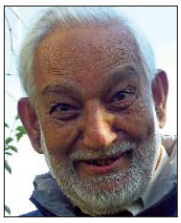

Going to the Grassroots

Renewable energy pivotal to poverty alleviation

By Dr H.N. Sharan, Chairman, DESI Power

The pace of poverty reduction in villages, mostly of farmers and landless labourers, has been much slower than the progress achieved by educated Indians living in urban areas and working in organised and industrial sectors. It is widely recognised that the major causes for the endemically slow pace of economic and social progress in rural areas in the country are inadequate and interrupted supply of electricity, lack of investments in productive enterprises and energy services, and the lack of education and development of local skills.

When DESI Power was started in 1996, renewable energy technologies were in their infancy. Reliable and affordable equipment for biomass, solar or wind technologies was either not available or was prohibitively expensive. Most villages did not have national grid-supplied electricity. Diesel engines were the sole source of electricity and mechanical power. Today, in contrast, we can supplement power supply from the newly arrived grid by utilising the most suitable local renewable energy sources to supply electricity, mechanical power, and water and energy services in a village. Reliable, affordable and economically viable power plants and local grids can serve farming, businesses and productive enterprises to drive the social and economic progress of villagers with a very small carbon footprint.

Meanwhile, the future of power generation for the urban and organised industrial sectors is being driven by the imperatives of climate change. In fact, the penetration of renewable energy sources and technologies in organised sectors and urban areas is proceeding at a much faster rate than in the villages. Since electricity supply and energy services play a significant role in the continuing social and economic disparities between our rural and urban conditions, renewable energy can play a key role in accelerating the progress of villages.

India's energy trilemma

Our declared national objective is to ensure that no Indian should live in poverty and be deprived of basic human necessities. This objective cannot be achieved without a minimum quantum of electricity and other energy services. Given the state of our economy and indigenous energy and financial resources, our development policy was originally based on using mostly coal and hydro to meet our electricity demands. Today, while the goal of removing poverty has not been achieved, we have been confronted by a major problem caused by rising global warming and the dangers of climate change. India, therefore, has to tackle what the World Energy Council defines as the Energy Trilemma, "the triple challenge of providing secure, equitable and affordable, environmentally sustainable energy".

The task for countries such as India is extremely difficult since adequate amounts of electricity must be available for productive and social purposes to improve the living conditions of villagers, and not just for lighting, pumping and charging batteries. Reliable power and affordable energy services must drastically increase for more than 750 million people if poverty is to be brought down to acceptable levels. Even though the central grid has reached almost every village now, reliable electricity and energy services are not available in adequate amounts to create jobs, increase incomes and remove poverty. No wonder, India's Trilemma Index has been worsening

continuously since the year 2000: in 2019, it was down to 50.3 per cent, placing India at 109 on the global list. In comparison, Switzerland at No. 1 position had a rating of 85.8 per cent and the US with 77.5 per cent was ranked 54.

Role of renewable energy in the future: Centralised sector

Global emissions of carbon dioxide (CO_2) and other greenhouse gases are continuing to rise. India has signed the Paris Agreement and has pledged to reduce CO_2 emissions to acceptable levels by about the middle of this century. A mainly coal-based power system, and oil and gas-based energy and transport systems, are no longer tenable.

Renewable energy is, of course, the lynchpin of such a transformative energy policy. People now realise that renewable energy, including hydropower and a focus on energy efficiency, ultimately has to replace coal to provide CO_2-free electricity in the centralised grid for the growing organised industrial and infrastructure sectors. The CO_2-free grid must also replace oil for the growing transportation sector. Renewable energy in various forms will also have to replace gas for process applications and cooking. The success of India's transformative policy regime will depend very much on the pace at which coal and oil can be replaced by renewable sources of energy.

Large wind and solar photovoltaic (PV) power plants are becoming a major plank of the centralised power generation and distribution systems, and they will certainly be supplemented by solar thermal power plants sooner rather than later. Solar PV and wind generators need extensive battery storage systems, which have substantial negative economic and environmental impacts. The capacities of battery banks should, therefore, be kept to a minimum. Solar thermal plants incorporate larger capacity thermal storage systems, which are more economical and have a much lower impact on the environment than batteries. Investment costs for solar thermal plants are coming down now and their integration into the grid can be optimised on the basis of the total life cycle and economic and ecological costs, including grey energy and recycling.

The other major source of renewable energy is biomass. Large biomass power plants, co-fed by municipal waste, are round-the-clock providers of electricity and will reduce the cost of storage in composite grids fed by wind, solar PV and solar thermal generators. But large, grid-connected biomass power plants may not be suitable for India, as our forest cover is not substantial and the cost of transportation and security of supply of residue biomass is quite significant.

Smaller grid-connected solar thermal and biomass-solar-thermal hybrid power plants with cogeneration and trigeneration have great potential, especially if they are built by process industries and in designated process-energy zones. A network of pipes will supply hot water, steam and chilled brine for heating and cooling to industrial and food processing plants, commercial complexes, and urban offices and households. This is a well-established, highly efficient, low CO_2 emission and financially viable technology with long years of experience that can be introduced very expeditiously. District Energy Systems are, in fact, major components of energy transformation plans in the European Union. In India, setting them up in and around existing power stations that are still running old, inefficient and polluting coal-fired units will be an excellent starting point for an accelerated phasing out of coal firing.

In any case, decentralised solutions do exist that will enable biomass to be a much more effective component of the national energy mix. Utilising the abundant supply of agricultural and plantation residues in rural areas productively and efficiently will significantly accelerate the social, economic and ecological progress of the rural sector.

It goes without saying that the transmission and distribution (T&D) grid and networks will have to be redesigned and restructured at the same time, as changes to the mix in power generation are carried out in order to maintain uninterrupted, stable and good quality power at consumption points with the least T&D losses.

Role of renewable energy in the future: Decentralised sector

Renewable energy sources are ideally suited to decentralised applications. As they are diffuse, the area required to generate equal amounts of energy (kWh per year) using solar, wind or biomass is much larger than that needed for fossil fuel-based systems. Optimisation and management of land use is easier when smaller areas are needed in any one location. Every rooftop can be a power plant. Offshore installations are one of the solutions. The use of onshore water surfaces for PV may also help solve the problem, but the long-term impact needs to be assessed.

Power and energy systems can be integrated with farming and agro-processing and plantation (tea, coffee, coconut and others) activities that create win-win situations:

- Biomass residues become an energy resource with manageable economic and ecological transportation costs.
- Hybridisation of biomass, PV, wind and biogas can be optimised more easily when all inputs and outputs are local.
- Electricity can be utilised directly within short distances, thus reducing losses and T&D costs.
- Waste heat utilisation (possible even with solar PV), cogeneration and trigeneration increase the overall efficiency, reduce costs, encourage local processing and reduce pollution and emissions.
- Charging stations for intra-village e-transportation systems can be built up expeditiously.
- Local microgrids can easily be linked to the local distribution system point of the grid under a suitable regulatory frame. This will help microgrids to maintain reliable services.
- Reliable supply of electricity, ideally with local management in charge of generation, supply and services, provides one

of the critical inputs needed for setting up local enterprises that generate revenues, create jobs and provide energy, water, education, health, transport and IT services in the village.

DESI Power's employment and power partnership programme

The concept described below has emerged from DESI Power's experience of implementing its Employment and Power Partnership programme (EmPower) in several villages in Araria district, Bihar, during the past 20 years. The programme was successful because of the close involvement of villagers and the induction of biomass gasification technology developed by the Indian Institute of Science, Bangalore. Prototypes were tested, adapted in several pilot projects and productionised by Dasag Switzerland/Netpro, Bengaluru, for commercial operation. Villagers were trained in biomass processing and management, village surveys and assessments, and in operating and maintaining power plants. The first units were run with diesel engines in dual-fuel mode with producer gas replacing 70-85 per cent of the normal diesel consumption. Subsequent plants were run with modified natural gas engines in a pure gas mode, which made the plants CO_2-neutral. One of the first microgrids in the country was set up in one of the EmPower villages in 2006, providing lighting to 250 households, and power to run motorised pumps for irrigation, run motors to replace diesel engines and electrify a local market place with different types of shops and businesses.

Since then, a large number of projects have been built and operated. Even after disruptions caused by major floods in 2017, many of the village plants continue to be in operation. DESI Power continues to introduce and adapt new solutions for productive and income-generating activities linked to decentralised power plants. Some examples are:

- Hybridising biomass with PV.
- Developing and testing "Smart Power System Management Modules".
- Introducing and testing tiny grids to increase the reach of electrification to larger numbers in a village.
- Setting up a commercial pilot plant for food processing units with hybrid solar dryers.
- Testing DC solar pumps.
- Producing and selling home-delivered clean drinking water.
- Producing biomass residue-based pellets for clean cooking as well as for coal replacement.
- Producing and selling cattle feed.

Configuration of a decentralised rural energy and enterprises programme

Villagers living in sustainable, poverty-free villages should have regular incomes for adequate food and nutrition; clean cooking energy; clean drinking water; health services; education and skills training; housing and sanitation; mobility; and communication and IT services. A holistic approach should replace the traditional departmentalised planning of schemes and implementation of projects for rural development.

Every village will not have resources, markets and other essentials to undertake all activities needed for a successful development programme. The planning process should, therefore, start by collecting and assessing data for all villages in a panchayat and defining a cluster that could meet the social, economic and ecological conditions and become a viable entity. While each village will have a decentralised power system (a microgrid and a number of tiny grids), energy and water services and other viable enterprises, it may be necessary to install larger generating units and larger productive enterprises at a suitable cluster centre (for example, a pelletising plant, food processing unit, training centre, an IT centre, health centre and e-riksha service centre). The intra-village transport of people, raw materials (for example, agro-residues for pellets, vegetables for drying, etc.) and finished products (for example, pellets, drinking water, dried vegetables and spices) will necessarily have to be a part of the package.

Conclusion

Our data on the building and running of renewable-energy-based power systems and energy services in villages clearly shows that biomass and biogas systems can create more jobs in villages than any other source of energy. The cost of job creation in agro-processing and other social and economic enterprises in villages is much lower than in the organised industrial sectors. However, the quantum of electricity consumption in villages will have to rise very substantially to reach an income level for all villagers that is above the poverty level. Meeting increased demand through a central grid with high CO_2 emissions is hardly an option since it runs counter to measures required to combat climate change.

The solution to this dilemma is, on the one hand, introduce a large number of cogeneration and trigeneration power plants with much lower CO_2 emissions, and on the other, to apply renewable energy technologies, as described above, in all villages. But this should be done concurrently with the setting up of suitable local enterprises and businesses to create jobs and meet the growing social and economic needs of the villagers. In practice, it has been shown that it is possible to set up and run power systems, and sell reliable and affordable power to customers, but it has not been possible to find adequate loads to make the power systems profitable. Finding investors for local enterprises and businesses, even when power supply is guaranteed, seems to be an insurmountable barrier in the absence of policies to incentivise investors and provide a regulatory framework to minimise their risks, according to the United Nations Foundation.

The pandemic and its impact on villagers may just have given a jolt to policymakers and made them rethink their options. Changes in the policy framework to link renewable energy-based rural electrification and development programmes holistically, and thus accelerate the pace of village progress without any increase in CO_2 emissions, is quite a low-hanging fruit. ■