asian subregion includes seven LLDCs, Armenia, Azerbaijan, Kazakhstan, Kyrgyzstan, Tajikistan, Turkmenistan and Uzbekistan – all of them former Soviet republics. Up until the dissolution of the Soviet Union in 1991, the energy systems and economies of these constituent republics were highly interconnected. The production and consumption of electricity and fossil fuels, and the use of water for agriculture and energy production were closely coordinated. When the republics became independent countries, these long-standing linkages fell into disrepair. As a result, the current fragmented structure of power systems of the subregion falls short of its proven potential. In recent years, however, the restoration of regional energy connectivity has become a topic of discussion along with greater cooperation among the countries in the subregion. For example, after a hiatus of nearly a decade, Tajikistan in 2018 resumed electricity exports to Uzbekistan.

Several subregional institutions, including the Commonwealth of Independent States Electric Power Council and the Eurasian Economic Union, support cooperation on energy, including power system connectivity. The Coordination Dispatch Centre "Energiya" manages the Unified Energy System of Central Asia and South Kazakhstan, which includes Kazakhstan, Kyrgyzstan and Uzbekistan. Tajikistan is a former member of the system and is in the process of rejoining it (Gazeta.uz, 2022).

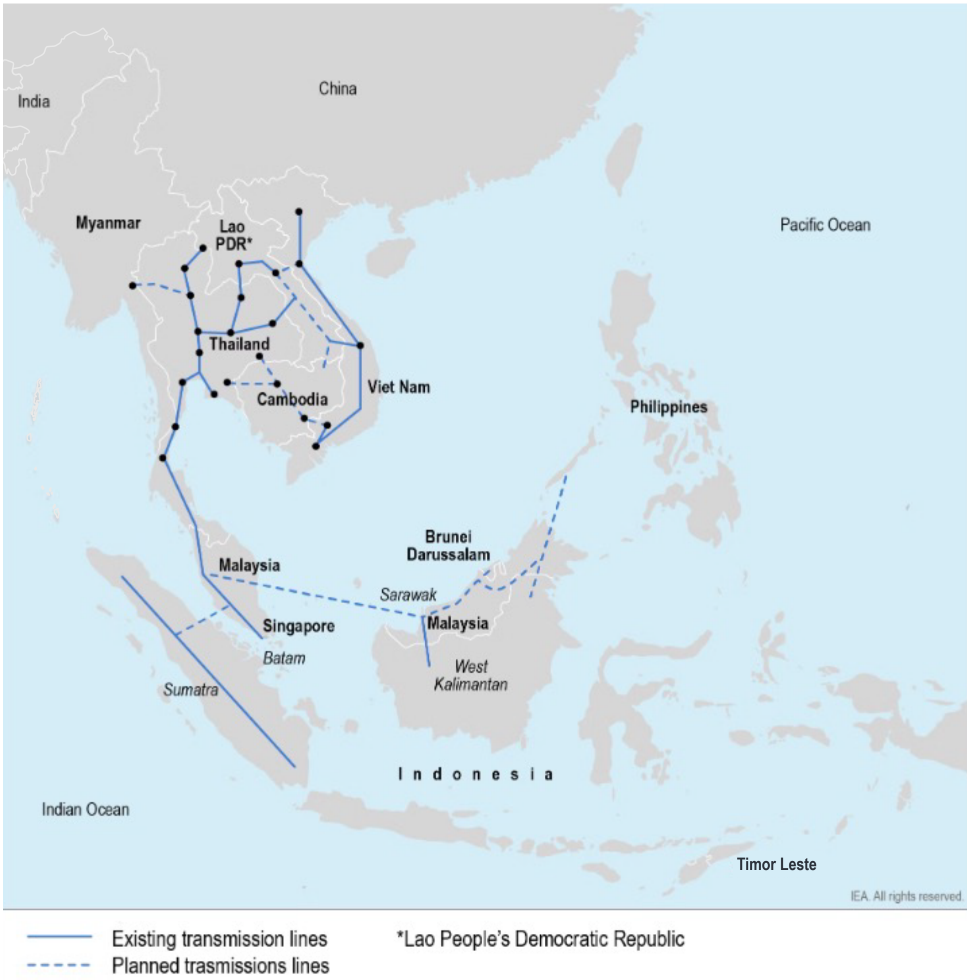
Some Central Asian countries are considering developing closer cooperation with their historical partner countries. One of these efforts is the CASA-1000 project, which began when Pakistan and Afghanistan in 2006 signed agreements with Tajikistan and Kyrgyzstan to import electricity through a 500 kV high-voltage electricity transmission system.[17] The project involved the construction of transmission lines from Kyrgyzstan and Tajikistan, which produces abundant hydroelectric power during the summer, to Afghanistan and ultimately Pakistan, where a quarter of the population has no access to electricity (IEA and others, 2022).

B. South-East Asia

The countries of South-East Asia have long recognized the benefits of energy connectivity. The blueprint for collaboration on energy development in ASEAN is the ASEAN Plan of Action for Energy Cooperation (APAEC 2021−2025). A key goal of the Plan is the development of an ASEAN power grid (APG), which was first envisaged by member States at the 16th ASEAN Ministers of Energy Meeting in 1998 as a part of the Hanoi Plan of Action (figure 2-2). The objective of the power grid is to fully integrate the power systems of all member countries and accordingly take advantage of the region's diverse allocation of energy resources. The interconnections would reduce the costs of power systems through economies of scale and shared investments (IEA, 2019) and pave the way for integrating renewable energy. Landlocked countries with a high resource potential and development needs would benefit the most from cross-border connectivity. The Lao People's Democratic Republic, for instance, has more than 8,000MW of installed hydropower capacity. The capacity is expected to rise as the Government seeks to meet surging domestic power demand and increase electricity exports to boost foreign exchange revenue (Energy Market Authority, 2022).

The ASEAN Power Grid initiative comprises two parts: developing electricity transmission infrastructure; and facilitating power trade that moves beyond bilateral, unidirectional power purchase agreements. Despite its potential notable benefits, the development of a pan-ASEAN power grid has yet to be achieved.

Figure 2-2 ASEAN power grid



Source: IEA (2020).

The boundaries and names shown and the designations used on this map do not imply official endorsement or acceptance by the United Nations.

The full vision of the ASEAN power grid was formulated in three iterations of the ASEAN Interconnection Masterplan Study (AIMS). Member States endorsed the first plan in 2003 and, in the second plan, 16 promising interconnection projects were proposed. Since then, interconnections with a capacity of 7.6 gigawatts (GW) have been developed. Some include LLDCs: Thailand-Lao People's Democratic Republic; Lao People's Democratic Republic-Viet Nam; Viet Nam-Cambodia; and Thailand-Cambodia (ESCAP, 2022e). Despite this progress, the capacity of active interconnections falls short of the estimated potential of 26.6-30.1GW. In 2021, member States endorsed AIMS III and an updated vision of interconnected regional transmission network that maximizes the use of renewable energy resources (USAID, 2021). The United States Agency for International Development (USAID) puts the current volume of grid-to-grid power exchange in ASEAN at 4,781GWH (the estimate does not include Malaysia-Singapore and Brunai-Darussalem-Malaysia exchanges nor exchanges involving Myanmar and China). The estimate is a benchmark for regional power trade developments and is independent of the AIMS process.

The ASEAN power grid will undoubtedly boost cross-border power trade, but the pace of future progress and types of trading arrangements remain uncertain. The electric power systems in South-East Asian countries are at different levels of development, and countries' diverse regulatory and policy environments complicate the implementation of the ASEAN power grid. While a fully integrated regional power grid remains far off, the Governments in the region continue to back the initiative because of its potential benefits, including making the power systems in ASEAN member countries more flexible and capable of integrating renewables.

South-East Asia is also notable for the engagement of the first multilateral power trade in the Asia-Pacific region. Since mid-2022, the Lao People's Democratic Republic, Thailand, Malaysia, Singapore Power Integration Project (LTMS-PIP) has enabled the sale of 100MW of electricity from the Lao People's Democratic Republic to Singapore, via Thailand and Malaysia (Lao People's Democratic Republic, Thailand, Malaysia and Singapore, 2014). The project supports economic development in the Lao People's Democratic Republic and contributes towards the goal of achieving net-zero emissions by 2050 set by Singapore.

C South Asia

Cross-border electricity interconnections have been established in several countries in South Asia to accommodate power trade between India and Nepal, and India and Bhutan. Due to its size and central geographical location, India acts as the subregion's hub for energy trade. In November 2021, Nepal started trading power on the Indian Energy Exchange, one of two power trading platforms in India. Bhutan followed suit in early 2022. Trades on the Indian Energy Exchange are only bilateral mainly because it is currently not possible to wheel or transfer electricity through India to a third country. Cross-border import and export capacity between India and its neighbours is 1,050 MW and 1,500 MW, respectively. The Government of India had set plans to more than double the capacity in both directions by the end of 2022 (ESCAP, 2022e). Meanwhile, the potential for multilateral trading in the subregion remains untapped. This is despite long-standing efforts to establish regional power connectivity.

More than two decades ago, countries in the subregion launched the South Asia Regional Initiative for Energy Integration (SARI/EI) project. The Integrated Research and Action for Development (IRADe) institute, a New Delhi-based think tank, served as the SARI/EI secretariat (USAID, n.d.). The project closed in 2022, but while it was active, SARI/EI promoted energy integration, the development of regional clean energy and cross-border electricity trade involving Afghanistan, Bangladesh, Bhutan, India, Maldives, Nepal, Pakistan and Sri Lanka. A key objective of the project was to develop a common template for the technical and commercial aspects of a regional power exchange. The project cooperated with other subregional bodies, such as the Islamabad-based South Asian Association for Regional Cooperation (SAARC) Energy Centre. SARI/EI has been replaced by the USAID-sponsored South Asia Regional Energy Partnership (SAREP).

Going forward, the development of interconnections between the countries of South Asia, a subregion rich in renewable energy, will be key in balancing the supply and demand of energy and boosting the sustainable energy transition. For now, however, differences among market regimes hinder greater regional power cooperation.

D. North-East Asia

Power trade in the North-East Asia subregion has also developed bilaterally, mainly between the Russian Federation and Mongolia and China, respectively. Due to its central geographical location, size and significant renewable-energy potential, Mongolia could become an important energy hub. The country relies heavily on fossil fuels and electricity imports from China. Developing its immense solar, wind, and hydroelectric power potential could transform Mongolia from a net-energy importer to a net-exporter of renewable energy.

Subregional cooperation can play an important role in encouraging investments in the power sector and improve incentives to adopt renewable energy and complementary modern technologies. With support from international organizations, several subregional initiatives have been created in North-East Asia. However, unlike in other subregions of Asia, North-East Asia lacks formal subregional institutional arrangements.

To promote regional power interconnection, ESCAP, the China Electricity Council, the State Grid Corporation of China and the Global Energy Interconnection Development and Cooperation (GEIDCO), an international non-governmental organization, jointly organized the first North-East Asia Power Interconnection and Cooperation Forum in 2018. The Forum, which functions as a cooperation and communication mechanism for power sector stakeholders, meets annually (ESCAP, 2018d).

Another noteworthy initiative in the subregion is the Northeast Asia Power System Interconnection project. Supported by the Asian Development Bank (ADB), a study conducted over the period 2017−2019 focused on the development of 5 GW of solar and wind generation in the South Gobi region of Mongolia, the construction of a transmission interconnection between South Gobi and northern China, and the installation of an undersea transmission interconnection between eastern China and the Republic of Korea (Oksanen, 2019). Based on the results of the study, it was recommended that infrastructure projects be commissioned by 2026 as a first step towards developing a fully integrated regional grid by 2036 (ADB, 2021c). Progress in this regard has been slow, however, in part due to the absence of formal subregional institutional mechanism. In 2022, ADB began the second phase of the project.

E. Pacific islands

For the small island developing States in the Pacific, the limited energy demand and long distances between islands make cross-border grid interconnections not viable. At the same time, SIDS urgently need to develop sustainable energy resources. Doing so would reduce their reliance on imported fossil fuels, increase access to affordable electricity and support climate change mitigation. The Pacific is one or the world’s most climate-vulnerable subregions. Extreme weather events, along with other impacts of global warming, are becoming more frequent. Some of the impacts are loss of land in coastal regions due to rising sea levels and storm surges, failing subsistence crops and coastal fisheries, and losses of coral reefs and mangroves.

Given their small populations and remoteness, there is little SIDS can do to reduce the cost of imported energy. This makes efforts to develop their domestic renewable energy resources even more critical. In 2021, with the support of ADB, the Office of Pacific Energy Regulators Alliance (OPERA) was created to accelerate capacity-building and knowledge exchanges among energy regulators in the subregion (ADB, 2021a). The key aim of the alliance is to enhance regulatory decision-making skills and technical capacities through information collection and exchange, mentoring, workshops, and trainings (ADB, 2022). OPERA supports countries in resolving challenges, such as a lack of funding or the absence of a regulator, insufficient skills and data collection issues. Over time, the alliance could become a regulatory centre of excellence that promotes effective regulation and common standards, and helps lower the cost of clean energy for countries in the Pacific.

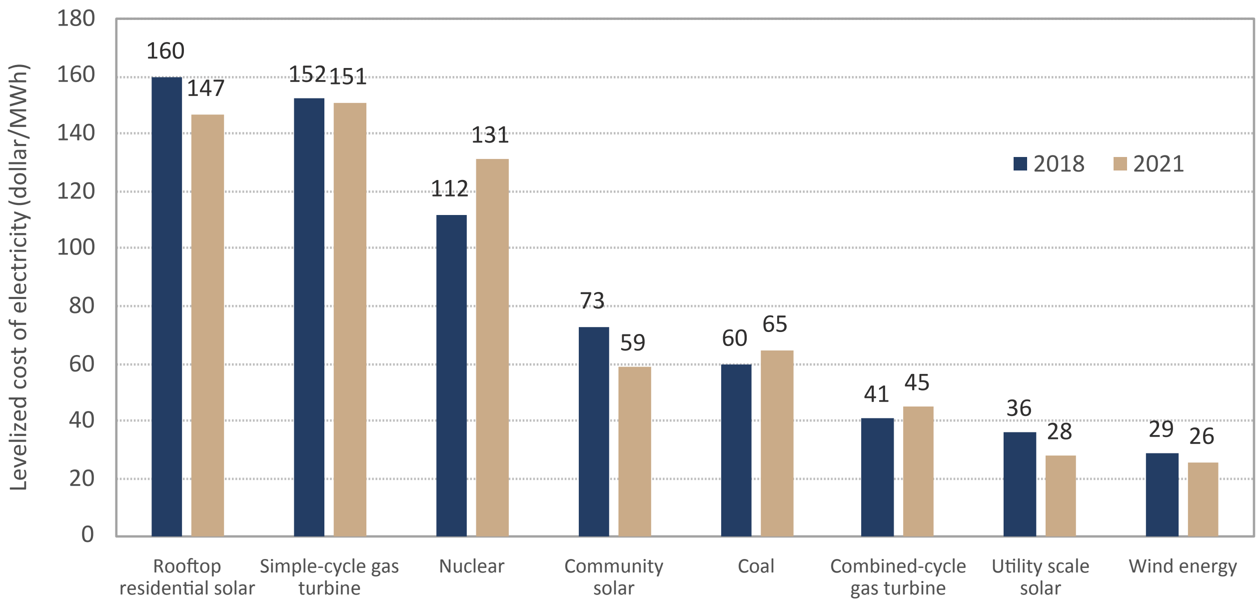
2.2. Opportunities for power system connectivity

This section provides an outline of the sustainable development opportunities of international power system connectivity for LDCs, LLDCs and SIDS in the region.

A. Opportunity to reduce costs and diversify resources

International energy connectivity is required to improve access to the region's most affordable clean energy resources. For many decades, hydropower facilities in the region have provided a dispatchable and renewable energy resource that is cheaper than fossil fuel-based power generation. More recently, variable renewable energy resources, such as solar and wind generators, have become the most cost-effective options for electric power generation (figure 2-3).

Figure 2-3 Levelized cost of electricity in the United States in 2018 and 2021

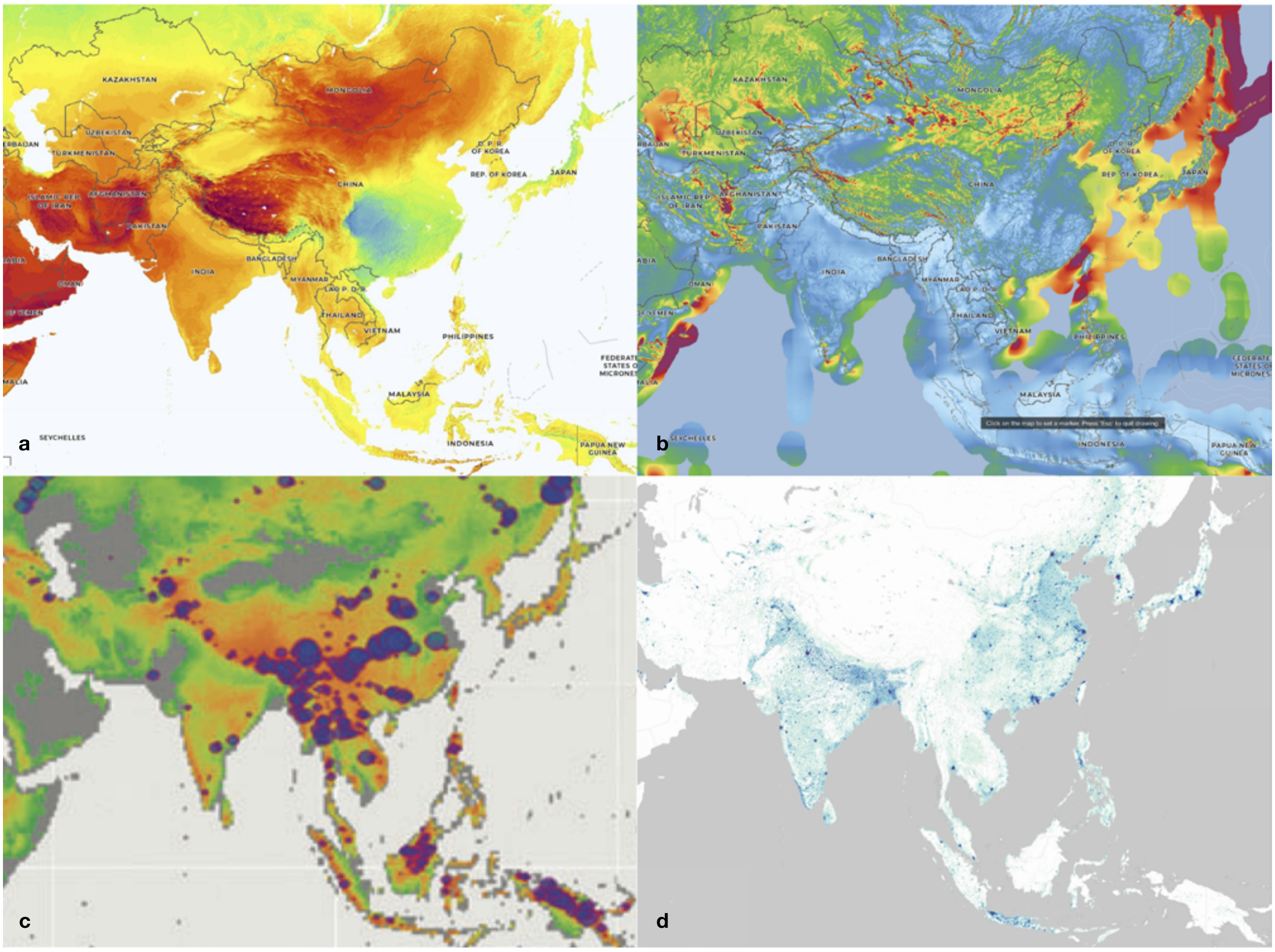


Source: Energy Systems Integration Group (2022).

Note: Levelized electricity costs vary among countries and depend on enabling power sector environments, including the regulatory set-up, the level of competition, the weighted average cost of capital and the quality of market price discovery, among other factors.

Figures 2-4 shows the potential of solar, wind and hydro power relative to population density across the Asia-Pacific region. For all three energy sources, the electric power generation potential is the greatest in sparsely populated areas. This makes electric power transmission essential for bringing renewable energy to the region's cities and densely populated areas. Without it, the use of variable renewable energy would be severely limited and economically unviable.

Figure 2-4 Potential of solar, wind and hydro power in Asia and the Pacific, relative to population density



Sources: (a) Global Solar Atlas. Available at https://globalsolaratlas.info/. (b) Global Wind Atlas. Available at https://globalwindatlas.info/en. (c) Zhou and others (2015). (d) World Population Density. Available at https://luminocity3d.org/WorldPopDen/#3/12.13/10.02.

Notes: (a) Solar power potential (from lowest in blue to highest in red); (b) Wind power potential (from lowest in blue to highest in red); (c) Hydro power potential (from lowest in green to highest in purple); (d) population density (from lowest in white to highest in dark blue)

The boundaries and names shown and the designations used on this map do not imply official endorsement or acceptance by the United Nations.

The case for international energy connectivity as a tool to reduce costs and diversify resources is compelling. First, connectivity helps diversify countries' energy resource portfolios by making accessible previously untapped renewable energy resources and thus mitigate climate risk. Second, in addition to steeply falling generation costs, the operating costs of renewables are typically lower than those for fossil-fuel based generators. Third, renewables are not directly affected by global fossil fuel price shocks, which, as a result, makes them a natural hedge against energy price volatility. Fourth, connectivity enables the smoothing of generation variability across borders. Fifth, international energy connectivity can balance out differing rates of peak demand between countries. To illustrate, adding new generation capacity in one country carries a financial risk unless the peak load expands at the same time. Developing cross-border electric power transmission is a way of sharing and reducing risk.

B. Opportunity to increase economic activity and energy access

International energy connectivity can serve as an engine for national and regional economic development. It can reduce the so-called “levelized cost” (the average lifetime cost of generation equipment per megawatt hour of generated hour of electricity), reduce the need for additional electric power generation capacity and connect previously unserved communities to the grid. When sparsely populated countries rich in solar, wind and hydro resources serve cities in a neighbouring country, both countries benefit. The exporter creates jobs in the power sector and generates revenue, while the importer gets access to low-cost energy that can make industries more competitive. This cost-reducing effect is especially important in the manufacturing of consumer goods and energy products, such as hydrogen.

In many developing countries, rural communities have no access to the grid. Connecting them is essential to meeting Sustainable Development Goal 7, as well as Goals 1, 4, 5, 8 and 11. Unfortunately, the small amount of electric power these communities require often does not justify a large capital expenditure. In many cases, however, international energy connectivity can still be an option, especially when rural communities in one country are close to a city in another country. In such cases, short transmission and distribution lines are relatively short, and investments may be commercially viable.

2.3. Overcoming challenges to power system connectivity

While the opportunities for power system connectivity are formidable, to date, progress in this area has been modest. Given the complex challenges at hand, this is unsurprising. Power system connectivity is not just an engineering problem. Electric power systems are complex, multi-faceted, sociotechnical systems. A host of technical, economic, regulatory, political, social, and even cultural factors influence the way they work. Joining power systems across an international border requires the harmonization of these factors.

Before any development of technical or regulatory procedures can proceed, there must be the political will to implement the project. Power systems are part of countries’ critical infrastructure. Consequently, cross-border integration of power systems requires support at the political level. To build political will, it is key to consider the benefits of power system connectivity and how the systems are linked with priority policy objectives, such as environmental sustainability, energy security or economic development. Geopolitical tensions can easily get in the way of connectivity projects because they are intrinsically linked with energy and national security.

The harmonization of power systems requires a certain level of sociotechnical readiness. Some countries in the region, including, among them, Afghanistan, Cambodia, the Lao People’s Democratic Republic, Mongolia and Myanmar, have poorly integrated, low or medium voltage grids.[18] Such systems are not amenable to transmitting electric power over long distances. Ultimately, they need to be replaced with a high voltage transmission system backbone. Furthermore, national electric power system must meet reliability tests, such as the System Average Interruption Duration Index and the System Average Interruption Frequency Index, which are measures of the duration and frequency of outages, respectively. If a country’s electric power system is unreliable, neighbouring countries are unlikely to consider proposals of power system connectivity, especially synchronized, grid-to-grid connections. At the same time, connecting a weak power system to a strong one can benefit the former. For example, the connection between Thailand and the Lao People’s Democratic Republic stabilizes the latter’s grid. While this is beneficial to the Lao People’s Democratic Republic, ultimately the country will need to upgrade its power system and human resource capacity to manage its grid independently.

Historically, regional connectivity initiatives have been the precursor to bilateral power system connectivity. Other key factors that serve as a gauge of sociotechnical readiness of power systems are the presence of a high voltage backbone and high system reliability. In the remainder of this section, it is assumed that these criteria are met and focus is placed on the harmonization required to connect national electric power systems.

A. Harmonization of operational procedures

The harmonization of operational procedures is key to alleviating economic, political and national security concerns that arise when linking power systems across an international border. One type of harmonization that is essential for connecting two electric power systems relates to operational procedures shaped by countries' respective grid codes and technical standards. When followed diligently, these standard operating procedures serve as best practices that give the operators and regulators confidence in the reliability of their electric power systems. "N-1 contingency analysis", for instance, is an operating procedure that tests if a grid continues to operate reliably in the event of an outage of a generator or a transmission line. It is important to ensure that a cross-border connection does not breakdown in case one system fails. Operational procedures also ensure that congestion on electric power lines is alleviated, voltage limits are respected, and generators and electrical substations are adjusted as needed.

In many cases, the operational procedures of electric power systems rely on real-time or in-time data. Grid operators use sophisticated monitoring software, or "state estimators" to estimate real-time voltage levels and power flows. This situational awareness is the basis of many downstream procedures, including decisions by manual operators, demand forecasting and market operations. While all electric power systems use such software, the extent to which countries monitor their grid varies. Naturally, when national grids are connected, their respective monitoring software must accept real-time data from the neighbouring grid. To make the systems compatible, international data-sharing agreements and harmonized procedures that specify the type and frequency of shared data necessary to ensure reliable operations are required. As an added benefit, harmonized data-sharing procedures provide clear guidance for software development companies and make it easier for them to develop and deploy systems.

Harmonized procedures also support the integration of variable renewable energy resources because they place technical standards on installable technologies and how they connect to the grid. This reduces the cost of deploying renewable energy and makes the power supply chain more resilient. For example, common standards for connecting variable renewable energy in the Pacific would compel power suppliers to remove non-standard and potentially disruptive technologies, and accordingly establish more mature and cost-effective power supply chains.

Mature and harmonized operational procedures are essential to alleviate security concerns. They ensure that unexpected events in one power system have a minimal impact on interconnected power systems. In this way, negative spillover effects can be reduced, but they cannot be eliminated. Consequently, it is important that harmonization includes robust procedures on how to deal with outages and how interconnected power systems can recover from blackouts. At all stages, effective and open communication among the power system operators is critical.

B. Harmonization of planning procedures

Another type of necessary sociotechnical harmonization relates to planning procedures. As countries work to limit the global temperature rise to 1.5°C, they must plan a sustainable energy systems transformation that phases down or decommissions fossil fuel-based energy facilities and includes the installation of renewable energy generation facilities and the electrification of entire economic sectors. As a result, the electric power system must be adapted to a new mix of power generation. Transmission and generation capacity must be expanded dramatically. The path countries take to achieve this transformation varies and often depends on the institutional and political context in which electric power system organizations operate. Some countries are expanding their generation and transmission capacity incrementally with targeted investments on a project-by-project basis. Others use model-based capacity-expansion planning software to create an optimal pathway of total life-cycle costs of their energy systems.

When two countries, or a region, envisage greater energy connectivity, contrasting planning methods can become a point of contention. Incremental, project-based planning approaches tend to produce negotiated bargaining on a one-off, bilateral basis. By contrast, model-based software-based planning approaches create the basis for long-term, synergistic, and multilateral collaboration and harmonization. Given the enormous task ahead, the sustainable energy system transformation is arguably the greatest infrastructure conversion ever undertaken and the more suitable approach is the one that is model-based software-based.

C. Harmonization of regulatory procedures

Regulation of national electric power systems varies considerably. In some countries, power systems are part of nationalized, vertically integrated utilities. In other countries, they are privatized and operated by a diverse group of power generation, transmission, distribution and retail companies. While international electric power connectivity is possible regardless of the regulatory approach, deregulated frameworks exhibit greater sociotechnical readiness. This is mainly because they already have mechanisms for transacting electric power between organizations.

One such mechanism for transacting power is third-party access in which independent power producers are allowed to access the national grid and trade electric power with electric distribution utilities and large power consumers. It is contingent upon adherence to operating procedures and the payment of access fees by the producer. The entity being granted third-party access can be a large consumer, such as an industrial facility, which can serve as a virtual power plant that is able to provide grid balancing services (that is, ensure that the grid operates at the right frequency). Once third-party access is established, a regulatory interface is created, which paves the way for international third-party access. This, in turn, enables international electric power connectivity.

To reap the full benefits of region-wide connectivity, the mechanisms for transacting electric power must evolve from using inflexible bilateral power purchase agreements to establishing trading that is responsive to a grid's operating condition. To date, cross-border power trade in the region is mostly bilateral and the result of negotiations with stand-alone agreements specifying the quantity and direction of cross-border flows. Unfortunately, such agreements do not reflect the continuous changes in the grid's physical flows, making them difficult to replicate across the region. This is unfortunate because the integration of variable renewable energy necessitates responsive electric power transactions. To illustrate, solar power generation peaks in the middle of the day, which reduces the need for other forms of electricity during this time, while wind power generation peaks in the early evening hours. As the share of variable renewable energy fluctuates in one country relative to another, the direction of cross-border power trades can reverse hourly. When these variable renewable energy resources are on two sides of a border, the associated electric power transactions must be designed to account for the shifting location of abundant generation. In this way, for instance, hydropower produced in Nepal can support the integration of solar power generated in India – with the former exporting electricity at night and the latter exporting electricity during the day.

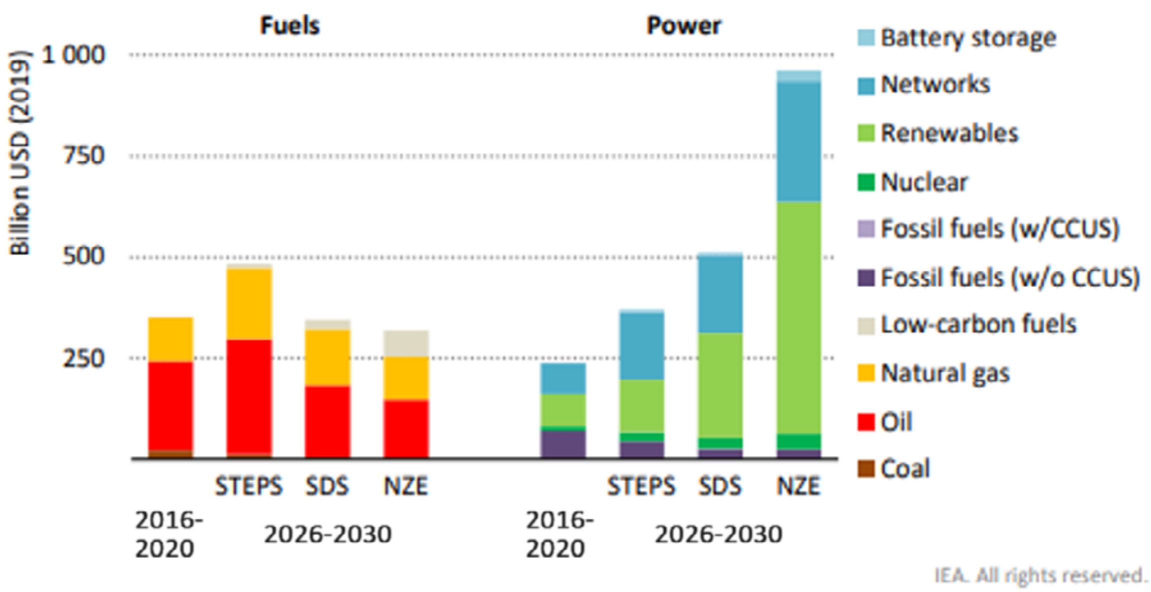
In sum, the time-varying, grid-balancing, multilateral and potentially bidirectional nature of cross-border electric power trades is often overlooked. Flexible trading relies on a harmonized regulatory framework at the subregional level that is incorporated into national regulations. Regulations should govern the marketplace for cross-border trade, specify the scope of data exchange and define the stakeholders eligible to take part in cross-border power trade.

D. Mobilizing investment through harmonized financial procedures

In addition to harmonizing operating, planning and regulatory procedures, it is important to mobilize more investment in regional cross-border infrastructure and national grids. For example, for Viet Nam to join LTMS-PIP, the power systems of the Lao People's Democratic Republic and Viet Nam would need to be connected, and the former's national grid upgraded.

Electric power system networks require more investment than all other resources expect renewable energy generation, according to estimates of the International Energy Agency (IEA) (figure 2-5). As outlined in section 2.3, power systems and unlocking renewable energy are tightly linked. In other words, investments in the renewable energy necessary to achieve net-zero emissions by 2050 require increased investments in electric power transmission and distribution.

Figure 2-5 Energy supply investment in emerging markets and developing economies with annual projections under different scenarios



Source: IEA (2021).

Notes: CCUS, carbon capture usage and storage; STEPS, sustainable, transparent and efficient practices: SDS, Sustainable Development Scenario; NZE, net-zero emissions.

In the Asia-Pacific region, most grids are financed by State-run entities. Public ownership and management of power grids are especially common in LDCs, LLDCs and SIDS. In such cases, financing the build out of grid infrastructure is often unviable because government budgets are already stretched. Accordingly, it is prudent to consider policies and regulations that encourage private sector investments in grid infrastructure.

In the Asia-Pacific region, Australia, India and the Philippines, among others, have successfully managed private-sector investment in electric power networks. The investments in these countries are based on financial models that quantify the expected return and associated risk. In India, the

Independent Power Transmission (IPT) model has been used to attract approximately $5 billion. The model takes its inspiration from the IPP model, which is widely used to attract private investment in energy generation assets across the region. The IPT model has the advantage that it can be piloted alongside traditional utility grid investments because it is suited for well-defined sections of transmission investment and does not require wider reform of the transmission sector. However, investments must be sizable to justify the transaction cost.[19]

Much work remains to advance financial models that reflect the key characteristic of cross-border electric power trades: time-varying: grid-balancing: multilateral: and potentially bidirectional. Governments and private investors often favour investments in new electric power lines as part of long-term, predictable bilateral power-purchase agreements. Electric power lines that serve the short-term needs of the power system are viewed less favourably because the flow of power is more uncertain. Similarly, investments tapping into domestic electric power demand are often preferred over those that cater to international demand. Such attitudes act as a brake on international energy connectivity, especially in LDCs and LLDCs. Making perceived and actual investment risks transparent is key to enabling greater international electric power system connectivity.

E. Institutional capacity for sociotechnical harmonization

The sociotechnical harmonization of operating and planning, regulatory and financial procedures require adequate capacity at the individual, national and regional levels.

At the individual level, it is important to recognize that sociotechnical harmonization and reform require a far greater level of professional competence than is necessary to maintain the electric power system's operating, planning, regulatory and financial procedures. Furthermore, copying sociotechnical procedures from international utilities, regulators and consultancies does not work. Local utility engineers, regulators and policymakers may disregard them or consider them ill-suited to the specific circumstances of their electric power system. It is, therefore, essential to build human capacity so that procedures can be adjusted to the local context. Professional programmes and active participation in international professional societies can help build capacity and give stakeholders the opportunity to familiarize themselves with international best practices. Examples of such international institutions are the Institute of Electrical and Electronics Engineers, the International Council on Large Electric Systems and the International Association for Energy Economics. By investing in people, countries in the Asia-Pacific region, especially LDCs, LLDCs, and SIDS, can better address specific needs in the power sector. This approach of home-grown sociotechnical development can ensure lasting and effective socio-technical advancement.

At the national level, the development of new operating, planning, regulatory and financial procedures require an institutionalized commitment by policymakers to reform. In general, policymakers in the electric power sector tend to be risk averse because they oversee critical infrastructure. Bureaucratic rules are sticky, and change can be difficult. Accordingly, a commitment to sustainable development must be written into mandates for advancing operating, planning, regulatory and financial procedures. Sociotechnical readiness scorecards can help in assessing institutional capacity and designing a road map for change management. Furthermore, many national utilities and regulators in the region need standing committees, task forces and working groups[20] to evaluate procedures and propose new ones. Ideally, the creation of these organizational mechanisms should be complemented with empowering specific parts of the bureaucracy to ratify new procedures.

Regulatory harmonization requires that national regulators collaborate. Many subregions in Asia and the Pacific collaborate at the multilateral level. However, for this collaboration to move beyond sharing of experiences, subregional regulatory bodies must have a clear mandate for collaboration. Often this is not the case. As an example, the ASEAN Energy Regulatory Network (AERN) facilitates the sharing of regulatory experience among ASEAN member States. However, AERN does not have a mandate to develop guidelines relating to the development of the ASEAN power grid. A clear mandate would empower regulators to collaborate with utility companies to design a regional market. It is important to stress that regulators are ultimately responsible for ensuring that regional power system connectivity benefits consumers. To fulfil that role, however, they must be empowered to act, and have the technical, financial, and human resource capacity to collaborate internationally.

2.4. Cross-cutting issues – convergence of information, communications and technology, transport and power system connectivity

Power connectivity is closely intertwined with ICT and transport connectivity. ICT systems depend on electric power to operate and electric power systems are operated and controlled by sophisticated ICT systems. In a similar way, electric power systems can only be built in locations with transport access, while transport systems are increasingly relying on electrified modes of operation. In this section, these interlinkages and their role in expanding power system connectivity are explored.

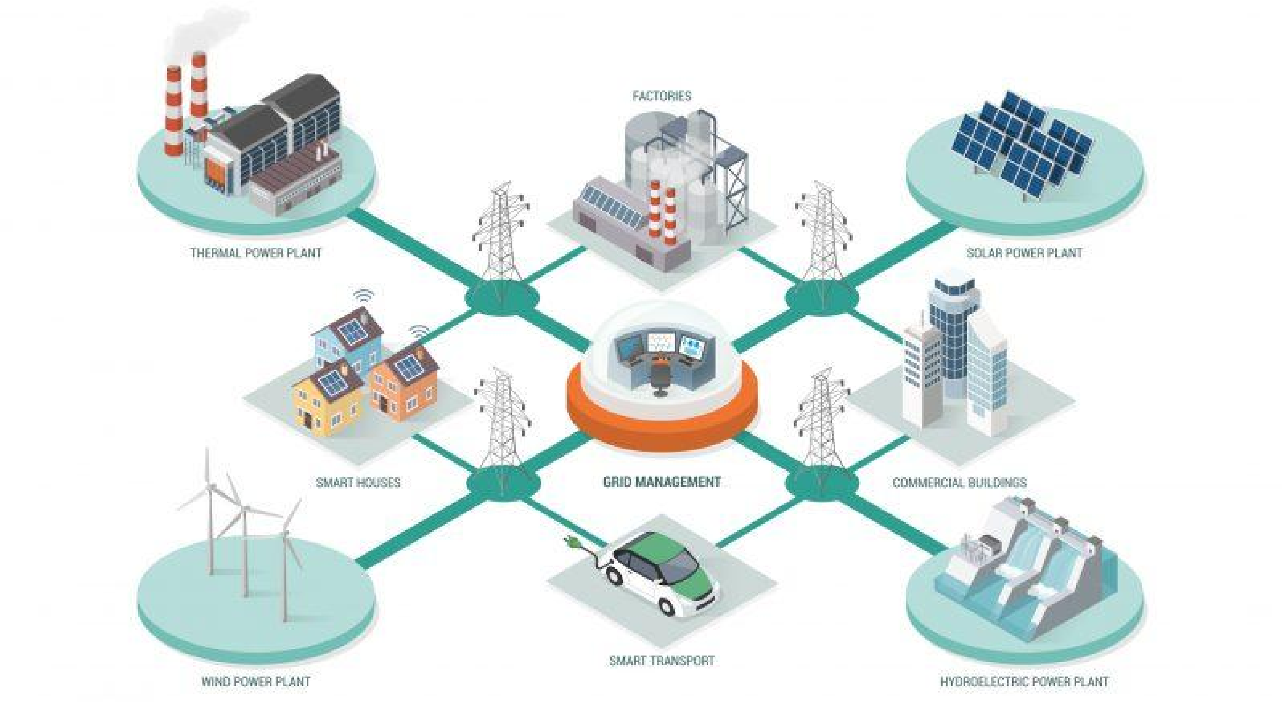
A. Information and communications technology innovations accelerate power system connectivity

While international energy connectivity can play a vital role in building an energy system that is affordable, reliable and sustainable, it can be greatly enhanced by digital connectivity. A valuable consequence is one of the greatest power failures in history; the 1965 New York City blackout, was a commitment made by the authorities to embrace digital connectivity through the creation of supervisory control and data acquisition (SCADA) networks. SCADA networks are common and indispensable in providing grid operators around the world with the situational awareness to maintain reliable operations. Unfortunately, only large assets in the electric power system are connected to SCADA networks. Smaller ones are usually invisible to system operators. According to a recent book entitled "eIoT: The Development of the Energy Internet of Things in Energy Infrastructure", which explores how the Internet of things can transform the energy infrastructure, this is a lost opportunity. In the book, it is argued that everyday electrical devices, ranging from household appliances to supermarket refrigerators, that are now increasingly digitally connected through the Internet and cellular networks, have the potential to transform the grid and open new frontiers for a grid that is more affordable, reliable and sustainable.

In the Asia-Pacific region, the potential benefits of the convergence of ICT and electric power infrastructure are most pertinent in SIDS. Due to their remoteness and small populations, investments in cross-border physical electric power transmission lines are often unviable. The small island developing States face a raft of additional disadvantages. They are susceptible to disruptions in the supply of fossil fuel shipments. More frequent extreme weather events threaten to make these disruptions more common. All this makes it imperative for SIDS to design tailor-made electric power systems and develop local renewable energy resources. Recent extreme weather events that disabled the grid in Hawaii and Puerto Rico present valuable lessons for sustainable development. Even facilities with backup diesel and gas generators proved vulnerable as a result of fuel shortages and disrupted transport infrastructure. In contrast, rooftop solar and battery storage systems were able to operate during the emergency. To make the most efficient and reliable use of variable renewable energy in an emergency setting requires ICT-enabled real-time measurement, operation, and control systems. These ICT systems can control the charging and discharging of battery energy storage and regulate the use of network-enabled appliances.

The convergence of ICT and electric power systems in SIDS is a precursor of a much broader trend. The integration of distributed energy resources, such as rooftop solar panels, battery energy storage and network-enabled appliances, is enabling decentralized and highly connected power systems with extensive data exchange and digital solutions. Power systems of the past tended to be centralized and communication flowed mostly from central power plants to system operators. In the future, as new business models emerge, and more parts of the power system become flexible and able to support the variability introduced to the system by renewable energy, communication will become multidirectional.

Figure 2-6 Communication pathways in the decentralized power system



Source: ESCAP (2022e).

Another possible synergy between ICT and energy is the co-deployment of infrastructure, in particular fibre-optic cables and electricity grids. As both ICT and power systems rely on infrastructure, such as cables, collaborative planning can unlock synergies.

Box 2-1: Co-deployment of information communications technology and power infrastructure in Bhutan and Europe

Bhutan, a country with mountainous terrain and scattered populations, has long recognized the effectiveness of improving telecommunications and information connectivity in supporting economic development.

In 2003, the State-run Bhutan Power Corporation, which operates and maintains the national fibre network, first co-deployed fibre-optic cables. The cables were laid over the power transmission lines between Thimphu, the capital, and the city of Phuentsholing on the border with India. Bhutan Telecom Limited received maintenance and lease fees, as well as the right to use 12 of the 24 cables. The project has since connected all dzongkhags (districts) with optical ground wire cables. The Government has given the telecome service and Internet service providers free access to a pair of dark fibres in a bid to make telecom and Internet services more affordable.

The COBRA Fibre Optic Cable is another example of synergies to be gained from the deployment of a new electricity cross-border transmission line and increased cross-border ITC connectivity. The 325km-long dark fibre G.654.D low loss cable connects Eemshaven in the Netherlands and Endrup (Esbjerg) in Denmark via the German sector of the North Sea. The cable is jointly owned by the Danish and Dutch transmission system operators Energinet and TenneT TSO, and leased out by Relined Fibre Network, a Dutch company. It runs alongside the COBRA cable high-voltage direct current (HVDC) submarine electricity interconnector. While the COBRA Fibre Optic Cable has primarily been installed to control the HVDC electricity interconnector, unused capacity has become available for commercial purposes.

Sources: ESCAP (2019c); ESCAP (2021); and Submarine Cable Networks (n.d.).

B. Transport innovations accelerate power system connectivity

Transport access is essential when expanding an electric power system. The siting of new electric power transmission and distribution lines is often tied to road networks. Overhead and underground lines run along roadways for regular maintenance and access, and the required rights of way are often planned in concert with their proximity to major highways. For this reason, the siting of offshore wind turbines is typically less contentious than for onshore wind turbines. Projects that turned a blind eye to these processes have failed. For instance, the Desertec initiative, which promoted the generation of renewable energy in deserts, proposed to bring the Sahara desert's solar potential to European cities. Ultimately, poor road infrastructure in the Sahara region made it unviable. Landlocked countries in the Asia-Pacific region should take note of this and develop transport networks if they want to exploit their local solar and wind power potential.

The electrification of transport is the single greatest driver of electric power demand. At the residential scale, the adoption of electric vehicles and micro-mobility solutions is estimated to increase daily home energy demand by 50 to 100 per cent. In many cases, electrified vehicles can serve as demand-side resources that provide grid balancing services through two-sided electricity markets and automatic feedback control systems. The provision of such services enables greater use of variable renewable energy – thus linking energy, transport, and ICT. The demand growth ahead can finance upgrades to the electric power system, including transformers and substations, distribution lines, and international power lines. It is important to recognize that in less developed regions, low demand may stall grid investments. Under these circumstances, a sustainable energy transformation plan that prioritizes transport electrification would make investments in grid infrastructure more likely. Furthermore, electrified transport requires highly distributed charging stations, including in remote areas along major transport arteries. In other words, the expansion of transport and energy infrastructures will have to move in lockstep. For now, the co-design, planning, and operation of transport and electric power system networks remain a largely unrealized opportunity.

2.5. Conclusion

There is great potential for international electric power connectivity to underpin sustainable development in the Asia-Pacific region. It can support economic growth, widen access to modern energy resources, and increase the use of renewable energy. Several efforts are already under way in the region to reap the benefits from improved power connectivity. Notwithstanding this, overall progress has been modest.

Improving power system connectivity is not just an engineering problem. Joining national electric power systems requires the harmonization of a raft of sociotechnical factors. Operational, planning, regulatory and financial procedures must be harmonized. Ultimately, the alignment of two systems is achieved through institution-building. Policymakers must be given a clear mandate to advance such harmonization and create the necessary institutional capacity. At the national, subregional, and national levels, power sector stakeholders can use sociotechnical readiness scorecards to guide actions and ensure progress. Multilateral institutions must support international power connectivity, but their efforts must be mirrored by institutions at the country level.

Finally, power system connectivity must be considered in lockstep with ICT and transport connectivity. Advances in the ICT and transport sectors have profound implications for the energy sector, including the ICT-enabled integration of variable renewable energy and demand-side resources, and increasing demand for electricity resulting from the rapid electrification of transport. The key to unlocking the potential of each of the sectors is to take an integrated approach to energy, ICT and transport planning.

ENDNOTES

16 See ESCAP/CE/2021/4. Also see www.unescap.org/our-work/energy/energy-connectivity/roadmap.

17 More details are available at CASA-100 (2022).

18 See, for instance, JICA (2020).

19 To learn more about models to attract private investment in grids, please see Kristiansen (2022).

20 IEEE and the International Council on Large Electrical Systems are committees that serve different purposes and have different mandates with respect to governance structures.

Chapter 3

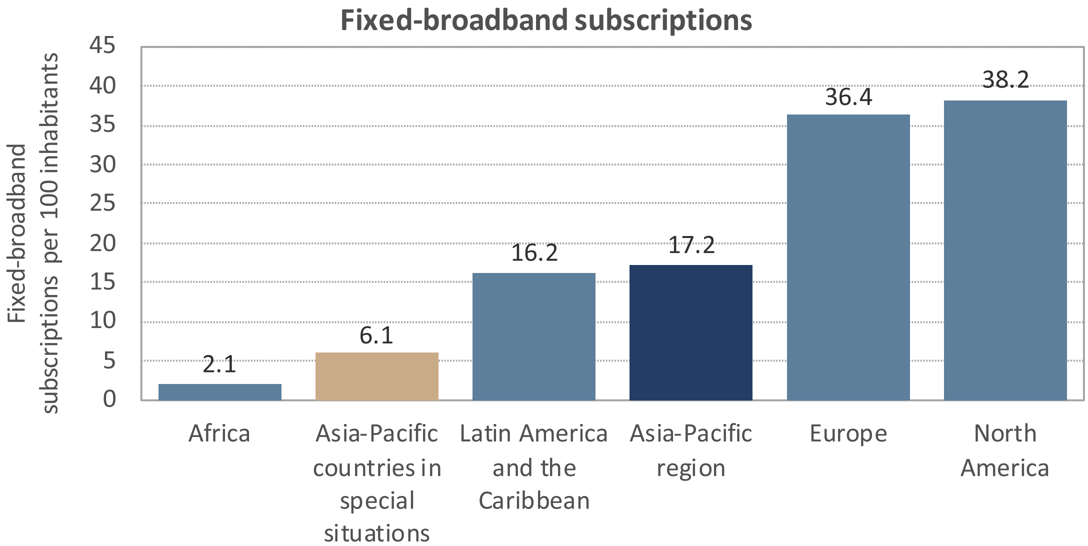
Regional cooperation for affordable and resilient information, communications and technology connectivity

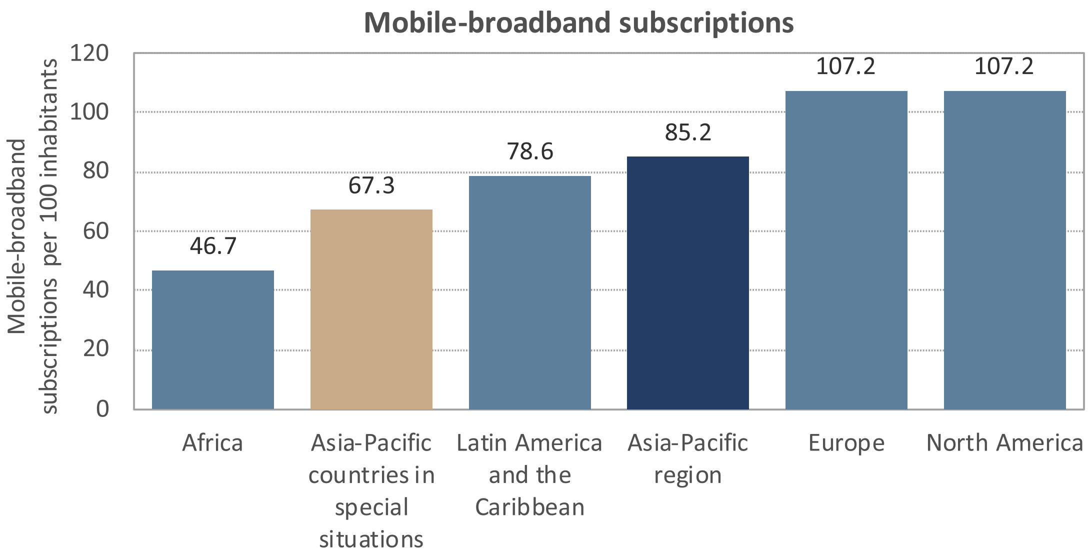
3.1. Trends in digital connectivity

A. Access to broadband Internet

Affordable access to the Internet and ICT infrastructures are essential to shaping an inclusive digital future and achieving SDGs. In the Asia-Pacific countries in special situations, only 6 out of 100 people have fixed-broadband subscriptions − approximately one third of the regional average (figure 3-1). Some 67 per cent of people in the region have a mobile broadband subscription, again, much lower than the regional average. This digital divide is complicating the social and economic recovery from the COVID-19 pandemic in these countries. A combination of low incomes, underdeveloped digital infrastructure and uncompetitive telecommunications markets often make Internet access unaffordable, especially in rural areas and for women.

Figure 3-1 Access to fixed- and mobile-broadband subscriptions per 100 inhabitants, weighted averages, by world regions



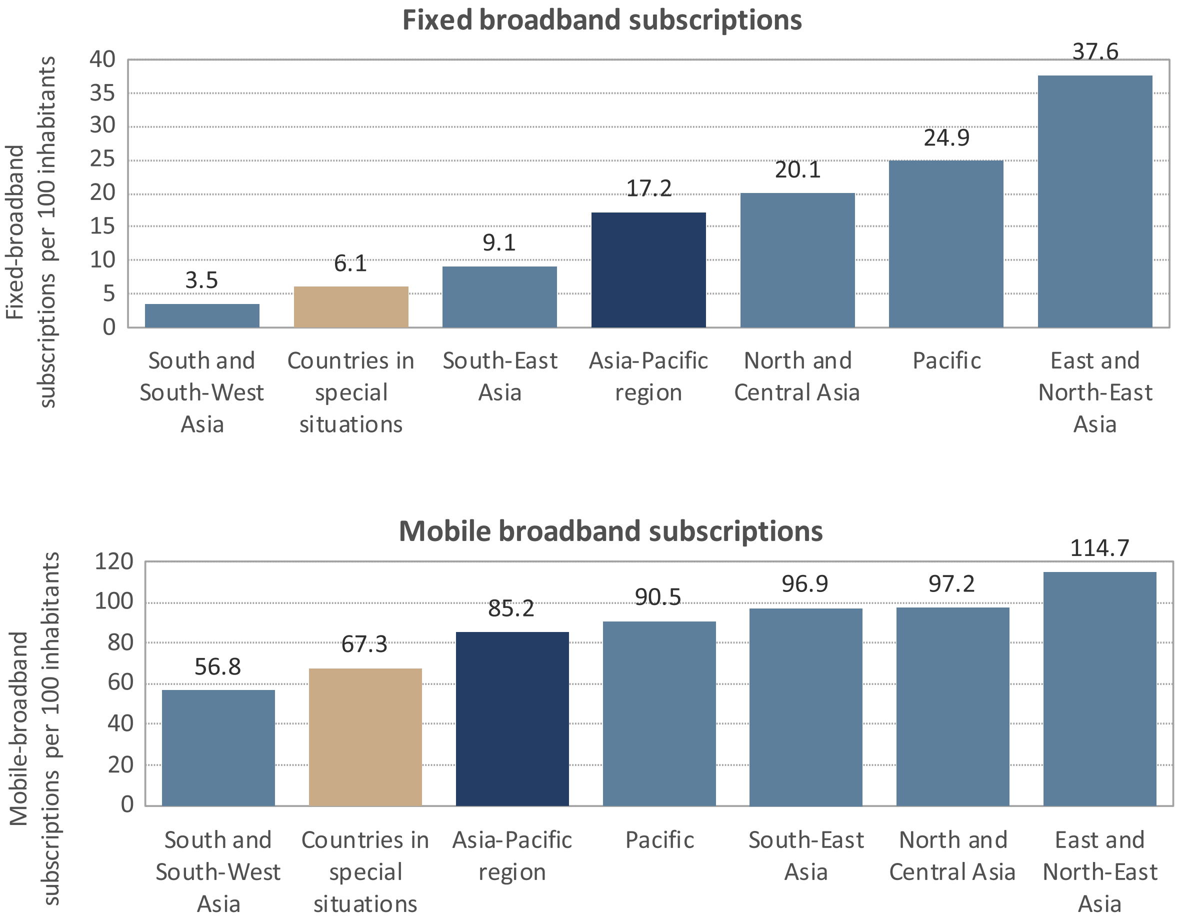


Source: ITU, World Telecommunications and ICT Indicators Database, 26th edition. Available at https://www.itu.int/pub/D-IND-WTID.OL-2022 (accessed on 15 October 2022).

Note: This figure is drawn from 2021 data or latest year available.

Among the ESCAP subregions, East and North-East Asia are recording the highest ratio of access to fixed and mobile broadband, which are similar to that of European levels. Asia-Pacific countries in special situations lag all ESCAP subregions except South and South-West Asia (figure 3-2). South-East Asia also has fewer mobile and broadband subscriptions than the average for the region, in part because the subregion contains many countries in special situations.

Figure 3-2 Access to fixed and mobile broadband subscriptions per 100 inhabitants, weighted averages, by Asia-Pacific subregions

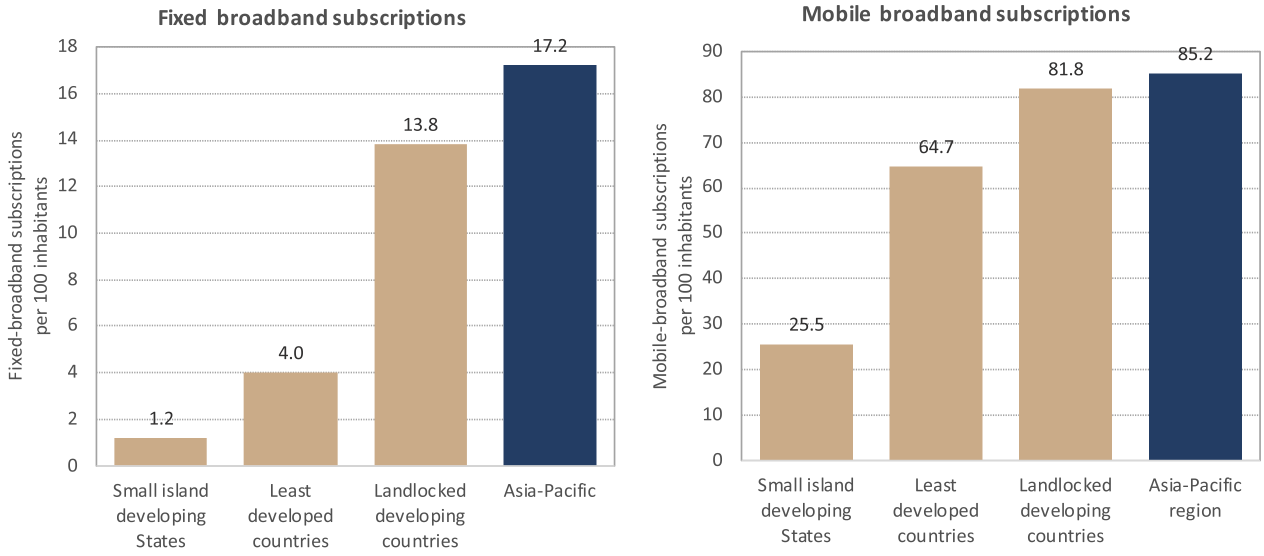


Source: ITU, World Telecommunications and ICT Indicators Database, 26th edition. Available at https://www.itu.int/pub/D-IND-WTID.OL-2022 (accessed on 15 October 2022).

Note: This figure is drawn from 2021 data or latest year available.

Asia-Pacific countries in special situations face a number of unique challenges in providing affordable and reliable broadband and mobile coverage (figure 3-3). In LLDCs with a low population density and mountainous terrain, laying fibre-optic cables can be economically unviable. Without direct access to submarine cables, people living in remote rural areas often rely on a lower-quality Internet network infrastructure with limited bandwidth and speed. To harness the full benefits of digital connectivity, investments in telecommunications infrastructure are essential (Internet Society, 2018). In Kazakhstan, for instance, the Government, in partnership with the International Telecommunication Union (ITU) and the United Nations Children's Fund (UNICEF), in 2020 launched "GIGA", a national initiative to connect every school to the Internet. The project increased digital access and affordability and greatly benefited schools in rural areas (ITU, 2020c).

Figure 3-3 Access to fixed and mobile broadband subscriptions per 100 inhabitants, weighted averages, in Asia-Pacific countries in special situations



Source: ITU, World Telecommunications and ICT Indicators Database, 26th edition. Available at https://www.itu.int/pub/D-IND-WTID.OL-2022 (accessed on 15 October 2022).

Note: This figure is drawn from 2021 data or latest year available.

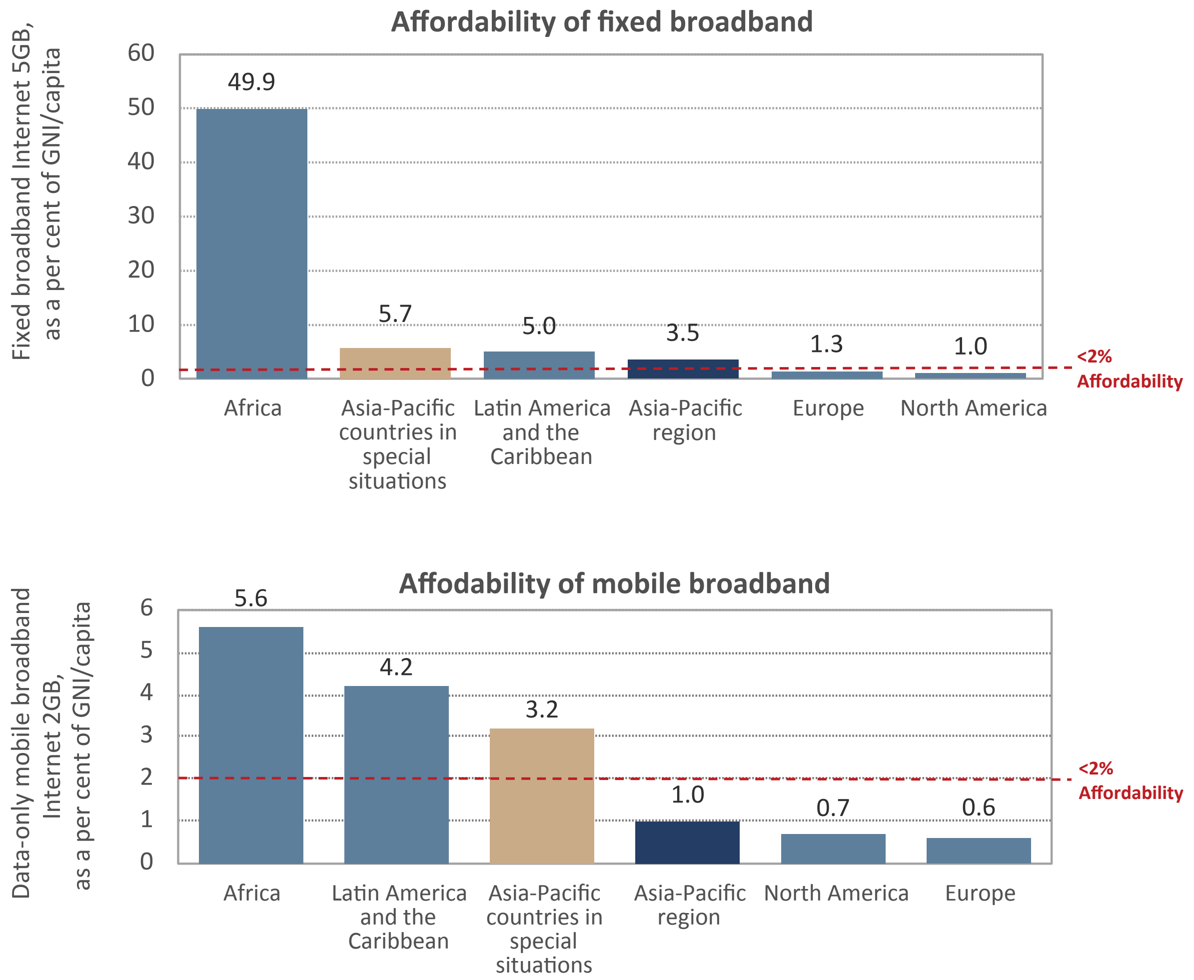
In SIDS, broadband access remains especially low and expensive, and is often unreliable. This is mainly due to the following unique characteristics of the islands: geographically remote and disperse; few people and resources; and highly susceptible to natural disasters, such as cyclones and tsunamis (ESCAP, 2018b). In addition, lack of local content and digital skills keep people offline. While coverage of mobile broadband networks may be extensive, Internet access often remains low because it is unaffordable (ITU and OHRLLS, 2021). In many countries in special situations, mobile and broadband Internet is more effective and versatile than fixed broadband (ITU, 2020b).

One way to improve broadband access in SIDS is to use satellite technology to supplement submarine fibre-optic cables. For instance, Kacific Broadband Satellites Group, a Singapore-based broadband satellite operator, is deploying high-speed Ka-band satellite connectivity services in Pacific SIDS. The firm is using high frequency in the spectrum range of 26.5–40 gigahertz (GHz), which allows the satellites to reuse the spectrum multiple times. The result is high spectral efficiency and fast download and uploads speeds at a low cost. The technology also ensures stable connections when it rains (Kacific, n.d.).

B. Affordability of broadband Internet

Mobile broadband in Asia-Pacific countries in special situations is, on average, three times as expensive as in the region (see figure 3-4). During the COVID-19 pandemic, the affordability of fixed and mobile broadband dropped further in most Asia-Pacific countries. Fixed broadband data also remain expensive in countries in special situations.

Figure 3-4 Affordability of fixed and mobile broadband, weighted averages, by world regions

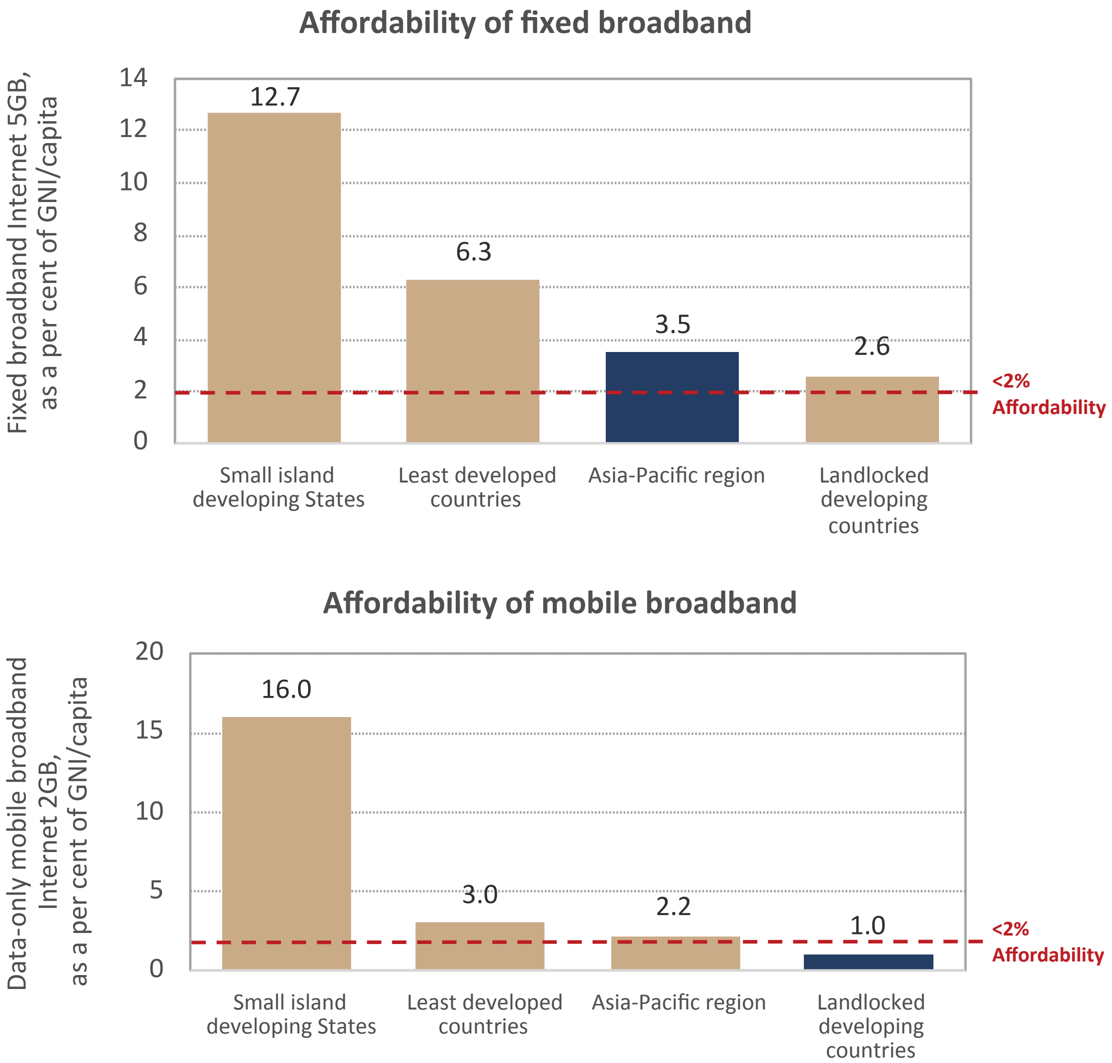


Source: ITU, World Telecommunications and ICT Indicators Database, 26th edition. Available at https://www.itu.int/pub/D-IND-WTID.OL-2022 (accessed on 15 October 2022).
Note: This figure is drawn from 2021 data or latest year available.

Among the Asia-Pacific countries in special situations, LLDCs, especially those in North and Central Asia, enjoy more affordable access to broadband services than LDCs and SIDS (figure 3-5). This is in part due to targeted government interventions. In Kazakhstan, for example, Digital Kazakhstan, a public digital infrastructure programme focusing on rural areas, has improved overall broadband access (Satubaldina, 2017).

While mobile broadband services have expanded in SIDS over the past five years, fixed and mobile broadband still remain unaffordable. On the positive side, mobile connectivity is playing an increasingly important role during and after natural disasters. In Tonga, where a devastating volcanic eruption and tsunami led to an Internet outage in February 2022, a high-speed SpaceX Starlink Emergency Satellite Service allowed government officials to connect to the Internet until the submarine damaged fibre-optic cable was repaired (Tonga, 2022).

Figure 3-5 Affordability of fixed and mobile broadband, weighted averages, in Asia-Pacific countries in special situations



Source: ITU, World Telecommunications and ICT Indicators Database, 26th edition. Available at https://www.itu.int/pub/D-IND-WTID.OL-2022. (accessed on 15 October 2022).

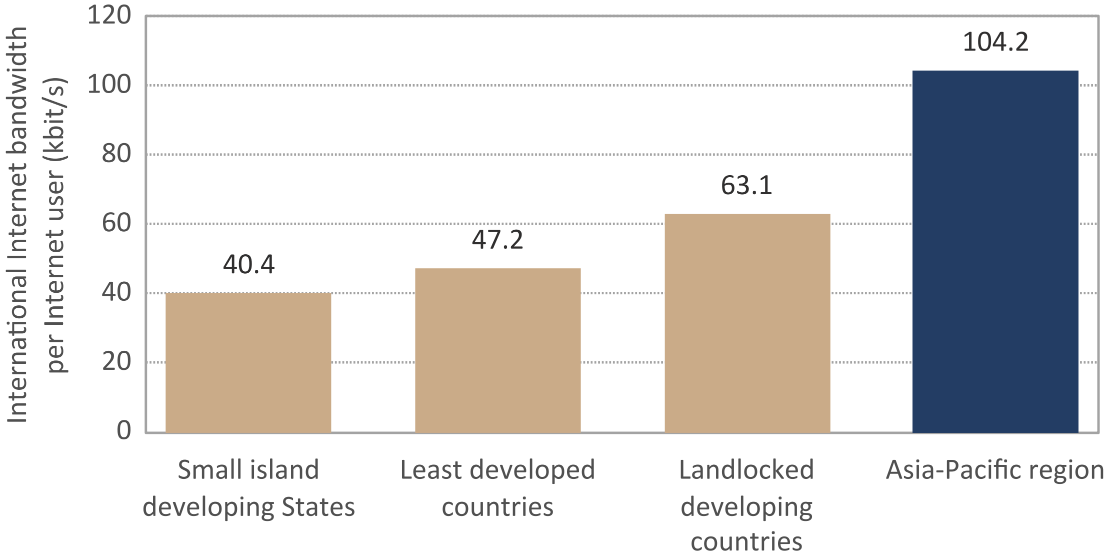
Note: This figure is drawn from 2021 data or latest year available.

C. Internet bandwidth capacity

The availability of Internet bandwidth relies on infrastructure, such as satellite technologies and submarine or terrestrial fibre-optic cables. Persistent and large gaps in digital infrastructure development in the Asia-Pacific countries in special situations, especially in the “last mile” connectivity, are a key barrier to higher Internet bandwidth capacity (figure 3-6). ESCAP estimates that LDCs, LLDCs, and SIDS in the Asia-Pacific region need investments of approximately $8 billion, or 1.2 per cent of their combined GDP, to close the ICT infrastructure gap by 2030 (Branchoux, Fang and Tateno, 2018). [21] The overwhelming majority of the funds would have to be spent on rolling out and maintaining last-mile broadband infrastructure networks (ITU, 2020a).

Internet users in locations with poor connectivity cannot access the same services or use data-rich content to the same extent as people living in places with high-quality connectivity. As more and more everyday devices and digital applications are connected to the Internet and disaster risks mount, a big push to invest in digital infrastructure networks is needed to meet various bandwidth demands from new technologies.

Figure 3-6 Internet bandwidth per Internet user, weighted averages, in Asia-Pacific countries in special situations



Source: ITU, World Telecommunications and ICT Indicators Database, 26th edition. Available at https://www.itu.int/pub/D-IND-WTID.OL-2022 (accessed on 15 October 2022).
Note: This figure is drawn from 2021 data or latest year available.

3.2. Opportunities and challenges for sustainable Information communications technology connectivity

A. Opportunities to advance affordable and resilient connectivity

A quality telecom network must provide resilient connectivity. The geographical diversity of routes, with minimal concentration of paths in a chokepoint, is vital to reducing the risk of a disaster disrupting the network. Ideally, international connectivity should not rely on digital connectivity through a single country; otherwise, data sovereignty cannot be assured.

Building resilience also requires multiple digital connectivity modalities – a mix of fixed, land and submarine, mobile, and space-based connectivity – to ensure continued service in case one or more systems fail. The volcanic eruption in Tonga illustrates the importance of diversity in digital connectivity modalities (see box 3-1).

Furthermore, networks need to be internally resilient to short-term hazards, such as earthquakes, landslides and tsunamis, as well as to long-term hazards, such as sea-level rise and coastal erosion, and destructive human activities, such as ocean bottom fishing and anchoring. The next section contains a discussion on the deployment of oceanographic sensors on undersea communication cables to deliver resilient connectivity and other benefits.

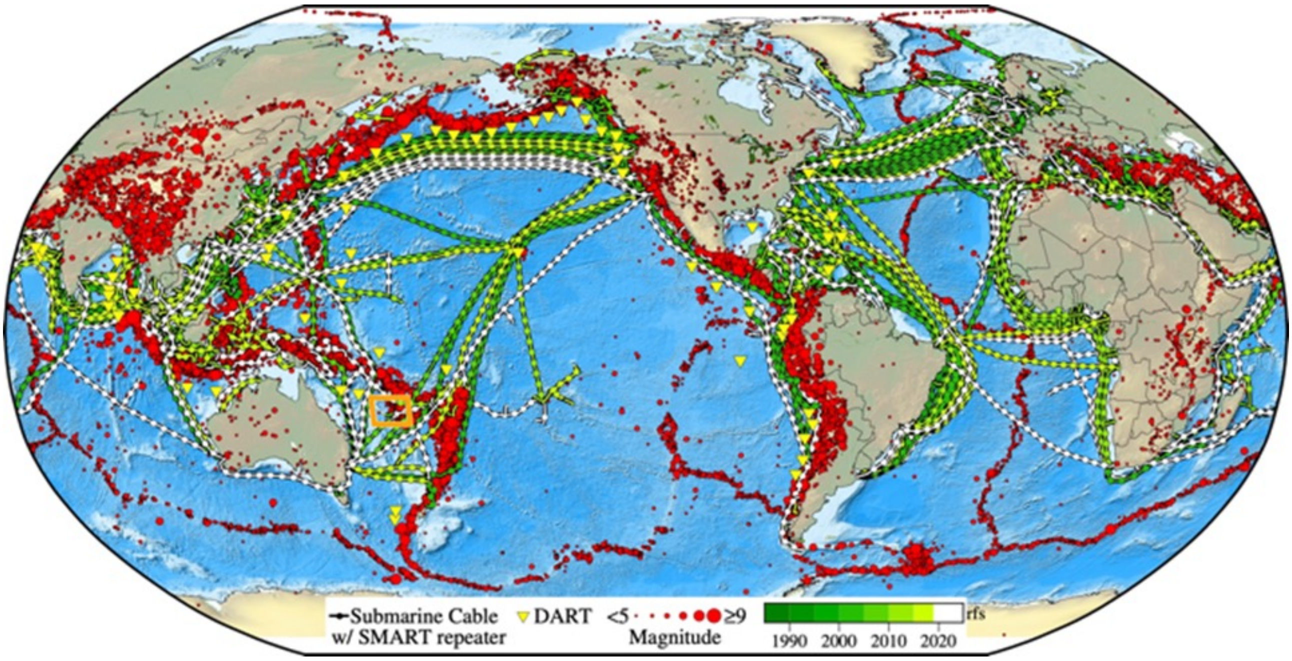
i. **Science Monitoring and Reliable Telecommunications (SMART) submarine cables for climate and natural disasters monitoring**

Submarine fibre-optic cables, the width of a garden hose, have long been the backbone of international telecommunication links. A new type of communication cable is being added to the more than 400 submarine cables on the world's sea beds, SMART submarine cables. These cables carry Internet traffic and monitor climate and natural disasters using sensors in their repeaters, electronic devices that amplify the signal and retransmit it.

The new breed of cables fills a gap in scientific knowledge. Lack of deep ocean monitoring capabilities threatens human security and resilience to natural disasters, including earthquakes and tsunamis. It also makes it difficult to respond to the threats of climate change, which disproportionately affects the most vulnerable. The oceans are the thermal flywheel of the climate system, storing heat and carbon dioxide, while covering some 70 per cent of the earth's surface. Yet, there is a dearth of comprehensive and sustained observation of the deep ocean. Without it, understanding and mitigating climate, earthquake and tsunami risks will be difficult.

In response to this challenge, a task force comprised of ITU, UNESCO-IOC (United Nations Educational, Scientific and Cultural Organization-Intergovernmental Oceanographic Commission), and the World Meteorological Organization (WMO) has developed the concept of a sustained global network of SMART submarine cables to support climate and ocean observation, sea level monitoring, and tsunami and earthquake early warning systems (see figures 3-7 and 3-8).

Figure 3-7 The global submarine cable network

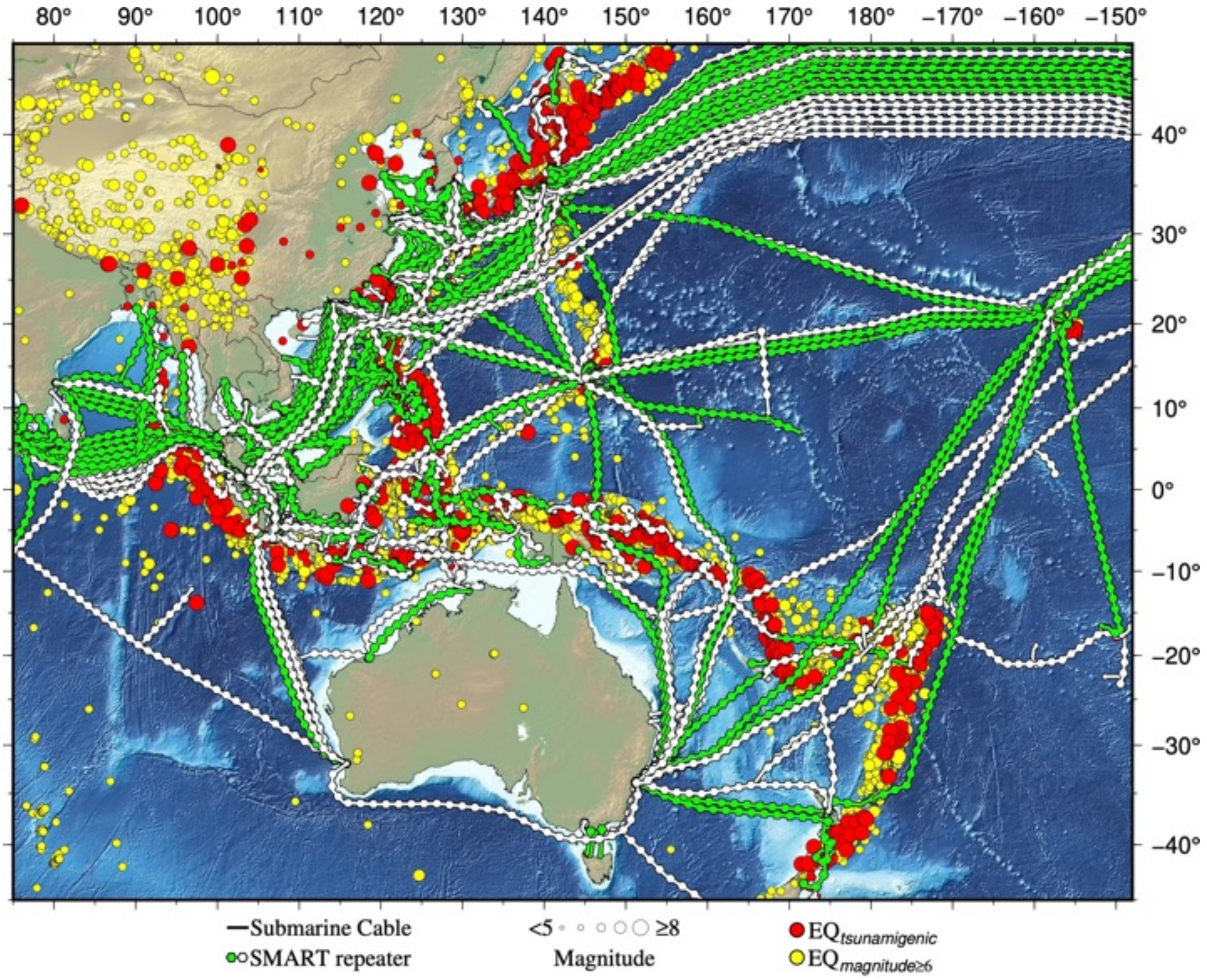


Source: Howe and others (2022).

Notes: The 1.4 million kilometers of operational submarine telecommunications cable spanning the globe with 20,000 repeaters every ~70 km that could host sensors ~initially, temperature, pressure, seismic motion. Current cables (green lines); in progress/ planned cables (white); historical earthquakes (red); and DART tsunami buoys (yellow triangles). SMART repeaters are shown every 300 km (rfs = year ready for service).

The boundaries and names shown and the designations used on this map do not imply official endorsement or acceptance by the United Nations.

Figure 3-8 Submarine cables and earthquakes in the Asia-Pacific region



Source: Adapted from Howe and others (2022).

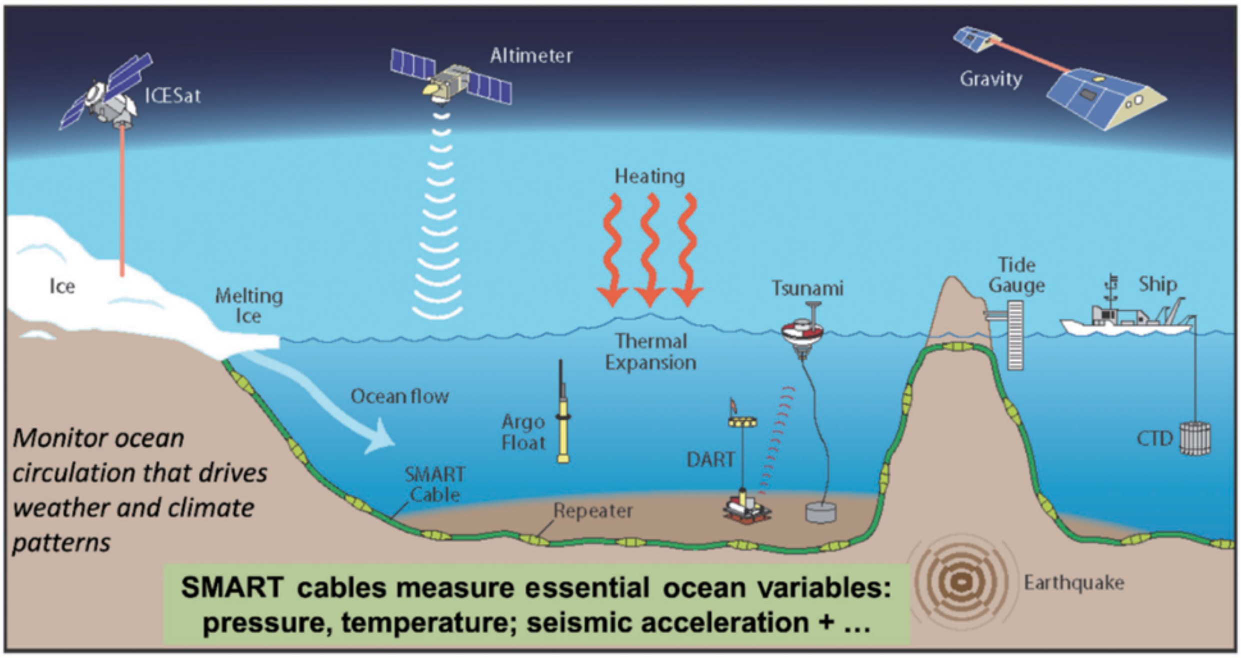
Note: Earthquakes stronger than magnitude 6 are shown in yellow; red dots indicate tsunamigenic earthquakes.

The boundaries and names shown and the designations used on this map do not imply official endorsement or acceptance by the United Nations.

The SMART Subsea Cables initiative seeks to integrate ocean bottom temperature, pressure and seismic sensors into the repeaters of future transocean commercial subsea telecommunications cables (figures 3-9 and 3-10). This effort builds on the resources and 170 years of experience of the multi-billion dollar cable industry. The idea is to transform over the 10 to 25-year refresh cycle of subsea cables, the “deaf, dumb, and blind” network currently being used into an ocean- and Earth-wide sensor array.

A SMART network of real-time data for disaster mitigation and climate observation would contribute to the implementation of the Sendai Framework for Disaster Risk Reduction. Real-time monitoring can help to gain a better understanding of disaster risks, facilitate the improvement of building codes and standards, and ultimately, contribute towards the realization of SDGs.[22] SDGs are essential to the United Nations Decade of Ocean Science for Sustainable Development (2021−2030), a framework to design and deliver the science needed to ensure ocean health. SMART data will advance scientific knowledge on climate change, including ocean circulation, heat content and regionally variable sea-level rise, as well as mitigate the threats of tsunamis and earthquakes. At the same time, the new generation of cables will improve the quality of connectivity through improved cable integrity by making the cables adaptable to the environment and greater network resilience (by using data gathered by SMART cables to better plan future cable routes).

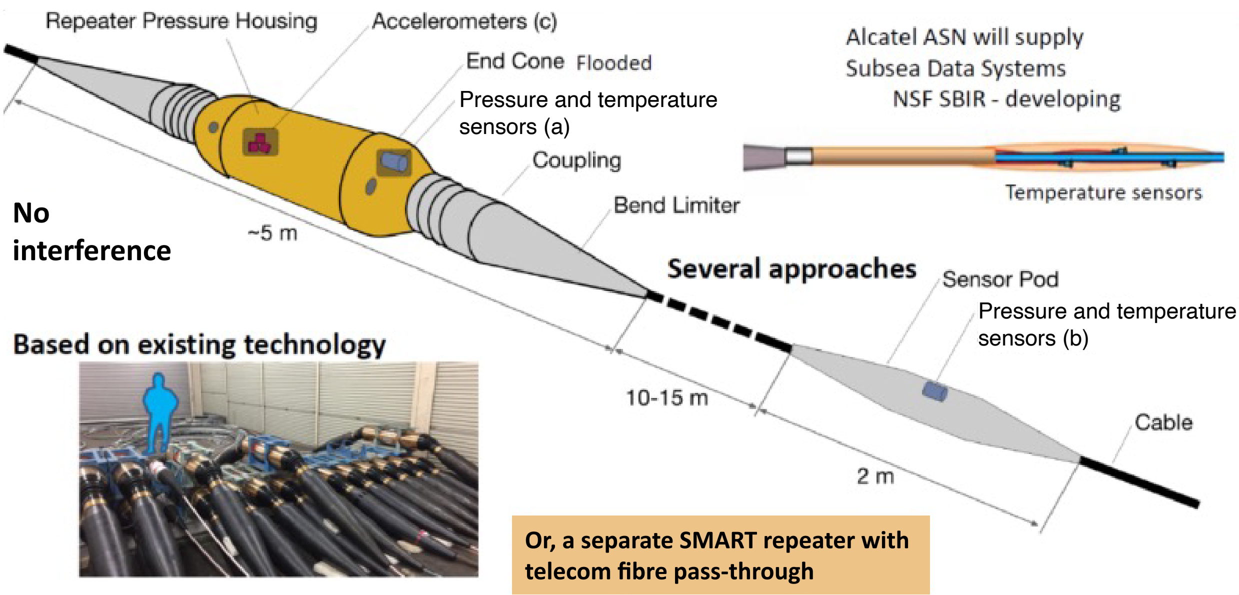
Figure 3-9 SMART cables will be one of many parts of the Global Ocean Observing System



Source: Provided by Bruce Howe, University of Hawaii at Manoa, 12 March 2023.

Note: SMART cables will be among many necessary tools in the ocean observing kit used to measure the ocean bottom boundary condition.

Figure 3-10 Mounting sensor in a SMART repeater



Source: Howe and others (2019). Photo courtesy of Stephen Lentz.

Notes: There are several possible ways to mount sensors, as shown in the figure, and some engineering issues need to be addressed, all tractable. The first systems will result in a SMART repeater with the industry standard 25-year life.

The main technical goal of the SMART initiative is to make the repeater a mass-produced component of the submarine cable industry that can be incorporated into any new system at an extra 10 per cent cost. Naturally, the sensing portion of the system must not negatively interfere with the cable's primary telecom mission. The instrumentation of SMART submarine cables includes digital signal processing, optical transceivers, and associated power supply circuits. These must be integrated with repeaters on commercial cables at regular intervals. However, there are still technical challenges in integrating new sensors with present commercial cables. For example, to attain effective measurements, the temperature and pressure sensors must be in contact with the ocean water. They must also be isolated from the high voltages in the repeater and be fail-safe. Alcatel Submarine Networks (ASN), the world's largest supplier of submarine cable systems, is committed to providing cables with SMART capability by 2025 (ASN, 2020).

As the global costs of climate impacts mount, it is vital to continually improve the observation systems, especially those directed at the largely undersampled ocean. SMART cables promise to be one of many necessary tools to observe the ocean and will complement satellites and other on site observing systems.

To date, approximately 70 Deep-Ocean Assessment and Reporting of Tsunamis (DART) warning buoys are used as the main means to detect tsunamis. Most of them are scattered around the Pacific Ocean and fully functioning only 70 per cent of the time. The systems are expensive. The Government of New Zealand recently bought 15 DART buoys for $47 million New Zealand dollars (ND) in a deal that covers five years of operation at an annual cost of approximately $500,000 per buoy. For comparison, the international Argo Programme, a partnership that uses 4,000 expendable floats to explore the ocean environment, costs about $40 million a year (University of California San Diego, n.d.).

SMART cables are even more affordable alternatives. They also offer the prospect of observing a coherent, large area wave field of a tsunami in real time. This is in stark contrast with the typically incoherent, time-delayed point observations of DART buoys and most oceanographic on-site sensors sensors. The commercial viability of SMART cables, though still uncertain because the technology is new, appears to be promising. Scientists estimate that at an annual cost of $40 million, assuming a 10-year refresh cycle, 2,000 SMART cable repeaters can be sustained (Howe and others, 2019). The sensors are expected to be reliable, with one design goal aiming for 95 per cent of the sensors working after 10 years. A SMART cable network spanning the Pacific region, where most of the DART buoys are located, could offer more valuable and reliable real-time data with minimum maintenance at a lower price. Public-private partnerships (PPPs) would be key to sharing the cost of such networks, especially in countries in special situations.

Even though the introduction of SMART cables is very recent, some countries have committed to implementing SMART cables. The Government of Portugal, for instance, has fully funded a SMART submarine cable connecting the mainland and Azores and Madeira islands in a system with sensors for earthquake and tsunami early warning and climate and ocean monitoring. The 3,700-kilometre ring, with 50 repeaters, costs an estimated 154 million euro (€) and is scheduled to go into service in 2025 as part of the European Digital Atlantic Gateway. The reason for this sizable investment, apart from replacing the 25-year-old cable system with a new one with much increased bandwidth, is improved disaster preparedness. In 1755, an earthquake and tsunami destroyed Lisbon and much of the Portuguese, Spanish and North African coastline.

SMART cables are a way of providing highly reliable early warning data at a low cost and low risk of vandalism. In Asia and the Pacific, Vanuatu and New Caledonia, in mid-2022, signed a memorandum of understanding for a second international submarine cable to be equipped with SMART sensing capability. Vanuatu is among the countries with the highest natural disaster risk and exposure in the world (World Bank, 2022a). SMART capability in the cable system will allow authorities to monitor and detect climate change signals, undersea volcanic activity, seismic activity, and tsunamis in real time. The system may be the first of its kind to become operational (RNZ, 2019).

Indonesia is developing SMART technology domestically. One system, off the coast of Labuan Bajo in the east of the country, is comprised of two ocean bottom units some 30 and 50 kilometres offshore, respectively, at a depth of 2,000 to 3,000 meters. It transmits data to the capital Jakarta in real time. Work is under way to integrate the system into the national tsunami early warning system. A significant milestone for the new technology will be a 300-kilometre-long cable across the Makassar Strait, which separates the islands of Borneo and Sulawesi, with multiple SMART modules, including commercial telecommunication links.

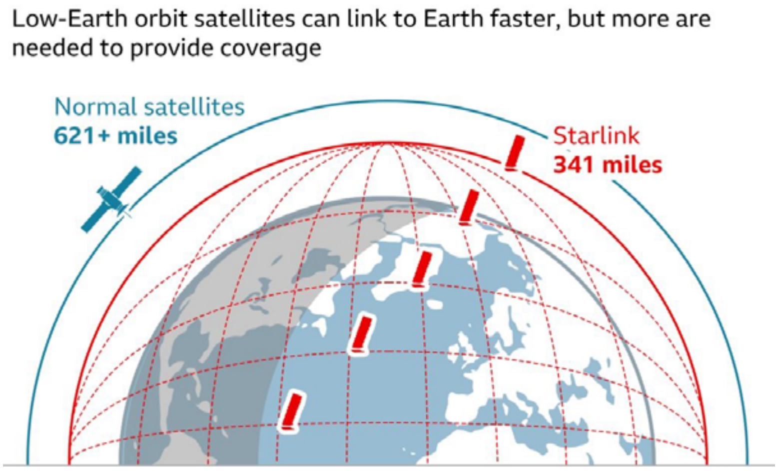
Other prospective SMART cable projects are Project Koete (Perth-Darwin-Malaysia), linking New Zealand-Chatham Islands and Antarctica-New Zealand, Far North Fiber (Japan-Europe), and the Medusa cable system in the Mediterranean Sea, which will link nine countries in North Africa and southern Europe (Howe, 2022).

Significantly, the European Union is backing the roll-out of SMART cables as it recognizes the considerable benefits that flow from adding sensors to telecom cables. A recent call for proposals for backbone connectivity for global digital gateways, included costs relating to integrating sensors into a submarine cable system (European Commission, 2022). These grants could cover 30-70 per cent of the costs of approval projects and facilitate project implementation in remote regions, countries and overseas territories, such as Greenland, the Caribbean, Azores, Madeira, the Canary Islands, New Caledonia, and French Polynesia. The supportive stance of Europe may well encourage governments and multilateral development banks to fund SMART cables projects.

ii. Low Earth Orbital Satellite technologies for post-disaster recovery

Another way to establish more affordable and resilient connectivity is through so-called Low Earth Orbital (LEO) satellites. These satellites orbit earth at an average distance of 2,000 kilometres, much closer than traditional geostationary satellites (figure 3-11). They operate in a revolving network of multiple satellites, which allows them to provide connectivity during air travel and even in the middle of the ocean (World Economic Forum, 2022). Several global technology companies run LEO satellite programmes, including rocketry firm SpaceX owned by Elon Musk, Project Kuiper funded by Amazon, OneWeb of the United Kingdom, the Indian operation, Bharti Enterprises, and Eutelsat of France.

Figure 3-11 Low Earth Orbital satellites by SpaceX (Starlink)



Source: BBC (2022).

Low Earth Orbital satellites constellations circle the Earth several times a day. This increases coverage with continued Internet connectivity. Crucially, their latency, or the time it takes for data to be transferred between source and destination, is only 27 milliseconds compared with 477 milliseconds for stationary satellites (ADB, 2021b). In addition, LEO satellites are cheaper to install because they require less rocket power to place in space (TechTarget.com, n.d.) and can provide cost-effective emergency Internet connections in the wake of natural disasters.

Box 3-1: Low Earth Orbital satellites and post-disaster Internet connectivity in Tonga

The eruption of the Hunga Tonga-Hunga Ha'apai volcano on 15 January 2022 triggered a 10-meter-high tsunami, which devasted the southern islands of Tonga and disrupted the country's only submarine fibre-optic cable. Tonga was cut off from the Internet for more than a month as attempts to repair the damaged cables faced delays (Seselja and Ewart, 2022). SpaceX offered to connect the island to the Internet and donated 50 VSAT terminals to support its relief efforts. The Prime Minister, Hon. Hu'akavameiliku, had the terminals installed at strategic locations (Tonga, 2022).

Starlink satellite terminals were installed in key locations in the Vava'u and Ha'apai group of islands, including, among them, in high schools, police stations and buildings of the health and fire services and other sites. In some of the locations, free public Wi-Fi hubs were made available. To make the technology work, collaboration with neighbouring Fiji, which is connected with Tonga via a subsea cable, proved crucial. The Government of Fiji gave SpaceX permission to build an emergency Earth ground station and granted the company a six-month emergency telecommunications licence, which was extended (Chand, 2022). This experience has demonstrated that Fiji, which is connected to eight Pacific Island countries via subsea cables, has the potential to become a telecommunications hub with a Starlink or other LEO satellite networks and an integrated 5G satellite network.

In late 2022, one of the country's Internet service providers deployed satellite terminals using Ka-band broadband satellite Internet service in the outer islands to complement LEO satellite technologies and submarine cable connectivity and increase resilience (Burkitt-Gay, 2022).

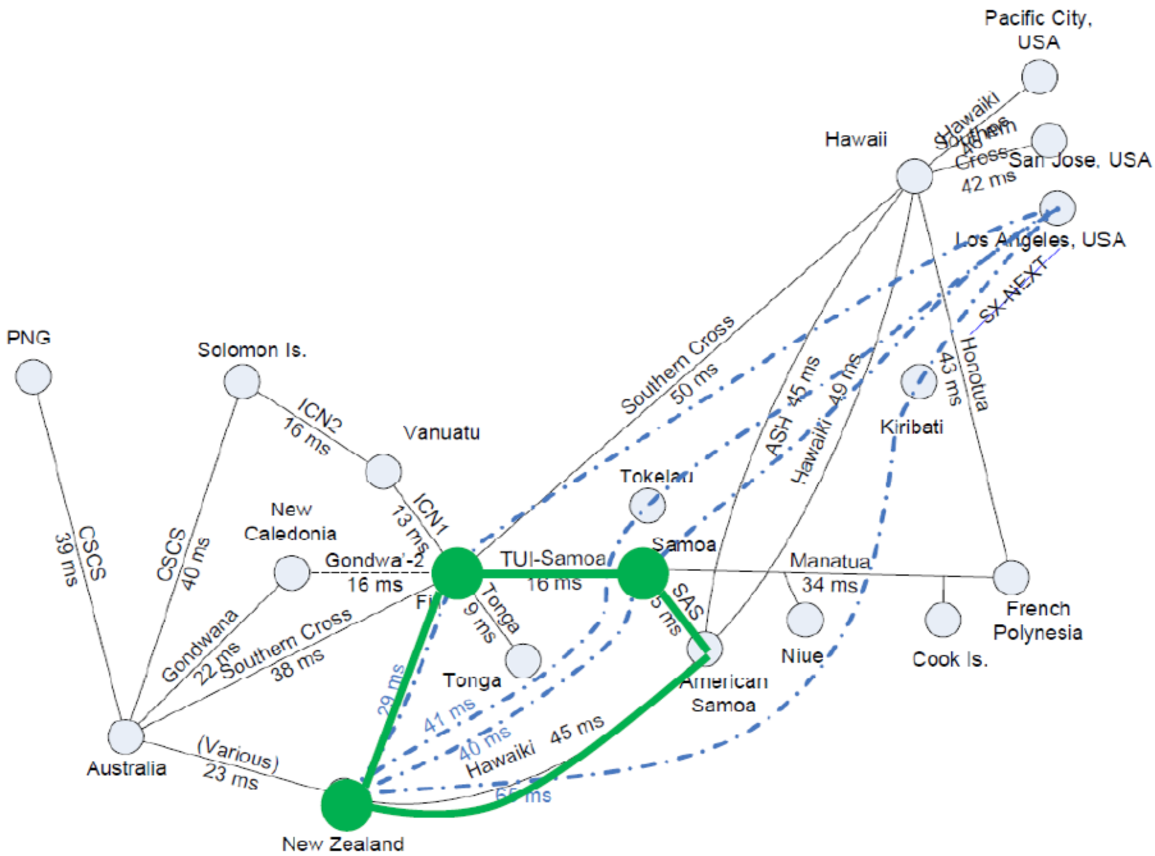
Some countries in Asia and the Pacific have launched Starlink satellite services. In Australia, the National Broadband Network[23] is operational with an advertized Internet speed of up to 200Mbps − eight times faster than speeds provided by Sky Muster, a satellite Internet service run by the State-owned National Broadband Network (Fogg, 2022). Some Pacific islands Governments are considering the deployment of Starlink. The Government of the Philippines believes that Starlink can provide reliable access to the Internet, especially in rural areas susceptible to natural disasters, by mid-2023 (Rosales, 2022). Anectodal evidence of a Starlink satellite used during Cyclone Gabrielle in New Zealand in February 2023 that killed 11 people and displaced 10,000 indicates that it remained operational during the cyclone with minimum disruption (Speidel, 2023).

iii. Promoting affordable and quality Internet connectivity through Internet exchange points

The network latency and affordability of Internet connections vary greatly across Pacific SIDS. The network quality is often erratic due to the long distances that fibre-optic cables have to cover. In several Pacific Island countries, high Internet latency, or signal delays, have been linked to the lack of national or international Internet exchange points (IXPs) (Ofa, 2022). In the Pacific, Australia, New Zealand and Papua New Guinea have established neutral IXPs. The island countries of Fiji, Tonga, and Vanuatu have their own national IXPs, which is making the Internet faster, cheaper and more reliable. Most Pacific Island countries, however, do not have national IXPs.

Brooks (2019) found that Internet latency between South Pacific SIDS and New Zealand could be improved considerably by connecting Fiji, New Zealand, and Samoa via a subregional IXP. The link would reduce the average latency of seven Pacific island countries from an estimated 187 milliseconds to just 6 milliseconds (figure 3-12). As part of the Asia-Pacific Information Superhighway regional cooperation initiative, Fiji, New Zealand and Samoa have established a task force comprised of officials from relevant ministries, regulators and others to discuss the operationalization of a Pacific IXP with the support of the ESCAP secretariat.

Figure 3-12 Pacific Internet exchange point proposal



Source: Brooks (2019).
Note: The yet to be deployed "ICN2" submarine cable is included for the purpose of estimating average latencies only.

iv. Co-deployment and management between information communications technology and transport connectivity

Advances in ICT connectivity have played an important role in fostering progress in implementing the 2030 Agenda for Sustainable Development in Asia and the Pacific. They have spurred economic growth and laid the foundation of the modern digital economy and society, including in the energy and transport sectors.

One key area of synergy is the co-deployment of fibre-optic cables and transport or energy infrastructure. The installation of cables along highways or roads not only allows telecom operators to extend the broadband backbone network, but gives transport operators direct access to the high-speed broadband required to manage their systems. According to an ESCAP study, the co-deployment of fibre-optic cables and highways in Myanmar has reduced the cost of broadband infrastructure by more than one half, or more than $7,000 per kilometer, compared with separate telecom and transport infrastructures (ESCAP, 2018a). Bangladesh and India have had similar experiences (ESCAP, 2018c), and some countries in the region have included co-deployment in the design of future infrastructure projects. Another way of sharing cost and maintenance is the installation of fibre-optic cables along power lines. In Bhutan, this type of co-deployment has helped expand the spread of affordable telecom and Internet services (see chapter 2) (ESCAP, 2021).

For the region's countries in special situations, these examples can serve as a guide to improve their broadband connectivity. The International Think Tank for Landlocked Developing Countries hosts an online portal on co-deployment to facilitate information-sharing (box 3-2).

Box 3-2: Partnership portal on co-deployment

The Partnership Portal on Co-deployment is a joint and collaborative online workspace aimed to support ICT infrastructure co-deployment with road transport and energy infrastructure. Supported by ESCAP and the International Think Tank for Landlocked Developing Countries, the webportal provides developers and owners of ICT, road and energy infrastructure and other stakeholders an opportunity to do the following:

- Register new infrastructure facilities and find other compatible infrastructure development projects (planned or those at early development stage);
- Make an assessment of technical compatibility, cost-effectiveness, and economic efficiency of the co-deployed infrastructure facilities;
- Take the knowledge and learn from other infrastructure co-deployment projects;
- Initiate and generate interest of potential partners for infrastructure co-deployment starting from the initial correspondence to the formulation of the joint infrastructure co-deployment projects and promote partnerships and cooperation on co-deployment of ICT and other infrastructure.

This tool contributes towards achieving the Sustainable Development Goals on connectivity (Goals 1, 5, 9, 17), resilience (Goals 9, 13, 17), traffic and network management (Goals 9, 16, 17), and broadband for all (Goals 9, 17), as well as the Priority 2 on infrastructure development and maintenance, which emphasizes (a) transport infrastructure and (b) energy and information and communications technology infrastructure in LLDCs, and Priority 4 on regional integration and cooperation of the Vienna Programme of Action for the Landlocked Developing Countries (2014–2024).

The applicability and practicability of the web-based tool were first verified for three landlocked developing countries - Kazakhstan, Kyrgyzstan and Mongolia – in 2021. The toolkit was then formally launched after the inputs from peers and partners and with the updates of the knowledge base were incorporated into it.

The portal provides working desks for many professionals who co-work in real-time to scope the infrastructure co-deployment in multifold combinations. It streamlines the efforts of decision makers, development agencies, investors, infrastructure owners and service providers to pragmatically find each other for co-deployed infrastructure development.

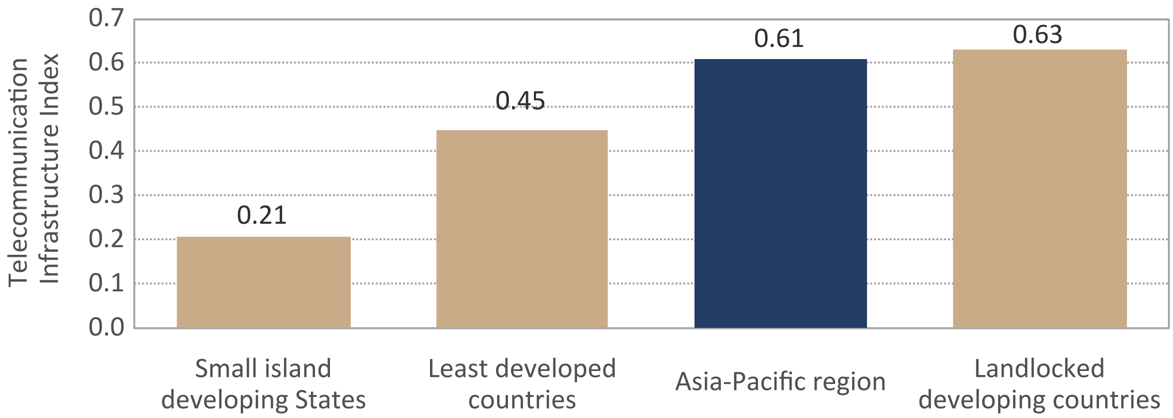
Further information is available at
https://drrgateway.net/partnership-portal-co-deployment and
https://land-locked.org/infrastructure-co-deployment-opportunities-for-the-lldcs/

B. Challenges to achieving affordable and resilient information and communications connectivity

v. Limited information and communications technology infrastructure development

Asia-Pacific countries in special situations suffer from the consequences of poor ICT infrastructure. According to a telecommunications infrastructure index compiled by United Nations Department of Economic and Social Affairs, ICT infrastructure is the least developed in SIDS and LDCs (figure 3-13).

Figure 3-13 Telecommunication Infrastructure Index, weighted averages, in Asia-Pacific countries in special situations, 2022



Source: United Nations, UN E-Government Knowledgebase. Available at https://publicadministration.un.org/egovkb/en-us/About/Overview/-E-Government-Development-Index. (accessed on 15 March 2023).

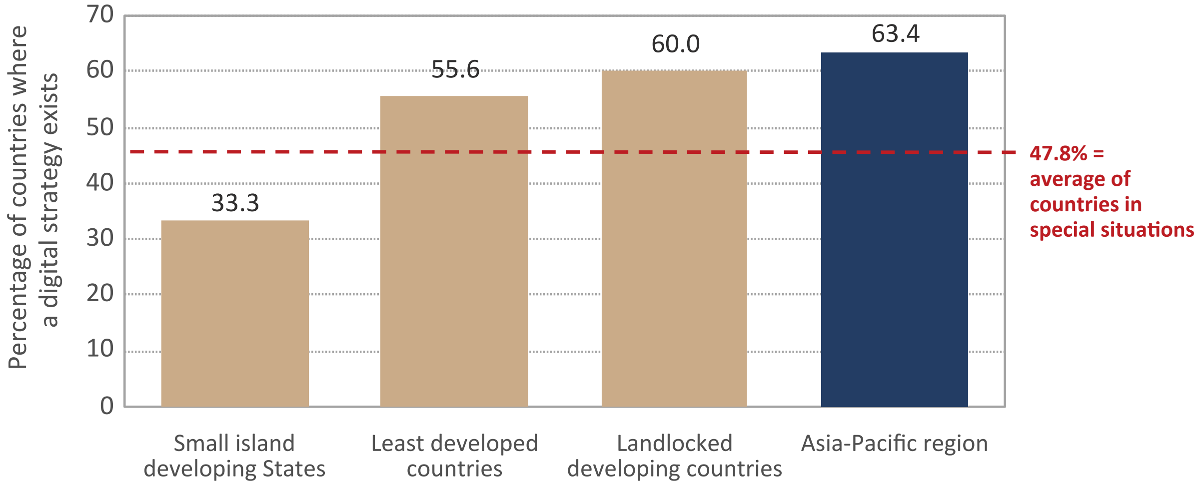
Small island developing States face unique challenges, which make ICT development costly and result in limited fixed and mobile broadband access. The barriers include size, scattered and small populations, challenging fiscal positions, and extreme vulnerability to climate change and natural disasters. For SIDS, connections via a submarine fibre-optic cable are often not commercially viable (Jensen and Minges, 2017), leaving them reliant on donor support to build such infrastructure.

In LDCs, deploying ICT infrastructure is challenging because rural communities tend to be dispersed. The prohibitive costs of connecting remote rural areas are at the heart of a big gap in the use of mobile services in urban and rural areas. In Bhutan, for example, 71 per cent of the urban population uses mobile services compared to 29 per cent in rural areas. Similar rural-urban gaps are in Mongolia (25 and 58 per cent, respectively) and Samoa (2 and 11 per cent, respectively) (ESCAP, 2022b). This digital divide is bound to prolong the post-pandemic recovery in countries in special situations and slow progress towards achieving the 2030 Agenda.

vi. Lack of conducive information and communication technology policies and frameworks

Market competition among Internet service providers can foster innovation and make ICT services more affordable and accessible. For multiple private players to enter the market, however, robust and credible ICT regulatory policies and frameworks must be in place. According to a survey on digital strategies and broadband plans by ITU, Asia-Pacific countries in special situations lag when it comes to digital strategies and broadband plans (figure 3-14). SIDS are especially unlikely to have a digital strategy or broadband plan.

Figure 3-14 Digital strategies and broadband plans in Asia-Pacific countries in special situations, percentage of countries with strategies, 2022



Source: ITU, ITU DataHub, Digital strategies and broadband plans, markets, policy and operational frameworks, 2022, Available at https://datahub.itu.int/data/?i=10053 (accessed 15 March 2023)

Note: The figure covers 41 countries in the region, including 9 LDCs, 5 LLDCs and 9 SIDS. It is drawn from 2021 data or the latest year available.

Some aspects of geographical disadvantages can be overcome. Landlocked Bhutan, for example, has reached the "2%-target" set by the Alliance for Affordable Internet, which posits that mobile data are affordable if one gigabyte can be purchased for less than 2 per cent of a user's gross national income (GNI) per capita. The country liberalized its telecoms sector, established an independent regulator and implemented an infrastructure-sharing policy for fibre-optic networks along its electricity grid (Alliance for Affordable Internet and ESCAP, 2021). According to the GSMA Mobile Connectivity Index for 2020, Bhutan does especially well on the infrastructure score. Key to this performance has been a shared and open access backbone, deep penetration of networks into rural areas and the public offer to operators to use infrastructure in exchange for universal service commitments (Alliance for Affordable Internet and ESCAP, 2021).

In SIDS, although network expansion and market liberalization have led to increased users and the adoption of mobile technology, access continues to be low because of a lack of private investment (Watson, 2021). One of the barriers to entry in telecommunications in the Pacific Island States is the market dominance of State-owned monopolies. A lack of credible and conducive regulation for private sector investment often sustains these monopolies and hurts consumers. A sound regulatory framework is a prerequisite for competition and market certainty, and without it, improving connectivity is exceedingly difficult (Watson, 2021).

To boost the development of ICT infrastructure, especially in unserved and underserved areas, some Governments in the region have established universal access or service funds.[24] The funds have the potential to facilitate affordable and accessible broadband connectivity and lead to the creation, adoption and usage of applications and services. In practice, however, they do not live up to their potential. An ESCAP study found that countries with universal access and service funds did not achieve greater expansion of broadband and the Internet than countries without them (ESCAP, 2017). This suggests that governments should reassess the objectives, scope, and disbursement of universal access and service funds.

vii. Low digital literacy

Low digital literacy is a challenge for countries in special situations in the Asia-Pacific region. Improved access to broadband Internet is of little use for people who cannot read or write. Similarly, low digital skills hinder the development of local Internet content in local languages, which keeps people who do not speak English, the lingua franca of the Internet, offline.

Adult literacy in countries in special situations in the Asia-Pacific region varies considerably (table 3-1). The less widespread of the basic skills of reading and writing is the less likely people are to access the Internet for productive use. In Afghanistan, only one in three people are literate; in Bhutan the ratio is two out of three. This compares with a reported literacy rate of 100 per cent in North and Central Asian countries.

In part, these differences are a function of varying length of compulsory education in the region's countries in special situations. In New Caledonia, there is no compulsory education at all, in Bangladesh it is five years, while in the Marshall Islands, the Federated States of Micronesia, and Tonga, children must attend school for 13, 14 and 15 years, respectively. The longer children are legally required to attend school, the greater the opportunity is for them to benefit from learning, including through acquiring ICT skills.

Table 3-1 Literacy snapshot for Asia-Pacific countries in special situations

Asia-Pacific countries in special situations	Literacy rate, adult total (percentage of people ages 15 and above)	Compulsory education, duration (years)	Primary education, pupils (percentage of female)	Secondary education, pupils (percentage of female)
Afghanistan	31	9	39	35
Papua New Guinea	62	..	46	41
Bhutan	67	..	49	52
Nepal	68	9	51	51
Timor-Leste	68	9	48	51
Bangladesh	75	5	51	53
Solomon Island	77	..	48	47
Cambodia	81	..	48	45
Lao People's Democratic Republic	85	9	48	48
Vanuatu	88	..	47	49
Myanmar	89	5	49	52
Palau	97	12	46	50
Maldives	98	7	49	
New Caledonia	98	0	..	..
Marshall Island	98	13	49	50

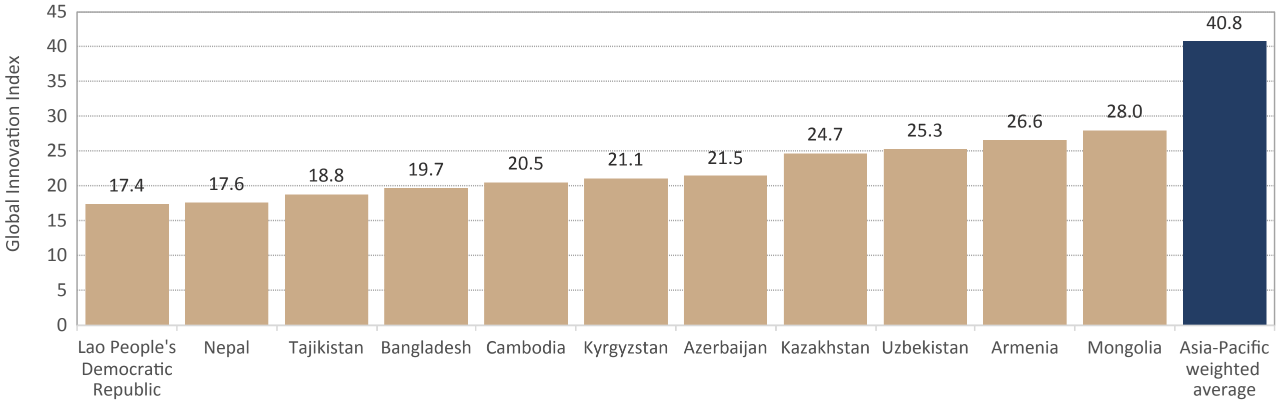
Asia-Pacific countries in special situations	Literacy rate, adult total (percentage of people ages 15 and above)	Compulsory education, duration (years)	Primary education, pupils (percentage of female)	Secondary education, pupils (percentage of female)
Samoa	99	8	48	51
Mongolia	99	12	49	51
Tonga	99	15	47	49
Kyrgyzstan	100	10	49	49
Turkmenistan	100	12	49	48
Kazakhstan	100	9	49	49
Armenia	100	12	47	47
Azerbaijan	100	10	46	47
Tajikistan	100	9	48	46
Uzbekistan	100	12	48	49
Tuvalu	..	8	48	
Fiji	..		48	51
Federated States of Micronesia	..	14	49	50
Nauru	..	8	47	52
Kiribati	..	9	51	51
Average	*87*	*9*	*48*	*49*

Source: World Bank, World Development Indicators, Online Database. Available at https://databank.worldbank.org/source/world-development-indicators. (accessed on 2 November 2022)
Notes: Data reported are for latest years available. Two dots (..) indicate that data are not available.

viii. Limited capacity for technological innovations

Developing countries in the Asia-Pacific region, including countries in special situations, are embracing science, technology, and innovation to accelerate socioeconomic development (NIRAS, 2019). However, many of the countries are still playing catch up and have yet to reach their potential. According to the Global Innovation Index 2022 (WIPO, 2022), which ranks countries' innovative capacity, eleven countries in special situations fall short of the regional average (figure 3-15). Mongolia, which ranks 71st out of 132 countries, is the best performer among countries in special situations. The country has implemented several initiatives to boost innovation, including the Master Plan of Science and Technology 2007−2020, developed with support from UNESCO. In addition, ADB has funded a project to prepare a road map for its science, technology, and innovation sector. The road map is centred on prioritizing the sector in policy dialogues and establishing a committee on ICT (Mongolia, Ministry of Education, Culture and Science, 2007). It was designed to help Mongolia reduce its reliance on natural resources and develop a new source of public revenue (Locatelli, 2019).

Figure 3-15 Global Innovation Index in selected Asia-Pacific countries in special situations



Source: WIPO (2022).

Notes: The overall Global Innovation Index score is the average of the Innovation Input and Output Sub-Index scores. The Innovation input sub-Index is comprised of five input pillars: (1) institutions; (2) human capital and research; (3) infrastructure, (4) market sophistication; (5) business sophistication and two output pillars: (6) knowledge and technology outputs; and (7) creative outputs.

ix. Digital data development and secure usage

Digital data are a foundational resource and enabler of digital transformation and connectivity. They can enhance the effectiveness of evidence-based policies that promote affordable and universal Internet connectivity. Digital data need to be accessible, managed safely and handled in line with principles of privacy and data protection.

Digital connectivity and mutual communications are likely to generate even greater amounts of data. Explosive data hikes generated from greater digital connectivity require artificial intelligence technology and new data architecture, platforms, and infrastructure to store, use and manage them. The availability of “big data” entails both rewards and risks. Big data are used in many development sectors, including industries, social services, disaster risk reduction, air pollution monitoring and risk mitigation. The risks of big data are the loss of individual privacy, unintentional misuse of data and the deliberate abuse of big data by governments, the private sector or other actors.

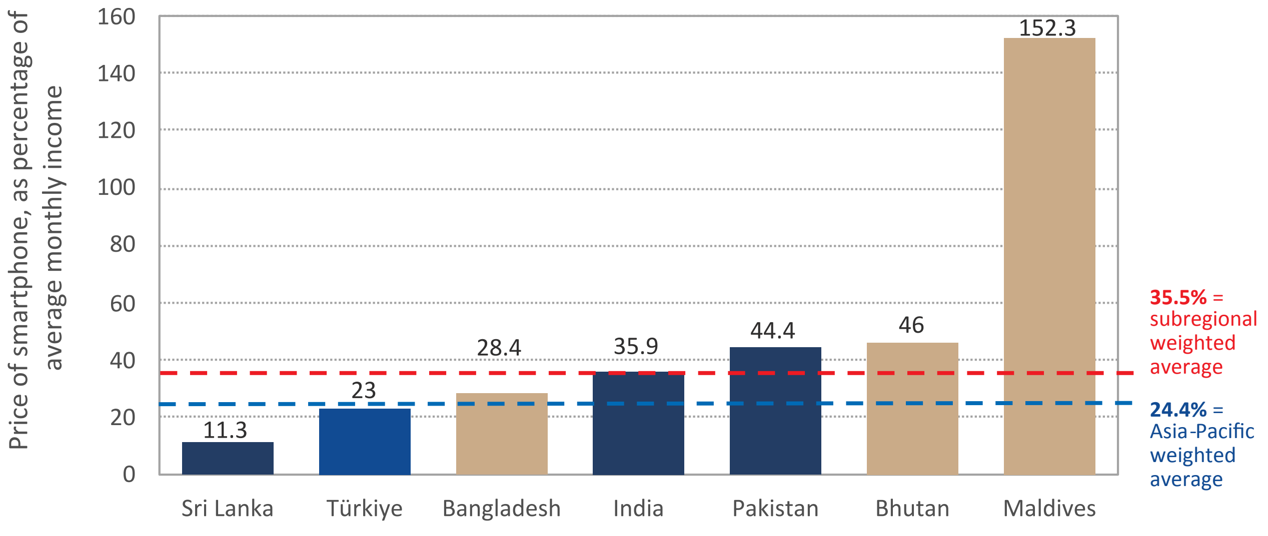
In Asia-Pacific SIDS, ITU and other international partners have helped several Pacific island countries build capacity to thwart cyberthreats, including extending assistance to formulate cybersecurity strategies, establish national computer incident response teams and build human capacity through cyber-drills and training programmes (ITU, 2022). In Vanuatu, ITU and other international partners assessed the national computer emergency response team, and conducted training workshops with stakeholders to enhance the nation’s cybersecurity capacity. Through the same partnerships, national computer emergency response teams have been established in Tonga, Samoa, Papua New Guinea and Fiji (Australia, Department of Foreign Affairs and Trade, n.d.).

According to the ITU report on the Global Cybersecurity Index 2020 (ITU, 2021), only 16 countries in Asia and the Pacific have passed data protection legislation compared with 45 countries in Europe. In terms of overall cybersecurity readiness under the Global Cybersecurity Index 2020, the Republic of Korea was ranked fourth globally, on par with Singapore. Out of 182 countries surveyed, the 10 Asia-Pacific countries in special situations with the least capacity and digital technologies to counter cyberattacks were Afghanistan (ranked 171), Solomon Islands (166), Vanuatu (152), Kiribati (145), Bhutan (134), the Lao People's Democratic Republic (131), Mongolia (120), Fiji (112), Samoa (111) and Kyrgyzstan (92).

x. Expensive smartphone devices

Between 2021 and 2022, the average global price of smartphones declined from 22 per cent of the average monthly income to 20 per cent (Alliance for Affordable Internet, 2022). However, in some Asia-Pacific countries, including countries in the South and South-West Asian subregion, ICT devices remain prohibitively expensive (figure 3-16). In Bangladesh, Bhutan, and Maldives, smartphones are more expensive than in the subregion average. A mix of policy, economic structure and geography are at the root of high prices. In Maldives, for instance, all phones are imported, the market is tiny and smartphones are subject to high import taxes and other charges (Alliance for Affordable Internet, 2022).

Figure 3-16 Price of smartphone, as percentage of average monthly income in South and South-West Asian countries



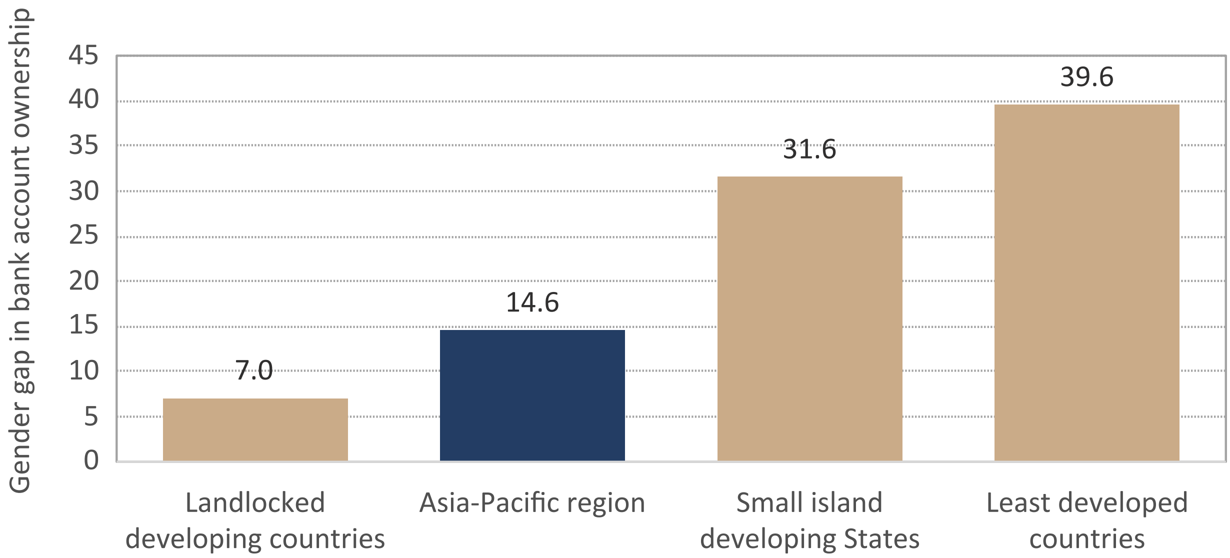
Source: Alliance for Affordable Internet (2022).

Notes: The red bars indicate countries in special situations in South and South-West Asia. No data are available for Afghanistan, the Islamic Republic of Iran and Nepal.

xi. Gender divide on financial services

In LDCs, women fare poorly in terms of access to financial services compared with men. The workforce in LDCs is predominantly male, and men are more likely to have a bank account than women (figure 3-17) (World Bank, 2022b). The greater access to financial products and services is one reason why men are more likely to own a mobile phone and have access to the Internet compared to women. Improving the financial inclusion of women is essential to improving opportunities for women and female-owned businesses (World Bank, 2014). As more and more women in countries in special situations move into e-commerce (Haque, 2021), financial inclusion of them will be key to bringing about a digital transformation. Despite the large prevailing gaps, in many countries, digitalization and the roll-out of digital identity cards are paving the way for previously financially excluded women to access online banking (Global Partnership for Financial Inclusion, 2020).

Figure 3-17 Gender gap in bank account ownership, weighted averages, in Asia-Pacific countries in special situations



Source: GSMA, GSMA Mobile Connectivity Index, 2021. Available at www.mobileconnectivityindex.com/#year=2021&dataSet=indicator (accessed on 15 February 2023).

Notes: The figure covers 42 countries of the region, including 22 countries in special situations. It was derived from the indicator "Gender Parity Index for having an account(female/male)". Values have been reversed for clarity by subtracting from 100.

Despite technology-driven greater inclusion, women's access to the Internet remains low. Globally, men are on average 21 per cent more likely to be online than women. This share is 52 per cent in LDCs. The associated economic hit stemming from lost taxes that could be spent to improve education, health, and housing is considerable. The Alliance for Affordable Internet estimates that the economic loss in 32 low and lower-middle income countries as a result of exclusion of women from the digital world amounts to $1 trillion (Pulgarín and Woodhouse, 2021).

3.3. Policies to advance affordable and resilient information and communications technology connectivity

Broadband networks are prone to disruptions by natural disasters. A key challenge is to strengthen the resilience of ICT infrastructure and its ability to support disaster-response efforts. This section includes a discussion on ICT for disaster response and recovery, and ICT for disaster risk prevention, risk reduction, and preparedness.

A. Promoting information, communications technology infrastructure connectivity through innovative investments

A rethink of established ways of delivering infrastructure projects is at the heart of building ICT connectivity. Potential pathways are the co-deployment of fibre-optic cables, and transport and energy infrastructures. Other promising steps are innovative PPPs for digital infrastructure, the adoption of SMART fibre-optic cables for enhancing climate and natural disaster resilience, and an increase in the redundancy of Internet connectivity through LEO satellite technologies, especially during and after natural disasters. As outlined above, governments may also review their national universal services funds for deployment of digital infrastructure in rural areas. Innovative PPPs that implement a special purpose vehicle for a private operator to design, build, maintain and operate a facility, are among the alternatives. The Indonesian Palapa Ring Project (Kharti, 2020) and the national fibre-optic network, BharatNet of India, are good PPP models for universal access and service funds (Kharti, 2020; RailTel Corporation of India, n.d.).

A key message is that governments' involvement in accelerating digital transformation remains critical. Governments can introduce e-platforms and digital tools through public service delivery, covering areas ranging from tax and customs to online registration services. In countries in special situations in the Asia-Pacific region, the digitalization of public services can be implemented in lockstep with the expansion of the Internet and digital technologies. Calibrated carefully, such a gradual approach can foster Internet use as well as help improve digital literacy and the development of local content, and encourage the use of digital services in the private sector.

Finally, governments and other stakeholders must collaborate and strengthen Internet network infrastructure connectivity for all. The financial sustainability and environmental impact of new ICT network infrastructure must be considered carefully (Woodhouse, 2021). The availability and use of parallel infrastructure, such as the electricity grid, promises to reduce greenhouse gas emissions. By tackling social barriers to Internet use, such as changing traditional gender norms that discourage Internet use by women and girls, policymakers can narrow digital gender divides (Woodhouse, 2021).

B. Strengthening digital capacity and literacy on digital technologies and applications

While broadband diffusion and new digital technologies carry enormous opportunities, they may have drawbacks when peoples' digital skills do not keep pace. This situation is especially pertinent in the Asia-Pacific region, which is the home of nearly two thirds of the global youth population.

During the COVID-19 pandemic, digital technologies and applications became a central part of peoples' everyday lives. The surge of online education and health diagnosis helped slow the spread of the virus. Amid long and repeated lockdowns, e-commerce, and online shopping − a convenient and safe way to buy goods and services − boomed. Many Governments supported the adoption of digital technologies and applications to facilitate online services, including digital payments, and established secure legal frameworks for e-transactions and personal data protection. Other measures that will strengthen the ongoing digital transformation in the Asia-Pacific region must centre on improving digital literacy. The Asian and Pacific Training Centre for Information and Communication Technology for Development (APCICT), for instance, trains government officials through capacity-building programmes and e-learning courses. In addition, Governments of countries in special situations need to implement programmes that teach digital literacy to primary and secondary school children and teachers.

C. Promoting the safe management and use of resilient digital data infrastructures

Given the importance of adapting in the rapidly changing digital world, there is a growing need to improve peoples' basic understanding on how best to safely manage and share digital data. This is one of the essential preconditions for making progress towards realizing the Sustainable Development Goals. Countries in special situations in the Asia-Pacific region must strengthen educational institutions and build robust regulatory policies on data privacy and protection, information security and trust, and cybersecurity. In many of them, significant data gaps must be closed. There is, for example, a lack of disaggregated data by gender, which hinders timely policy analysis and action. To address some of these shortcomings, governments must earmark more resources to improve the collection, management and secure use of data.

D. Promoting regional information communications technology connectivity through the Asia-Pacific Information Superhighway platform

The Asia-Pacific Information Superhighway initiative is a regional platform for bridging the digital divide and accelerating digital transformation through regional cooperation. Its action plan,[25] which runs until 2026, includes 25 collaborative actions in the three policy areas discussed above. It serves as a regional blueprint for the next phase of cooperative actions among members and associate members of ESCAP, as well as others, and is centred on bridging the digital divide and fast-tracking digital transformation.

The action plan is guided by four principles: it should be action-oriented, promote ownership of actions by ESCAP members and associate members; promote the engagement of all stakeholders; and support regional and global digital agendas. The individual actions are interrelated and linked to a Sustainable Development Goal or target, as well as the relevant action contained in the outcome documents of the World Summit on the Information Society of 2003. Actions aimed at promoting cooperation among members and associate members, and others take several forms, including, among them, joint studies on common digital opportunities and challenges, digital policy guidelines, common initiatives, such as research, and capacity-building and awareness-raising events.

Governments, the private sector, donors, non-governmental organizations and academics, among others, can benefit from information-sharing and learn from best practice examples in the area of innovative technologies for digital transformation that are delivered through the Asia-Pacific Information Superhighway initiative. A good example is the promotion of regional cooperation to strengthen digital ID systems for crisis resilience, digital transformation and improving digital literacy in the Pacific.

ENDNOTES

21 ITU (2020a) estimates that $428 billion would be needed to achieve universal access of broadband connectivity at the global level by 2030.

22 Goal 9 – Build resilient infrastructure, promote inclusive and sustainable industrialization and foster innovation; Goal 13 – Take urgent action to combat climate change and its pacts. Goal 14 – Conserve and sustainably use the oceans, seas and and marine resours for sustainable development.

23 Available at www.infrastructure.gov.au/media-communications-arts/internet/national-broadband-network.

24 The universal access and service fund is a public financing mechanism aimed at connecting sparsely populated rural areas that do not attract investments by private telecommunications operators. Initially, the focus of such funds was to provide basic telecommunications services, such as landline telephones, in unserved and underserved areas. However, their role has shifted towards building broadband infrastructure and providing universal broadband access.

25 See ESCAP/CICTSTI/2022/INF/1.

Conclusion: Going forward

This *Asia-Pacific Countries with Special Needs Development Report* includes an assessment of the development challenges of LDCs, LLDCs and SIDS, collectively referred to as countries in special situations, in the wake of an unprecedented series of global crisis − the COVID-19 pandemic, geopolitical shocks, ongoing global economic uncertainties and a worsening climate crisis. It is against the background of this polycrisis that this report provides in-depth policy-oriented socioeconomic analyses of the status, challenges and prospects of countries in special situations and includes policy options to promote sustainable development.

The report focuses on challenges and opportunities in enhancing connectivity in three areas − transport, energy, and information and communications technology − and contains a discussion on how regional cooperation can address the challenges and foster a transition to a low-carbon, climate-resilient and green economy in countries in special situations in the Asia-Pacific region. Progress in achieving SDGs and advances in connectivity in these countries have been undermined by the polycrisis. Yet, the strengthening of transport, energy and digital connectivity remains vital to help them deal with their unique challenges of geographical remoteness, small populations, and limited economies of scale, and ensure a path of sustainable development.

Given the resource constraints countries in special situations face, smart solutions that connect existing infrastructures are preferable to building entirely new ones. Such solutions are more affordable, unlock previously untapped synergies, and underpin sustainability though they require close bilateral and regional collaboration.

One of the key recommendations of this report is to **prioritize regional efforts for transport corridor development that promotes decarbonization and resilience.** The wider developmental impacts of multimodal transport corridors have gained greater attention in recent years and are now a vital consideration when developing, upgrading and operating infrastructure. Multimodal transport corridors can provide competitive long-distant connections if border delays are reduced, and technical and digital cross-border interoperability is ensured. Among the various modes of transport, rail transport has great potential, especially for LDCs and LLDCs along the non-traditional transport corridor between China and Europe. It can also contribute towards the decarbonization of regional supply chains, given the lower emissions generated by rail transport. In SIDS, initiatives, such as the green shipping corridors, could boost maritime connectivity and development of resilient and sustainable ports. The Green Shipping Corridors initiative aims to establish shipping routes on which vessels use low- or zero-emission fuels to cut greenhouse gas emissions to zero by 2050.

One way to foster connectivity and sustainability in countries in special situations is to **facilitate access to and the deployment of new technologies and ICT solutions for climate and disasters monitoring and recovery.** New technologies, geospatial data and smart solutions can enhance the capacities and resilience for climate and disaster monitoring and recovery. Some of the most promising options for these countries are the roll-out of SMART fibre-optic cables for enhancing climate and natural disaster resilience, the use of LEO satellite technologies to improve Internet speed and reliability (especially during and after natural disasters) and more affordable quality Internet connectivity through new IXPs. Funding and technical assistance that enables access to these new technologies is of paramount importance. In SIDS, a push for port digitization can enable more resilient and sustainable maritime connectivity.

Not all advances in connectivity require technological progress. **At the core of greater energy and transport connectivity is the harmonization of existing operational, planning and regulatory procedures.** There is an urgent need to strengthen regional cooperation to ensure the interoperability of connectivity projects. Infrastructure and technical procedures along international transport corridors must be harmonized to cut costs and promote seamless cross-border movements of goods, transport vehicles and people. In that regard, it is vital to introduce electronic interoperability in international transport operations. Such interoperability does not require fundamental changes to national transport systems, but it can be achieved through close regional and international cooperation.

Getting down to the nitty-gritty matters. For instance, to advance energy connectivity, subregionally coordinated grid planning processes must be established. Once countries have agreed on a common vision, subregional institutions to implement cross-border multilateral trading arrangements can be established. It is only with credible development plans and harmonized regulations and procedures that energy connectivity efforts in the Asia-Pacific region will leap from the concept to the implementation stage.

Finally, connectivity must be placed within the larger context of cross-cutting issues common to transport, energy and ICT connectivity. Tying the different areas of connectivity together, the report provides an outline of **the benefits of unlocking the synergies across the transport, energy and ICT sectors through co-deployment and management.** Advances in the transport and ICT sectors, for example, have profound implications for the energy sector, including the integration of more variable renewable energy. The key to unlocking the potential of each of these sectors is greater integrated planning. In the Asia-Pacific region, the benefits of jointly planned electric power and ICT infrastructure are especially relevant in SIDS striving to develop local renewable energy resources.

Innovations in transport also have great potential to accelerate power system connectivity. Transport access is essential for expanding electric power systems as the siting of new transmission and distribution lines is often directly tied to road networks. Going forward, the expansion of transport and energy infrastructures must move in lockstep not least because the single greatest driver of the increase in electric power demand is the electrification of transport. To date, potential synergies from the coordinated design, planning, and operation of transportation and electric power system networks remain largely untapped.

To recap, synergies in the areas of transport, energy and digital connectivity − and their potential to address climate change − present an important development opportunity for countries in special situations. To reap the economic, social and environmental benefits of national and multilateral connectivity initiatives, closer South-South cooperation is needed. Furthermore, national stakeholders − ranging from regulators to policymakers − must expand their institutional capacity and be empowered with a clear mandate to engage in regional collaboration on transport, energy and digital connectivity.

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Annex

Productive capacities to enhance connectivity

International economic cooperation among countries plays a key role in furthering sustainable development. Seamless and sustainable connectivity and adequate transport, energy and ICT infrastructure are critical to achieving this, but synergies from cooperation can only be fully realized if countries build their domestic productive capacities.

Productive capacities determine a country's ability to produce goods and services that help it grow and develop. The capacities are a function of productive resources (factors of production, including natural resources, human resources, physical, capital and financial capital); entrepreneurial capabilities (the skills base; local technological and innovation capabilities; and the quality of supporting institutions at national and sectoral levels); production linkages (flows of goods and services in the form of backward and forward linkages; market-based information flows; inter-firm interactions; and the development of local value chains; among other factors. Domestic productive capacities shape a country's international competitiveness and its propensity to build domestic infrastructure and promote connectivity to facilitate development.

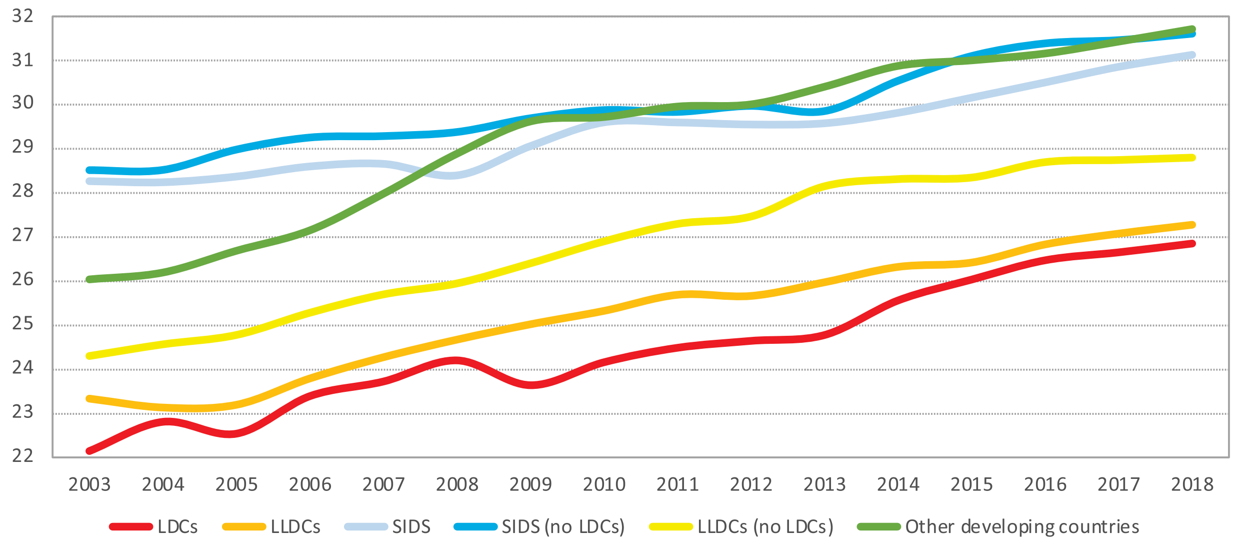
The United Nations Conference on Trade and Development has developed the Productive Capacities Index (PCI)[26] as part of its effort to foster productive capacities in developing economies. The multidimensional composite index estimates countries' domestic productive capacities, which are used to assess their capability to bring about structural economic transformation and sustainable development. It is an important, empirical tool that can inform policy at the national and sectoral levels. The index is composed of eight components – human capital, natural capital, transport, ICT, energy, private sector, institutions and structural change. The components are estimated by using 46 indicators, which are scored between 1 and 100. Sixteen indicators determine the "infrastructure" component of the index (table A-1).

Table A-1 Indicators used in the energy, transport and information and communications technology components of the Productive Capacities Index

Energy	Transport	ICT
• Share of people with access to electricity • Transmission and distribution losses as a share of primary supply • Renewable energy consumption as a share of total final energy consumption • GDP per kg of oil consumption • Total primary energy supply per capita • Total energy consumption per capita	• Air transport, registered carrier departures worldwide per 100 people • Air transport, freight (million ton-km) • Air passengers per capita • Logarithm of km of roads/100km2 land • Logarithm of total km of rail lines per capita	• Number of fixed broadband subscriptions per 100 people • Number of mobile telephone subscriptions per 100 people • Number of fixed lines per 100 people • Secure Internet servers per million people • Number of Internet users as share of population

Overall productive capacities of LDCs, LLDCs and SIDS[27] in Asia and the Pacific are trending higher, but the gap between countries in special situations and other developing countries is widening. This divergence is particularly striking with SIDS, which at one point displayed higher productive capacities than other developing countries, but have now fallen behind.[28] The progress of LDCs (4.7 points over the period 2003–2018) has been slightly faster than that of LLDCs (4.5 points) and exceeded progress in SIDS (3.9 points) (figure A-1), which is favourable considering their greater needs to advance development.

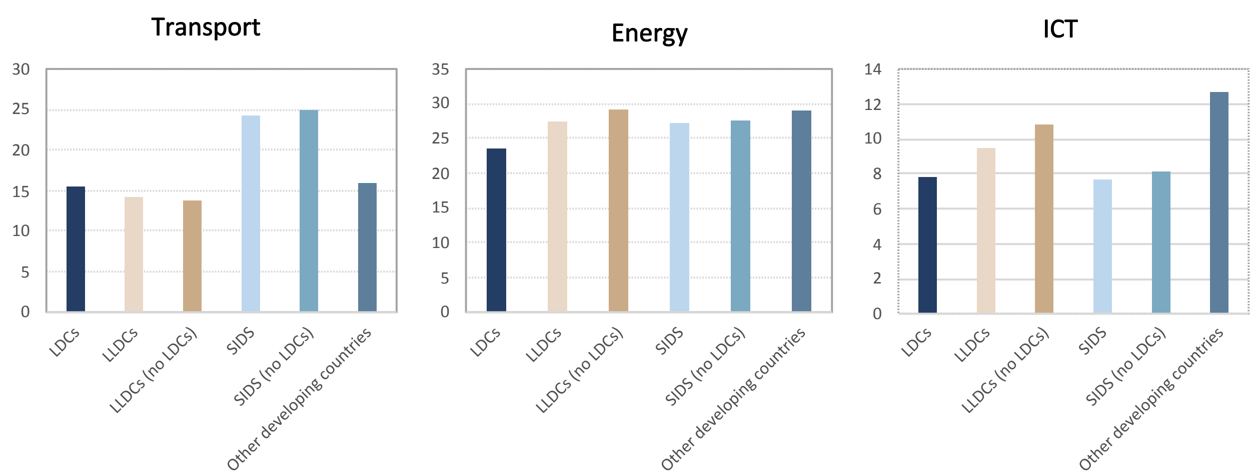
Figure A-1 Productive Capacities Index – Overall scores, 2003–2018



Source: UNCTADstat. Available at https://unctadstat.unctad.org/wds/ReportFolders/reportFolders.aspx/ (Accessed on 20 December 2022).

Regarding countries' ability to enhance connectivity, the picture is more nuanced as illustrated by the PCI components that capture transport, energy and ICT development.

Figure A-2 Productive Capacities Index – transport, energy and information and communications components, 2018



Source: UNCTADstat. Available at https://unctadstat.unctad.org/wds/ReportFolders/reportFolders.aspx/ (Accessed on 20 December 2022).

In terms of transport, LLDCs are in the most unfavourable position. Their score for the PCI transport component is the lowest in the region. The poor performance points to sectoral gaps that must be addressed for LLDCs (particularly those that are not LDCs) to increase their participation in the global economy through trade and regional and global production value chains. With relatively high scores on the energy and ICT components, transport infrastructure thus remains the biggest barrier for LLDCs to ensure seamless and sustainable connectivity. Overall, Asia-Pacific countries in special situations lag other developing countries on the ICT component, which is a concern because the ICT sector can be a catalyst for structural economic transformation. To address this shortcoming, more interventions are needed in SIDS and LDCs. The scores for the energy component of the PCI show limited variability, with LDCs lagging slightly behind the other groups.

The results of PCI underline that further efforts must be made to foster productive capacities of countries in special situations in the Asia-Pacific region, as the gaps between them and other developing economies are widening. Productive capacities are necessary to address development challenges and policy shortcomings. Greater focus on building productive capacities has the advantage of tackling development challenges in a robust and holistic manner and guiding long-term solutions in terms of policy and institution building. The overall conclusions and policy recommendations point to an urgent need to (a) accelerate investments in the expansion and modernization of the ICT infrastructure in all Asia-Pacific countries in special situations; (b) enhance transport infrastructure in the LLDCs of Asia; and (c) ensure focused and intensified efforts aimed at Asia-Pacific LDCs. Only progress in these three fronts will build the foundation for achieving seamless and sustainable connectivity and unleash associated gains in economic and social development in countries in special situations.

ENDNOTES

26 The full dataset is available at UNCTADstat (https:/unctadstat.unctad.org/wds/ReportFolders/reportFolders.aspx/).

27 The median is used to calculate PCI scores for the groups. The SIDS group includes Fiji, Kiribati, Maldives, the Marshall Islands, Palau, Papua New Guinea, Samoa, Solomon Islands, Timor-Leste, Tonga, Tuvalu, and Vanuatu. Other developing countries include Brunei Darussalam, China, Georgia, India, Indonesia, Iran (Islamic Republic of), Malaysia, Pakistan, the Philippines, Sri Lanka, Thailand, Türkiye and Viet Nam.

28 However, the performance of SIDS on PCI needs to be interpreted with caution given their small population and geographical sizes, which tend to bolster the score on some of the ratio-based indicators, such as share of people with access to electricity and logarithm of km of roads/100km2 land.

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Seamless and sustainable transport, energy and digital connectivity across countries is central to improving the lives of people of the countries in special situations, which comprise least developed countries (LDCs), landlocked developing countries (LLDCs) and small island developing States (SIDS) in Asia and the Pacific. It can, therefore, play the role as a catalyser of sustainable development. It is also an important tool to accelerate climate actions in and for these countries. For instance, improved multimodal transport connectivity can allow for more environmentally friendly modes of transport in these countries; greater energy connectivity can accelerate the cost-efficient deployment and integration of renewable energy; and enhanced digital connectivity can assist them in accessing green and innovative climate adaptation solutions. The long-term benefits of seamless and sustainable connectivity will be especially significant for these countries given the current and future climate impacts and the sustainable development dividends from having a low-carbon and climate-resilient world.

The *Asia-Pacific Countries with Special Needs Development Report 2023: Strengthening Regional Cooperation for Seamless and Sustainable Connectivity* examines how regional cooperation on seamless and sustainable connectivity can facilitate a long-term transformation towards a net zero carbon emissions future. Key suggestions of this Report include (a) prioritizing transport corridor development that promotes decarbonization and climate resilience; (b) facilitating access and use of new technologies and ICT solutions for climate and disasters monitoring and recovery; and (c) harmonizing operational, planning, regulatory and financial procedures to enhance energy and transport connectivity. Recognizing the ongoing efforts and existing initiatives, and considering the large financing gaps in the countries in special situations, the Report underscores the need to seek synergies across transport, energy and ICT connectivity through co-deployment and management.

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