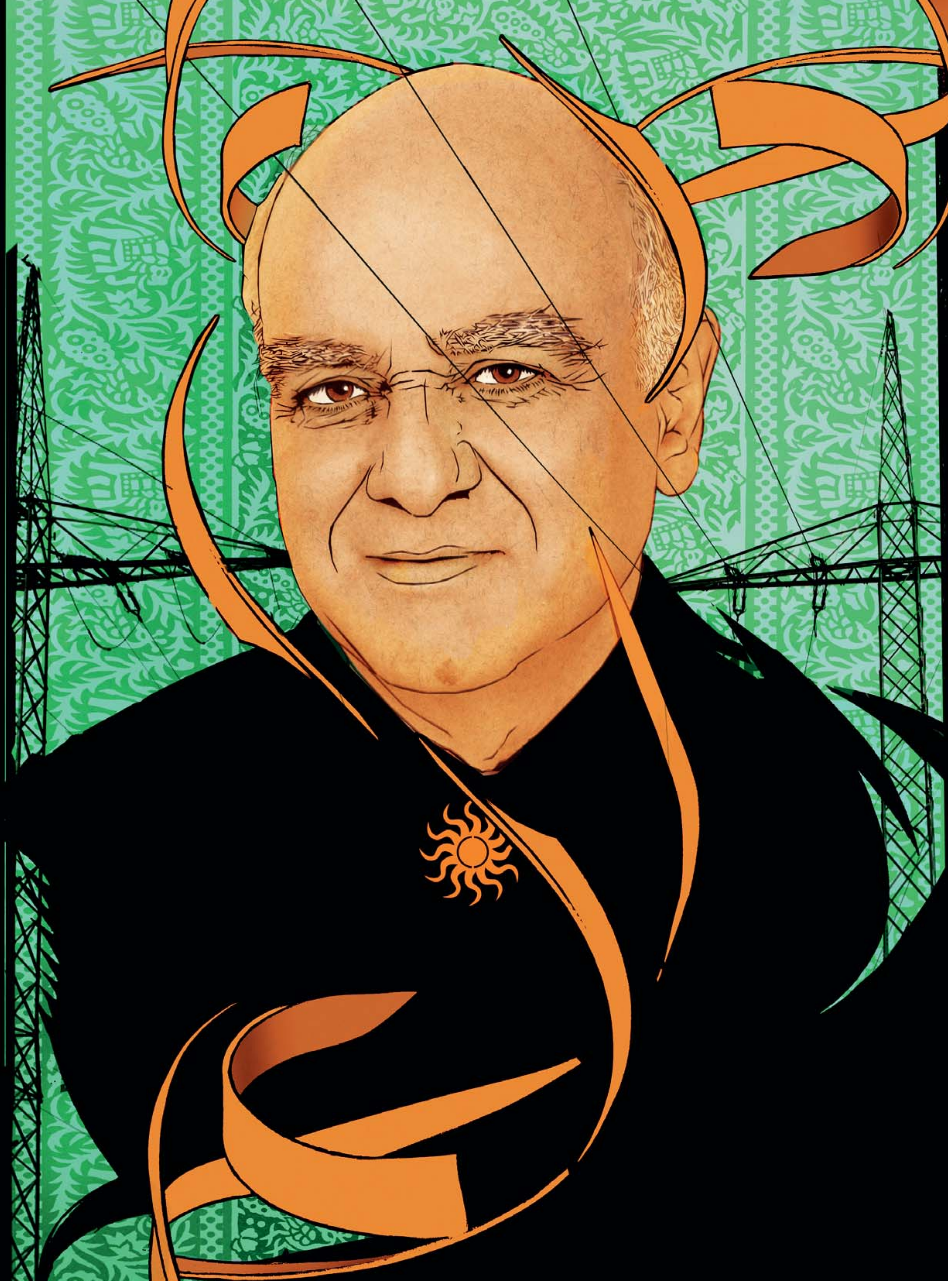


ANIL RAZDAN is the former Secretary of Power and Special Secretary/Additional Secretary of Petroleum and Natural Gas for the Government of India. He was Director of the Energy Management Centre (now the Bureau of Energy Efficiency) and Director/Joint Secretary for India's Department of Atomic Energy. He has been a Visiting Fellow at the University of Oxford for Energy and Sustainable Development: Global and Indian Perspectives. Razdan represented India at various international energy forums, including the IEA and CSLF. He currently chairs a global study on Energy for Megacities by the World Energy Council, and advises the Government of India on energy technology and project monitoring.

Illustration by BURKHARD NEIE

The Future of Energy in India

India is a land of contrasts. It has a multilingual and multiethnic population of 1.2 billion, with extreme wealth and poverty bracketing an educated middle class. Its greatest assets are a strong democracy, an independent judiciary and media, an efficient administration, a tradition of learning that has produced a huge technical workforce, and economic growth. These factors could make India a global leader in the energy sector.

By Anil Razdan

India's rich natural resources, hospitable terrain, over 2,000 years of Indo-Gangetic civilization, and its tolerant and nonviolent traditions made it a fertile ground for foreign invasions throughout history – the last being the British, who left in 1947 after nearly two centuries of domination. During these years, India was perceived more as a market than as a factory, and lost out severely in technological development. Not until independence did India establish sound foundations of scientific and technological learning and research in the 1950s and 1960s. Today, India has had tremendous successes in atomic energy and space technology, having developed one of the most advanced nuclear reactors and put a vehicle on the moon. Nevertheless, 40 percent of the population, particularly in rural areas, lack electricity and other kinds of commercial energy like modern cooking fuels. Rising levels of literacy, now close to 70 percent, as well as access to electronic media, rapid democratic empowerment, and political awareness warrant the widespread availability of affordable energy as soon as possible. This is the greatest challenge in the energy sector.
Availability of and access to energy are the catalysts for growth and the eradication of poverty. India ranked as the world's seventh-largest energy producer and the fifth-largest energy consumer in 2004 and could soon move to the third position. Its per capita energy consumption, at 455 kilograms of oil equivalent (kgoe), was low compared to the global average of 1,750 in that year. India needs to sustain a 9 percent economic growth rate over the next 20 years, to eradicate poverty. It must increase primary energy supply by 3 to 4 times, and its electricity generation and supply capacity by 5 to 6 times over 2003–04 levels

to meet the basic energy needs of its citizens. The current domestic production of crude oil is about 42 million tonnes. Coal India Ltd, which is a monopoly coal producer, expects to produce 460 million tonnes this year. Private operations have grown rapidly in recent years. An independent electricity regulatory apparatus was set up in 1998, and a very liberal Electricity Act enacted in 2003, opening generation and transmission to private players. The grid-connected power generation capacity is now 160,000 MW, and nearly 50,000 MW are proposed to be added by 2012. There is an inadequate petroleum regulator, while a coal regulator is expected soon.

The production and control of coal, oil, and natural gas is within the constitutional jurisdiction of the central government. Electric power is administered jointly by the central and the state governments. Water and water power are state regulated. This raises coordination issues, particularly in hydropower and the transmission of power. The coal sector needs more private enterprise for more efficient operation, as well as an independent regulator. The oil and gas sector was long controlled by foreign corporations, but was nationalized in the mid-1970s. After liberalization in 1997, the private sector became involved in exploration and production. This has led to the commercialization of a huge offshore gas find in the Bay of Bengal. The marketing and distribution of petroleum products remains in the hands of the three major public-sector companies. Administered retail prices, which have kept private companies away in the past, are now showing signs of being market driven. Demand for petroleum has risen steeply due to phenomenal growth of road transport and higher incomes among India's population. The share of cargo transported by road increased from 14 percent in 1950–51 to 61 percent in 2004–05, and passenger road transport rose from 15 to over 80 percent. In 2004, India had 73 million registered automobiles. The automobile industry expects to continue to grow between 10 and 15 percent in the coming years.

Coal and Nuclear: Mainstays of the Power Sector

One good development in recent years has been the public listing and increasing private ownership of almost all major public-sector energy companies, making them more transparent and efficient. Interestingly, all government-controlled energy companies are earning handsome profits and offer sound investment opportunities. Government control over these companies, accompanied by parliamentary scrutiny, has made them serve the larger public good through balanced regional development and restricted profits. However, the efficiency, boldness, and speed of decision making and project execution that thrive better in a competitive private sector are often constrained by an overcautious or complacent approach. Competition, efficiency, and large-scale private investment are urgently needed in India's energy sector.

Through most of the second half of the last millennium, the energy sector was largely state owned and subject to centralized planning. Though the government was resolved to providing a sound public infrastructure, private initiative and investment were lacking. The time has now come to reintroduce private investment through effective regulation and competition. This will also help "depoliticize" the price of energy for consumers, who will have to pay the retail price of power, including appropriate subsidies for the poor. While public-sector monopolies are bad, those in the private sector can be worse.

Coal is India's primary domestic energy source. At current consumption levels, reserves will last 80 more years. The projected 5–6 percent increase in production would deplete them in 40 years. Oil reserves will probably last about 20 years, and gas a little over 30 years. The hydroelectric potential is about 84,000 MW at 60 percent plant load factor (PLF), and about 40 percent have already been harnessed. A 50,000-MW hydroelectric initiative was launched in 2003. These projects are making slow progress due to stringent environmental rules and difficult access and working conditions in remote areas. They offer good business opportunities for tunneling and civil construction. Water will have to be stored in the coming years.

India is expected to require nearly 800,000 MW by 2031–32, the bulk of which will have to come from domestic and imported coal. Nearly 64 percent of the new capacity coming up for commissioning by 2012 and 2017 will be coal based, for lack of other fuel options. Private investment in generation in recent years has been remarkable. In order to add capacity faster, the government initiated Ultra Mega Power Projects (UMPP) with assured inputs like land, advance power procurement, environment clearances, transmission connectivity, and dedicated coal mines for pithead locations. Projects are allocated through a highly competitive, transparent, tariff-based bidding process for a 4,000-MW supercritical thermal plant. Four of the 14 identified projects are already under way.

The emphasis for coal-based projects will be on supercritical. India is now becoming a hub for the manufacture of supercritical generating equipment like boilers and turbines and is looking at ultra-supercritical and IGCC thermal technologies for maximizing efficiency gains and controlling emissions.

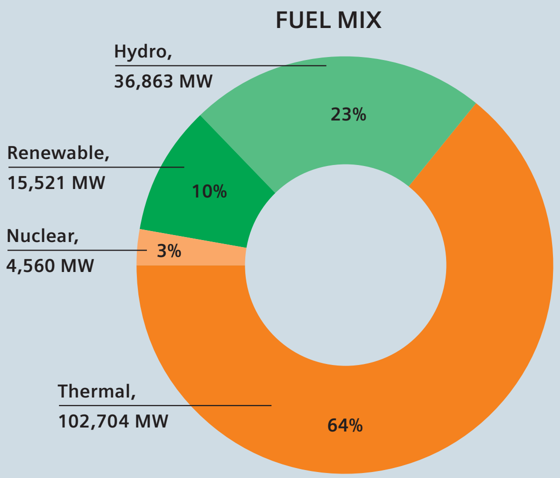
In the field of nuclear power, India was one of the pioneers. Owing to limited domestic sources of natural uranium and abundant thorium resources, a three-stage nuclear power program was envisaged about 50 years ago. The first stage involved pressurized heavy-water and light-water reactors (about 10,000–20,000 MW); the second stage, plutonium or fast-breeder reactors; and the third stage, thorium-based breeder reactors. This program would have provided the highest energy security to India. Restrictions on nuclear fuel slowed down the first stage. The decks are now being cleared quickly, and an indigenous 500-MW fast-breeder reactor for the second stage is also nearing completion. This technology demonstrator is a shot in the arm for Indian science and engineering.

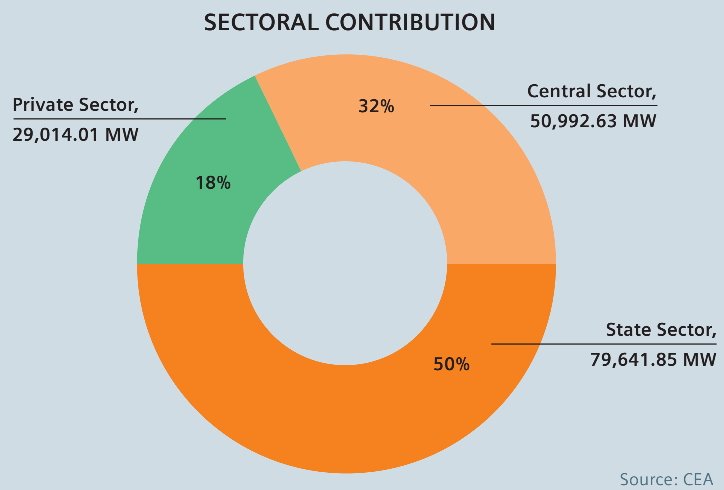
With an additional 150,000 MW coming up by 2017, a robust and reliable high-voltage transmission system has already evolved through a national grid, although open access through some states is causing problems. The interregional transfer capacity will soon touch 33,000 MW. The entry of the private sector in high-voltage transmission has been slow. It should catch up fast. In the power sector, the state entities, particularly at the distribution end, need vast improvement and an injection of funds. Power exchanges have come up, and power is moving across the country on HVDC, 765-kV, 440-kV, and 220-kV lines.

In the distribution segment, a performance-based, IT-controlled 15 billion dollar reform program was introduced in 2008 to bring aggregate transmission and commercial losses down to 15 percent from the presently unacceptable 30 percent. The viability of the Indian power program could hinge on success or failure in this sphere. The state-owned distribution segments of the power business in the states have been running huge losses owing to unremunerative tariffs, outmoded systems, and power theft. Fortunately, with India's strong IT sector, distribution reform in many states and smart grid initiatives in some pockets are in a reasonably mature

Power Infrastructure in India (End April 2010)

Generating Capacity:			
Hydro		36,863.40 MW (23%)	Total 159,648.49 MW
Thermal		102,703.98 MW (64%)	
	Coal	*84,448.38 MW*	
	Gas	*17,055.85 MW*	
	Diesel	*1,199.75 MW*	
Nuclear		4,560.00 MW (3%)	
Renewables		15,521.11 MW (10%)	





Source: CEA

"Availability of and access to energy are the catalysts to inclusive growth and are major instruments for eradication of poverty."

state for takeoff under the restructured distribution reform program. The Government of India has launched a 9 billion dollar, 90 percent funded program for connecting the 125,000 unconnected villages and 23 million poor households. This is a stupendous challenge in terms of execution and maintenance. Though the preference is for grid supply, it is obvious that nearly 25,000 villages will have to receive power from decentralized sources. For the program to be sustainable, the distribution entities or franchisees will need to recover the cost of power supply.

Making Way for Solar and Wind

The flavor of the season in energy supply and use in India in the coming decades will be a very aggressive energy efficiency program and the development of affordable new renewables, particularly solar power. The Prime Minister's National Action Plan for Climate Change has already launched two landmark missions – the Mission for Energy Efficiency and the Solar Mission. Under the Perform, Achieve and Trade mechanism of the Energy Efficiency Mission, nearly 700 industrial units, accounting for 50 percent of all fossil fuel consumption, will be ordered to reduce their energy consumption by a specified percentage. They would be entitled to trade their excess savings. This is in addition to an aggressive standard and labeling program, energy conservation building codes, and innovative demand-side management. These are hard areas, where credit is not easily forthcoming. Only a liberal dose of concessional international or multilateral funding can make it happen in developing countries.

India was the first country to have a separate Ministry for Renewable Energy. Out of the nearly 16,000-MW grid of interactive power, wind power accounts for over 11,000 MW and continues to grow. The National Solar Mission that was announced in January 2010 heralds a paradigm shift and a quantum leap for solar power. From a current base of only 10 MW, the Government of India proposes to add 1,000 MW of solar power by 2013 in the grid by blending it with cheaper thermal power, and 20,000 MW solar power by 2022 through solar PV and solar thermal devices. Given India's vast solar potential, with most parts of the country receiving 4–7 KWh per square meter per day, it makes perfect sense to develop and establish domestic solar technology assuming that volume will reduce the price.

The future energy business in India presents a whole range of opportunities, encompassing coal mining and transportation; oil and natural gas exploration and transportation; thermal, hydro, nuclear, and solar power generation and the accompanying state-of-the-art equipment manufacture; energy-efficient devices, appliances, and building materials; smart grid opportunities and distribution modernization; and efficient, affordable vehicle engines. For entrepreneurs, success will lie in the latest technology, the large volume of business, and affordable competitive prices. There is enough local enterprise for joint ventures.

Environmental stewardship is strongly rooted in Indian culture, though avoidable violations persist, particularly regarding water sources. The worship of animals, trees and water is a common religious practice in India. The combined habits of frugal lifestyle and tolerating harsh climatic extremes have kept greenhouse gas emissions low. Per capita emissions are among the lowest in the world, only about one-fourth of the global average. Fortuitously, the energy intensity in India's growth has been reduced by half from the early 1970s. Currently, Indians consume 0.16 kgoe per dollar of GDP compared to a global average of 0.21, and 0.22 for the USA, 0.17 for Germany and the OECD, and 0.15 for Japan. Although environmental issues are important to the citizens of India, climate change awareness is not widespread. The greatest public concerns are population growth and eradication of poverty. There is good news, too, though: On World Environment Day, June 5, 2010, a global survey by the National Geographic Society and Globescan consultancy showed that India had not only retained its top position as the greenest consumer from 2009, it even increased its lead.

India has to grow, and it must grow prudently and fast. It needs the 5 Es – Energy, Equity, Environment, Efficiency, and Enterprise – for maximizing the common good.