And governments and development agencies continue to play a key role in supporting the establishment of mini-grids which, at present, need some form of subsidy to achieve economic viability. Progress is being made in reducing the cost of power from mini-grids and innovative business models are being developed.

In the case of solar home systems and pico-solar lighting systems, lessons from East Africa and Southeast Asia show that a tipping point has been reached as commercial business models have emerged. However, access to working capital is an important constraint faced by many entrepreneurs seeking to scale-up the deployment of solar home systems and pico-solar lighting systems.

The success of many local energy projects depends on the ownership of the local communities. Therefore, it is extremely important to invest in understanding the cultural sensitivities, gaining the community's buy-in, and building on existing relationships. Capacity building of local communities is necessary for the success of energy access initiatives. John Holmes also highlighted the importance of better coordination and information sharing between development agencies and funders, which is necessary to maximise the impact of development interventions.

There are tremendous developments taking place on the technological front. The energy escalator approach shows that for solar home systems, people often buy-in at the basic level of access, paying by instalments, and then move-up the energy ladder. There are also moves to develop low-power domestic appliances using direct current, and there has been a move towards developing low-voltage direct current nano-grids. Technological progress has also been instrumental in the reduction of the cost of components like solar panels, and it is expected that costs are likely

to reduce further in future. One of the key stumbling blocks have been batteries; the rate of progress has been much slower. Improving the reliability of batteries and reducing their cost is extremely important for the growth of off-grid energy systems.

There is an urgent need to foster closer linkages between researchers based at universities and entrepreneurs involved in off-grid energy provision. Another major issue in many developing countries is the poor quality of products, especially pico-solar lighting systems and solar home systems. To deal with these problems, effective quality assurance mechanisms need to be developed along with consumer awareness programmes.

## Keynote Address

Amjad Ali Awan, Alternative Energy
Development Board, Ministry of Water and
Power, Government of Pakistan

Looking back over the history of the power sector in Pakistan, Amjad Ali Awan proposed that societal changes and developments are pushed by need. In the 1960s and 1970s, the power sector in Pakistan was vertically integrated. Subsequently, it was unbundled, and in more recent times, the private sector has become increasingly involved in electricity provision as state investment in the sector has reduced. Initially, the focus was on the availability of electricity supplies, and subsequently on sustainability, affordability and environmental impacts. Within the country's power system there has been a major focus on developing generation sources, at the expense of developing transmission and distribution systems. In some situations, for example in hospitals and for security installations, availability and stability of electricity supply is a key consideration.

Private micro-grids could be a way forward to supply electricity to clusters of villages in

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the Northern Areas and other areas that are not connected to the national grid. Microgrids can also augment electricity supplies to the national grid. The National Electric Power Regulatory Authority Act provides some guidelines allowing the deployment of localised grids; however, institutional support from the state has not evolved. The lack of policy frameworks at the national and provincial levels hampers the development of micro-grids.

To develop off-grid energy systems for rural villages, the communities need to be prepared. One of the reasons for the failure of off-grid electricity initiatives in the past has been the lack of preparedness at the state, regulatory, and community levels. This has hampered the adoption of distributed electricity systems in the country. An important role for the Alternative Energy Development Board is to recover trust in renewable energy systems with stakeholders within the public and private sectors.

Pakistan is gifted with good renewable energy resources. For example, there is an excellent wind corridor with 40 GW of potential capacity in the south of the country. But, so far, only 50 MW of installed wind capacity has been realised. There has not been enough focus on renewable energy. Over the next ten years, the government's aim is to generate 25% of electricity in Pakistan from renewable energy sources. Recently, solar PV standards have been put in place and equipment can only be imported if it meets the standards. There are also moves to develop standards for equipment utilised in solar-wind hybrid systems and micro-hydro power plants.

The issues and solutions in respect of renewable energy sources need to be conveyed to the top policymakers, and the benefits need to be communicated to rural populations. The allocation of responsibilities is important, and policies are now in place in Pakistan that define the roles of the various stakeholders.

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