Laying the Grid for Smart Energy

An IIT Bombay PhD scholar submits a research paper that makes a power hungry globe sit up in attention. His innovation, km-tech, turns smart grids smarter.

BY SANGITA THAKUR VARMA

An innovation or invention by definition is something that is new, revolutionary, creative and original. But when someone ventures into a field in which no one else has earlier imagined any such accomplishment possible, a high level of skepticism can be expected. VSK Murthy Balijepalli met a similar treatment when he presented his PhD research proposal to the panel at Indian Institute of Technology, Bombay (IIT Bombay). They questioned the functionality of his idea.

The young scholar, who was much ahead of his time, was undeterred. He went ahead and published his paper at the end of the term titled—*Towards Indian Smart Grids*. It was Balijepalli's concern about the power losses during distribution that had him mulling the idea of such a research. The field research served to sustain it further and industry interactions deepened his understanding of the subject. Thus, with the accumulated knowledge and insights from various quarters, he perfected what he called km-tech—a technology or a tool for load, price and grid frequency forecasting. It is an innovation that has the world taking note.

Balijepalli's achievement assumes significance in a much larger context as at the time he took up the research, smart grid was a largely unknown field. His pathbreaking innovation in 2012 and the subsequent global recognition that followed, won India a strong foothold on the smart grid map of the world.

In fact, just two years back in May 2010, the Government of India had announced the formation of a Smart Grid Task Force set up to execute a US$ 132 million pilot smart grid project. The central idea was to develop and showcase the power saving measures that can be undertaken to improve energy efficiency in distribution networks across the country.

The IITian's research was so novel that it caught the imagination of organisations like United Nations Industry Development Organisation (UNIDO) that invited him to co-author an in-house publication on smart grids titled *Smart and Just Grids*. The originality of his research, especially in the hitherto untouched field of forecasting with a smart grid, fetched Balijepalli, 26 at the time, a place in the MIT India TR35 2012 list (MIT Technology Review 35 Innovators Under 35 list). The Visakhapatnam (in Andhra Pradesh) youth's innovative project was also one of the top 50 innovations in 2012 short-listed by the Department of Science and Technology (DST) and the Lockheed Martin India Growth Programme. This again was no mean feat as Balijepalli was the only student to submit an innovation among established companies.

The gold medal and cash award of ₹1 lakh (US$ 1,628.4) were indeed welcome but what set Balijepalli on the next phase of his innovative journey was the assurance given by DST to finance his startup based on the business plan generated from his innovation. The promised financial assistance is to the tune of ₹50 lakh to ₹50 crore (US$ 81,419.96 to US$ 8.14 million). Additionally, the award made Balijepalli eligible for personal assistance from Indo-US forum to develop business in the USA, and a B2B membership of Federation of Indian Chambers of Commerce and Industry (FICCI) to participate in the S&T meetings and business development programmes—all free of cost. The student-innovator was now firmly set on the path of entrepreneurship. After patenting his innovation and commercialising it with Kalkitech, a Bangalore based SME that helps energy utilities across the globe enable the smart grid and achieve energy efficiency, Dr Balijepalli is currently working with Powergrid Corporation of India Limited and India Smart Grid Task Force (ISGTF) Secretariat in the Ministry of Power on achieving India's smart grid vision. "This innovation is generating income on royalties off each sale and the implementation cost is around ₹5 lakh (US$ 8,142)," reveals the innovator discussing the practical applicability of his invention.

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Defying the stereotype of a bespectacled and bookish scientist, Balijepalli comes across as a youthful all rounder with a zest for life. The positive energy he exudes is infectious and he displays a wide ranging interest. "I am interested in learning about other cultures, their traditions, related religions, mythology and demonology. My favourite hobby is playing chess and I like listening to classical music." Certainly not a geek, the inventor also finds time at weekends to "sometimes go to the cinema". His journey to becoming an innovator surprisingly does not originate in his pouring over large science journals. Rather, as he reveals, it springs from his interest in the stock exchange! "I regularly forecast stock prices. This expertise has helped me deal with uncertainties involved in the power sector to some extent," says Balijepalli. Perhaps volatility of any sort has a certain correlation in algorithmic terms, especially in this case as it concerns forecasting electricity prices. Whatever that maybe, for now, the IITian's innovation has many smart uses and immense benefits especially for the consumers. As Balijepalli explains, his research was focussed on easing consumers' power pain points. These complex models are inspired by electricity consumers' requirements in the power industry and the technology forecasts the price and load of electricity in the smart grid paradigm, taking the efficiency factor a step ahead.

So what is this km-tech innovation? In essence, the technology is an improvement on the current forecasting software leading to efficiency, be it price forecast, load forecast or even grid frequency. Balijepalli explains the concept, "A smart grid accommodates not only large, centralised power plants, but also the growing array of customer-sited distributed energy resources. These resources have coordinated forecasting requirements, among other needs. The innovation is all about a system and a method for electricity forecasting in the existing and future grid environments." Notably, one of the primary goals of a smart grid is to empower consumers to become active participants in the power demand-supply flow. By forecasting electricity parameters such as price, grid frequency, and load, Balijepalli's innovation facilitates the participation of consumers in balancing the power demand-supply ratio.

Km-tech or km-stochastic error correction technique (km-SEC) uses an advanced propriety mathematical

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function or in other words sophisticated algorithms to read the data of existing forecasting tools to arrive at accurate forecasts. Using these as inputs—the Indian energy exchange market's clearing price values, forecast values by the industry's standard software, and the history of errors—in addition to a Fibonacci module, which was developed at IIT Bombay, the km-tech innovation forecasts near precise data. In other words, km-tech is a core engine that uses the characteristic data matrix defined for an existing forecasting system, segregates the data and the different mathematical modules based on the locales and collates the data that will help improve the performance of the existing forecasting system. Explaining the km-tech advantage Balijepalli says, "The existing forecasting technologies face the drawback of using a large amount of historical data before being able to predict to standard practical accuracy levels. Moreover, most of the existing technologies fail to capture the dynamics of even moderately irregular variation patterns of the variables that are to be estimated. In order to attain these attributes some of these technologies tend to lose the golden property of 'simplicity'. Extendibility to the future electricity grid environment and applicability to a wide variety of forecasting problems are the other major drawbacks."

The accuracy of the system's load generation was tested by the Indian Energy Exchange (IEX), which studied the Indian regional load volume and what volume to bid. Additional parameters like maximum hourly load were also analysed and the results showed that the potential electricity saving ranged between 14.45 and 35.64 per cent per day. There was another study conducted by a Mumbai based energy distribution company that revealed that energy savings worth ₹104.6 crore (US$ 17.19 million) a year for 1,000 MW capacity can be achieved with km-tech tool's price forecasting feature.

The technology was welcomed widely by the industry and the young innovator who was also felicitated with the Gandhian Technology Edge award by Society for Research and Initiatives for Sustainable Technologies and Institutions (SRIST), National Innovation Foundation, says that km-tech can be used not only for price forecasting and load forecasting but also for wind forecasting and even grid frequency. "Km-tech also factors in the practical issues that may affect the price or the load frequency and these can be defined by the operator," says the inventor. In simpler terms, km-tech brings out new insights and better forecasts using the existing data. Km-tech's applicability is quite vast covering various industry players that make up the energy supply chain—from end consumers, power distribution operators, market participants, transmission operators, generators and system operators to governments.

Talking about the applicability of smart grids in the energy efficiency sphere, Balijepalli says it is the absence of accurate forecasting tools and flaws in the demand response program, called availability based tariff-unscheduled interchanges, that are the major reasons for power grid failures. "Smart grids address these issues by empowering the end consumers," says the innovator, elaborating that km-tech, by studying the behaviour at the distribution transformer (DT) level and at the transmission bus level, enables efficient grid management by effectively coordinating dynamic grid load changes. As near accurate data in real time becomes widely available on price and load predictions, it will lead to effective handling of transmission peaks, outage management and distribution systems. The decision modules can be embedded in the developed technology and such corrective action ensured in real time, adds Balijepalli.

The drive to achieve a smart energy India has not yet ended for the innovator. Talking about his current engagement, Balijepalli says, "Smart grid movement for modernisation of the grid is mainly driven by the systems (communication, IT and power system) integration and improvement of electricity consumer services. I have successfully worked towards orienting electricity grids to electricity smart grids where I developed consumer oriented interoperable systems (COIS). Recently, I have started working on developing pragmatic models for consumer products on plug-in electric vehicles in the Indian market setup." The innovator is also working hard to disseminate his message on smart grid energy management through his portal desismartgrid.com, India's first smart grid educational portal. Log in to learn more and manage your energy needs smartly, efficiently and cost-effectively. ■

FAQs on Smart Grid

Log in to India Smart Grid Knowledge Portal (indiasmartgrid.org) powered by the Ministry of Power, Government of India, for more details:

- A smart grid is an electricity network that can intelligently integrate the actions of all users connected to it—generators, consumers and those that do both—in order to efficiently deliver sustainable, economical and secure electricity supplies.
- A smart grid allows new large-scale, renewable-energy projects to connect to the grid. It integrates new digital technology into local electricity distribution networks and provides the pricing and control system to flexibly integrate new distributed energy resources close to the point of demand.
- Smart grid is characterised by consumer participation, real time pricing, power system efficiency and quality, and new products in terms of value added services.