support deployment of new technologies such as renewable energy based microgrids, with active participation of local communities to achieve the for last-mile electrification. ADB will promote the active participation of local communities to increase access to and deploy clean cooking technology and fuel combinations in remote areas or islands in DMCs.

Energy for the Cross-Cutting Needs of Communities

52. ADB will seek opportunities to work with DMCs as they update and revise their electrification and rural energy plans. The most successful electrification strategies are based on a high-level political commitment to electrification reflected in a national masterplan with coherent prioritized targets and implementation plans to achieve them, including for the last-mile household connections. Planning can currently be supported by multi-criteria techniques applying geospatial least-cost algorithms on satellite imaging. A transparent, impartial, and socially sensitive multi-criteria analysis is needed to guide the choice between national grid extension and off-grid solutions. It is also needed to identify the type of off-grid solution best suited for each population center, as well as to set the implementation schedule, and off-grid solutions can be made "grid ready" for future connection with the national grid. The analysis needs to hear voices of vulnerable groups, minorities, and refugees. The responsibilities for electrification should be allocated to those electricity sector entities that possess, or are granted, the necessary human, technical, and financial resources for the task as well as incentives to bring the process determinedly forward.

53. Bringing modern energy to unserved populations addresses multiple development goals, some of which may provide an opportunity for ADB to support DMCs in a cross-cutting manner combining infrastructure with social interventions. Bringing electricity service to a community, whether through grid extension or off-grid solutions, necessitates consideration of the kind of end-uses that may be prioritized, ranging from domestic demands to economically productive uses, street lighting, health centers, and schools.

54. In this context, community participation is vital, as it is also for organizing the operation, maintenance, and commercial services related to the system. Off-grid systems create new localized employment and business opportunities in sales, installation, and maintenance of the distributed grids as well as of end-use equipment such as solar powered pumps, flour mills, dryers, milk coolers, meat storage, lighting, household appliances, and electronics. ADB will support needed skill development and training in local communities.

55. Energy infrastructure also enables improvements in water supply and irrigation. If not managed well, however, water pumping for agricultural production can become a major user of subsidies, a source of losses for utilities, and lead to the waste and depletion of underground water. In designing possible energy interventions for water supply, ADB will consider support for smart metering and dynamic control of pumping based on water availability, cost-reflective electricity tariffs for farmers, solar-powered off-grid irrigation systems, and reductions in system losses and theft through medium voltage power distribution networks in farming areas. ADB can also consider providing cross-sectoral support for multipurpose dams that address water supply, power generation, irrigation, and flood control.

56. ADB acknowledges that sustainably sourced bioenergy can spur rural economies and provide a low-carbon alternative for a wide variety of energy end uses. Therefore, ADB will help DMCs develop policies to support use of agricultural wastes for energy, including uses such as for direct combustion in boilers and briquets (to replace charcoal), bio

compressed natural gas for households and industries, biogas digestion, and ethanol and biodiesel production. One avenue for this will be encouraging national biogas programs that deploy digesters using livestock manure and other agriculture waste as feedstock. ADB will also support efforts to scale up the technology through development of larger centralized biogas units providing methane for power generation, transport, or to be fed into the natural gas network.

57. To ensure sustainability of bioenergy expansion, ADB will encourage synergies in land use between food supply and energy production. Rural biomass investments could potentially help address air pollution issues caused by open burning of crop residues if adequately coupled with regulations. Restoring degraded land with agroforestry, for example, can contribute to the production of sustainable wood fuel, nitrogen-fixing wood crops, or oily plants, all of which would support farming, small-hold forestry, and developing more value-adding biomass-based energy supply for power and advanced biofuels for transport.

58. ADB is mindful of the fact that energy poverty in urban and peri-urban settlements is often not given the same attention as rural energy poverty. While it is common to have a programmatic approach to addressing rural energy needs, such as an electrification strategy and a specialized agency to promote and facilitate improved access to modern energy services, including clean cooking, the same attention is often not given to energy poverty in urban and peri-urban areas. The rates of rural-urban migration are high in many DMCs. This results in growing informal settlements and slums within and around cities with inadequate access to legal and safe electricity connections and clean cooking and heating solutions. ADB will support DMC efforts to eliminate urban energy poverty, including support for clean heating and cooling systems using renewable energy to support the urban poor while reducing pollution.

59. Household indoor air pollution is one of the leading causes of disease and premature death in the developing world. In partnership with local civil society organizations, ADB is ready to participate in pursuing substitutions of inefficient biomass cooking stoves for modern, clean cooking stoves or for those using gaseous alternative fuels such as liquified petroleum gas and pellet gasification. ADB also recognizes that it is important to consider electricity for cooking (rice cooker, induction cooker) when analyzing and designing rural and urban electrification projects. The deployment of electric cooking necessitates higher load carrying capacities for distribution networks or off-grid systems than if the system is designed only for lighting needs and powering small appliances, and is not technically feasible for the solar home systems and small mini-grids.

60. Many countries in Asia and the Pacific have long coastlines and large population centers by the sea. The oceans have a double significance for developing sustainable energy resources. The organisms they support, such as seagrass, seaweed, mussels, and starfish, can be used for food, feed, and biofuels, but the oceans are one of the main natural carbon sinks. Oceans also provide regenerative ecosystem benefits, such as those specifically targeted by ADB's Action Plan for Healthy Oceans and Sustainable Blue Economies. Marine energy can also be harnessed for electricity by exploiting tides and waves or differences in sea temperatures and salinity although these technologies are mostly pre-commercial.[22] ADB

[22] Offshore wind is a mature industry in developed countries, and is in the early stages of commercial deployment in Asia and the Pacific; the only deployments so far are in the PRC. Offshore wind and other offshore renewable energy are eligible for ADB assistance. ADB will continue to support commercially-proven technologies and systems, with selective support for pilot or prototype operations resulting in commercial deployment and scale-up.

will encourage such initiatives and provide technical assistance to DMCs willing to pursue these paths for developing the energy potential of oceans. However, both of these suggested paths are at an early stage of research, development, and piloting.

61. Women are disproportionally affected by lack of access to clean and modern energy services, and ADB remains committed to ensuring gender equality in its energy sector operations, as indicated in the operational framework for OP2 of Strategy 2030. [23] Services enabled by modern energy in both rural and urban environments have a major impact on citizens' day-to-day lives. The services prioritized in ADB-supported interventions should consider their potential to empower women, such as through opportunities for earning and for the education of women and girls. ADB will develop comprehensive approaches to increase and promote women's productive use of electricity, through provision of knowledge and skills on how to use electricity for income generating activities with access to credit for business development. ADB's project designs should take into account women's participation and will act to prevent their exclusion from crucial decision-making related to project activities by the implementing agencies and project beneficiaries, such as by village and township authorities and community-based organizations. ADB will promote energy-based livelihood and employment for women in project installation, maintenance, and operation, as well as encourage female entrepreneurs as private sector partners for the project activities.

Wrestling with Challenges

62. Delivering energy services, either by extending the grid or building mini-grids, to remote and difficult-to-reach communities presents not only technical and maintenance challenges but also economic challenges. Therefore, strong public sector support is needed to create awareness, build up a market, and develop the local ecosystem of associated entrepreneurial activities. Although many DMCs have well-established subsidy schemes for electrifying unserved populations, the last mile brings even greater challenges, challenges, including relatively low electricity usage per connection and relatively high electrification costs, leading to greater financial risks for such investments. In urban areas, the economic risks are exacerbated by the fact that areas that are not connected to the grid are often poor informal settlements where house occupants do not own land, houses may not be legally registered and are even at risk of being demolished in the future.

63. There are examples from within the region of possible ways to address these economic challenges. For example, a range of financing solutions have been tested in the region to support electrification through solar home systems and microgrids based on renewables and integrated battery energy storage. These solutions include micro-credits for equipment and appliances or fees for services that can be paid through various methods, including prepaid card payments or mobile phone applications. The private sector can play a major role in the customer interface by supplying equipment and appliances as well as offering financing.

64. Mini-grids can significantly improve gender equality and contribute to women's livelihoods and resilience to climate change. In ADB-supported mini-grids projects, gender mainstreaming should be done in all phases of project development: consultations and planning, construction, operation and maintenance, and end use of electricity. For example, involving women in community consultation for mini-grid planning taps into their knowledge about the natural resources and their potential electricity demand for mini-grid sizing. During

[23] ADB. Operational Priority 2: Accelerating Progress in Gender Equality. September 2019. Manila.

the operation and maintenance phase, women can play a supporting role in the administration of the mini-grid operations, or have a seat in the management committee, bringing the women's perceptive on board.

65. In alignment with its commitment to SDG 7, ADB seeks to ensure it is equipped to support actions to increase the adequacy and stability of electricity supply to grid-serviced low-income communities and enabling market-driven off-grid systems. Where there is an opportunity and DMC demand, ADB will engage with other development partners and civil society organizations to support DMCs with technical assistance and grants, results-based lending, or other appropriate financing modalities to set up investment programs for last-mile electrification and the provision of clean cooking.

2) Building a Sustainable and Resilient Energy Future

66. Strategy 2030 underscores the point that ADB's vision of a prosperous, inclusive, resilient, and sustainable Asia and the Pacific hinges on the success of the region tackling climate change, enhancing environmental sustainability, and building climate and disaster resilience. If the current trends of climate change are not addressed, this region will be one of the hardest hit by the effects. Climate change heightens the risks of exceptional weather phenomena occurring with increased frequency and greater magnitude, including cyclones, floods, landslides, droughts, and heat waves. Pacific countries, many small island states, and some areas in South Asia are the first to encounter the impacts of rising sea levels resulting from warming trends. Furthermore, many Asian DMCs are in seismically active regions and, therefore, are faced with the ever-present risk of earthquakes and tsunamis. Finally, while combustion of fossil fuels is the primary source of the GHG emissions that cause global warming, it is also the main source of conventional air pollutants, which result in immediate and lasting harm to public health and ecosystem services. These risks are already materializing and thus undermine the steadiness of the development efforts and pursuit of well-being in the region's DMCs.

67. All energy sector investments will comply with ADB safeguards policies regarding the environment, involuntary resettlement, and indigenous peoples to ensure that affected persons are protected from impoverishment risks and development programs for such vulnerable groups are incorporated and implemented. In particular, energy sector projects will need to uphold safeguards to avoid, minimize, mitigate, and offset the adverse environmental impacts.

68. ADB's direct response to the risks resulting from unsustainable energy systems will be:

i. to improve energy efficiency across energy supply and consumption chains,
ii. to accelerate the deployment of renewable energy,
iii. to pursue strategic decarbonization and rapid phase-out of coal around the middle of the 21st century, and
iv. to increase the resilience of energy infrastructure.

These actions support the transition to sustainable, lower-carbon, and resilient energy systems.

Improving Energy Efficiency