

MICROGRIDS BY MAIL

By Mahesh P. Bhave

With policy focus, creative use of technology, and good management, microgrids can deliver one hundred percent electrification for the ~ [1.5 billion mostly rural people](#) worldwide (around 400 million of whom are in India alone) affordably, without warming emissions, and within ten years.

Just as the miracle of universal telephony was inconceivable twenty years ago, and yet happened, universal electricity access is likely now. A new business with distributed topology, distinct from today's centralized infrastructure, is taking birth.

Universal electrification with microgrids is neither a fringe nor only a rural matter. Under its cover lies a potent new architecture for the restructuring of the coal-based and polluting electricity business as we know it, and replace it with something clean.

Early rural microgrids will be hybrids of solar, wind, (bio-) diesel generators, micro-hydro, and batteries. They will strive for electricity self-sufficiency, independent of the macrogrid. In urban and campus deployments, such as universities and military bases, renewables-powered [microgrids](#) can de-stress the electricity infrastructure, contribute surplus power to it, and work independent of it in the event of a natural disaster like hurricane Sandy.

Microgrids in this article include rural, village solutions providing minimal power for LED lighting and phone charging to campus-sized, industrial grade electrical supply as we know it.

GRID AS RUSSIAN DOLL

The power grid brings to mind the Russian [matryoshka doll](#), a set of nested figures, sold as a toy. The largest figure is analogous to the electricity grid as we know it – the generation, transmission, and distribution infrastructure that some call the largest machine in the world.

The smallest size doll is analogous to a pico-grid (let me call it) or a personal grid, solar panels on rooftops that feed appliances and lights in homes and office buildings. In between lie regional grids, community grids, minigrids, microgrids, and so on.

Just as each individual doll is related to the others and yet apart, so also the varieties of grids are related yet distinct. The analogy only goes so far; as the grid evolves, the smaller grids will be in the tens of thousands, too numerous to be enveloped within a homogenous, single grid, unlike the doll.

The purists will quibble; the grid is a network of networks, neither nested nor standalone. But electricity future may be as an orchard, and not a wide-area network in many parts of the world.

SYSTEMS INTEGRATION AND PROFESSIONALISM

To make universal electricity access happen, however, several distinct strands of research need to come together. For instance, the U.S.'s [NREL](#) (National Renewable Energy Labs) and [Lawrence Berkeley Labs](#) work on optimizing multiple generation sources, [demand](#)

[management](#) work in rural Bhutan, and the experimentation of grass root, next generation service providers such as [Simpa Networks](#), [Gram Power](#), [Husk Power Systems](#), and [Mera Gao Power](#). These complementary efforts must be synthesized to produce [industrial-grade, standardized](#), modular, and replicable microgrids.

Professionalism must complement well-intentioned, cause-driven, and social entrepreneurship efforts to meet the requirements of scale, scope, and reach. Markets need to be classified in order of financial feasibility. Cultural and institutional variations – regulations, affordability, and readiness of people – must be factored in with nuanced management.

EDISON – DISTRIBUTED GENERATION PIONEER

New topologies require new visualizations. In [Transmission and Distribution World](#), July 18, 2012, Paul Mauldin writes: *“For more than 100 years, it has been an axiom of the power industry that bigger generating plants produce cheaper power, as measured in dollars per kilowatt capacity. In fact, the economies-of-scale principle has been a driver of most of the power industry’s technical development... until recently.”*

Now is the age of distributed generation, tied to the grid most of the time, and sometimes independent of it. Mauldin points out that the first proponent of distributed generation was Thomas Edison himself. His *“low-voltage DC system could only distribute power within about a mile radius from the generator, so he built many small generation units.”*

Distributed generation, far from being a modern concept, is thus grounded in this bit of industrial history trivia. Of course, to the extent windmills and water mills are regarded as the precursors of today’s power industry, we have had distributed generation for a long time. Mauldin continues: *“But this paradigm of small, close-to-the-customer generation units disappeared for about a century. Technical ingenuity, growing electrical demand, and economics soon pointed to the direction that the industry was to follow for almost a century.”* New ingenuity and economics now points in a different direction.

BLESSINGS OF INTERESTING TIMES

We live in privileged times. First, we experienced the mobile communications revolution; then the Internet revolution that partially swallowed the communications revolution, e.g., Internet on phones. And now we have the electricity re-revolution. Re-revolution – because the electricity infrastructure was a revolution itself. It dispelled darkness, extended the working day, enabled the birth of new industries, permitted wholesale transport, and augmented human power.

Now the electricity grid intersects with the telecommunications and information infrastructure through smart grids, meters, and phone applications. It is fragmenting at the edges in regions where we have the grid. Where the grid does not exist, in rural India or Africa, the periphery is the *center* for electricity autonomy. This is mislabeled as “grid independence,” but there is no grid to be free from!

To characterize this new center, we consider how widely it will spread its generated power. If it encompasses neighborhoods with thousands of households, we have community grids; for tens

of households, we have the microgrids.

MAIL ORDER MICROGRID

The distributed generation movement, like new revolutions generally, needs to be nudged along. The Obama administration's energy policies have induced a draft to aid this nascent industry. The NREL has developed a microgrid that "*ensures power during times of interruption from the main electricity grid, or provide power at remote locations not readily accessible to a reliable grid...*" and "*The microgrid design ... includes diverse energy sources such as solar, landfill gas, natural gas, and diesel fuel to provide continuous and independent electricity.*"

The U.S. has 100% electrification; the microgrid's use is primarily at military installations, or for disaster management. In civilian use, the microgrid's role is optional and complementary to the grid.

For the wider world, the solution may be modified as follows. Village elders of non-electrified villages form cooperatives, check boxes on an electronic form to specify their needs, and make electronic down payments. Within days, a truck rumbles in the midst of about 50-100 homes. Children scamper excitedly to surround it.

From the truck emerges a box containing a microgrid, a semi-finished assembly like [IKEA](#) furniture, with solar panels, small wind turbines, structural hardware, inverter, battery, and cables. A manual describes how to hook the equipment to each other and place the assembly on a pre-fabricated foundation. A mason firms up the structures, and an electrician, certified for solar installations, strings wires to individual homes.

With the proverbial push of the button, all homes in the cluster get electric power. Rural electrification or urban microgrid deployments should be that simple; it is within our grasp.

The existing U.S.-India [Partnership to Advance Clean Energy \(PACE\)](#) might include the creation of a scalable, hybrid, rural microgrid within its scope. The World Bank and UN organizations, suppliers to the traditional electricity industry, and the [Gates Foundation](#) may sponsor widespread *commercial* deployment of microgrids around the world.

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