

Power Distribution System

An Insight into the Best Practices

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The global power distribution sector has undergone major changes over the last few years owing to the increasing demand of electricity in both rural and urban areas.

In developed countries like the US and the UK, where the need for having an advanced power generation system to channelise power to even the remotest parts of the country is high, it is important to have an alternate arrangement in hand so that no additional pressure is put on the existing set of systems.

The global power distribution system – how it works

The entire process of power management can be divided into three broad categories, namely –

- » Power generation
- » Transmission
- » Distribution

In most countries electricity is usually generated by turning turbines. The tur-

bines are turned by pressurised steams that are created by burning coal or fossilised fuels in massive boilers. While creating hydroelectricity from water force in barrages, the force of running water turns the turbines.

Once turbines create electricity, its voltage is increased significantly by passing it through step-up transformers. The electricity thus generated is routed on a network of high-voltage transmission lines capable of transporting electricity over longer distances. The ideal voltage for long distance transmission ranges from 155,000 to 765,000 volts, so that transmission losses are reduced. The maximum distance that can be covered by such voltage is about 300 miles (483 kms). Extra High Voltage Power cables are being used more often today in order to prevent further losses. At the electric substation that provides services to personal homes, the electricity is removed from the transmission system and channelised through step-down transformers to lower the voltage. The smaller transformers attached to the bus bar, which

facilitate electricity conduction, help to bring the power down to the standard line voltage of 7200 volts. The electricity is then transferred to the local network of distribution lines which then delivers it to the consumer's home.

Electricity generation stations in any developed or developing country is interconnected with the help of systems called power grids. This is essentially meant to allow electricity generated in one state to be transferred to another whose power generators might have failed.

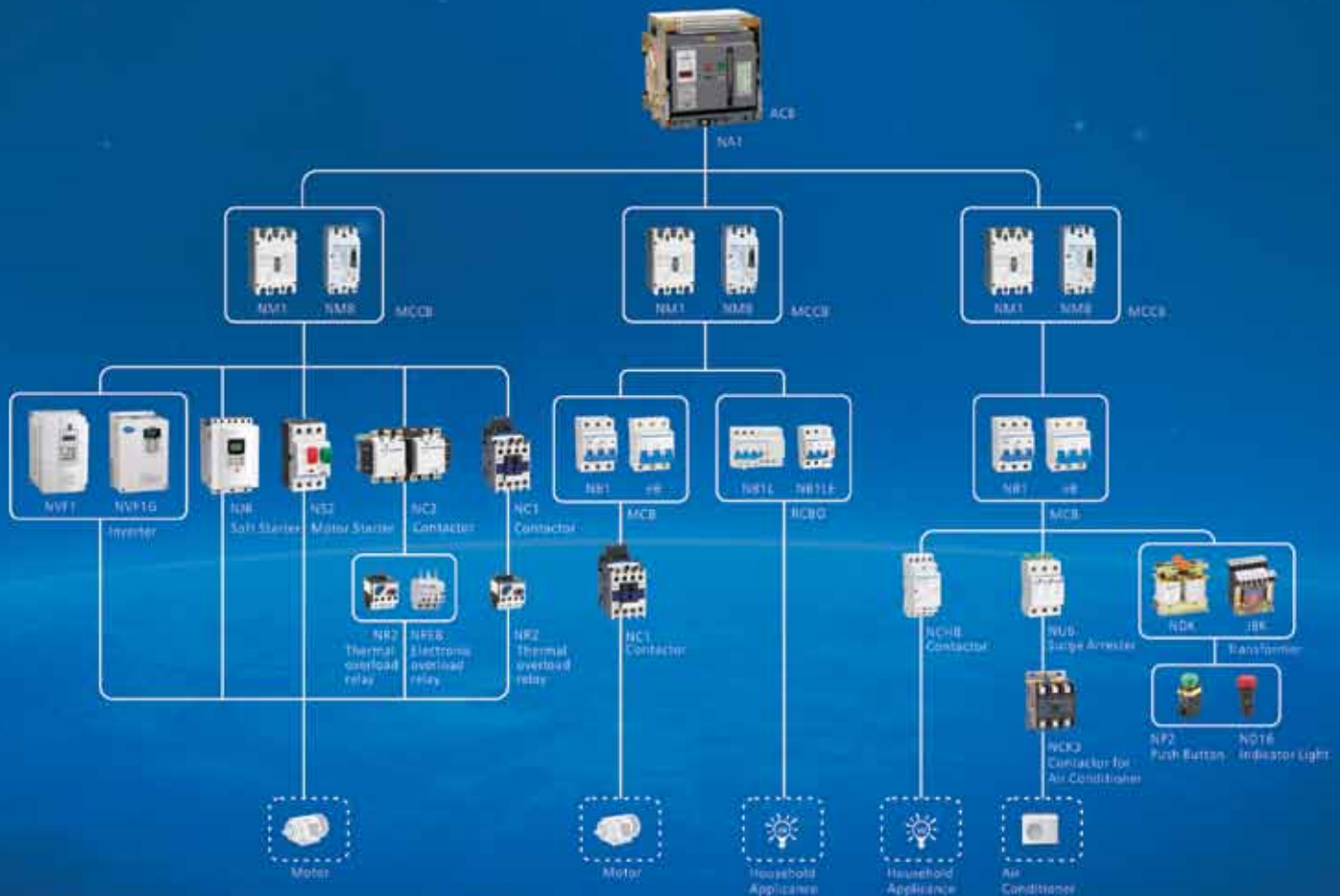
There are a few other sources capable of generating electricity as well. For example, in developed countries like the US and Japan, nuclear power continues to be a major source of electricity.

Distribution of electricity – the major challenges

The electric power lines have evolved into three large interconnected systems that move the electricity across any



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country. The electric power industry has developed standards to ensure that coordination is maintained for linked operations. However, there are some major challenges facing the power grid which need to be addressed in order to prevent power losses – a major challenge faced by both developed and developing countries. According to Energy Information Administration (EIA) report, annual electricity Transmission and Distribution (T&D) losses average about 7 percent of the total electricity transmitted throughout the US. The figure goes up to 10 percent globally with countries like India projecting almost 32 percent of the overall power losses. The figure is certainly alarming.

Electrical equipment in most countries have been in existence for many years, which justifies their inability to cope with major issues of power losses. Most countries have generally agreed to replace and upgrade the current system of power distribution while simultaneously constructing new lines to maintain the system's overall reliability.

Some of the major challenges facing the power grid sector are:

- » Local opposition while obtaining approval for the new route and the land needed to set up infrastructure.
- » Ensuring that the network of long-distance transmission line reaches sites having high quality renewable sources. In most cases it has been seen that such sources are located far away from the key areas where the demand of electricity is high.
- » Opting for an equitable approach for recovering the construction costs of setting up any construction line in one state, while the benefits are reaped by people of other states as well.
- » Addressing the uncertainty in regulatory procedures regarding the payment for new transmission lines which affects the private sector's ability to raise money while building them.
- » Uncalculated amount of power theft across the world also contribute hugely to power losses.

In order to calculate the total amount of T&D losses in a country, the estimated loss has to be divided by the Total Dispo-

sition, which then has to be subtracted from the Direct Use. Direct Use electricity is that amount of electricity that is generated from facilities and not put into electric transmission and distribution grid.

Overcoming the challenges

The best way of overcoming major power losses during transmission is to maximise the voltage while transmitting power. The power loss (P) during transmission is proportional to the square of the current ($P=I^2R$). Therefore, lesser the current transmission, lesser is the power loss. On the other hand, for a given amount of energy, the current is inversely proportional to the voltage ($I: 1/V$). Therefore, higher the voltage is lower the current will be. And lower the current, lower will be the loss.

For these reasons, in most countries power is transmitted at high voltages but used at a rather low voltage. The power generation stations usually transmit power at higher voltage but the local sub-stations tone it down while channelising it to the consumers.

Best practises by the developed countries

With power loss being as big a problem as it is today, most developed countries like the US, the UK, Japan, Spain and Australia have taken steps to ensure that power losses are minimised as much as possible.

USA – Interlinked Electrical Systems

In the US, the transmission and distribution lines owned by individual utilities are no longer exclusively used by them. In fact, they have been expanded and interlinked. The systems are equipped with facilities that allow them to provide associated transport of electricity on the transmission lines to the wide range of area where the buyers and sellers are geographically located.

The three large interconnected systems that are used to move electricity around the country have to be closely supervised in order to keep the various components linked together. These interlinked systems now include more

than a few thousand electric distribution utilities, over 10,000 generating units and almost a similar number of miles of transmission and distribution lines.

Japan – larger sacrifices to attain bigger gains

Being a country with limited natural resources, Japan had mostly depended on fossil fuel import, particularly from the Middle East Asia. However, the scenario has changed significantly over the last few years owing to the rapid growth in the nuclear power industry. Nuclear power is expected to play an even bigger role in the near future with the nuclear energy hopefully contributing about 60 percent of primary energy by 2100.

However, Japan 2011 has dented the growth prospects significantly. With power plants like Fukushima Daiichi being partially closed down, the onus has been on the consumers themselves to prevent power loss. Few of the steps are:

- » Opting for energy saving bulbs
- » Anything using batteries rather than mains power
- » Changing hours for work during night or in the morning. Some shops are open on Mondays while the others on some other day
- » Stopping the use of elevators or not having the air conditions turned too cold.

UK – National Grid delivering country-wide energy

National Grid is a high-voltage electric power transmission network spread across the UK connecting power stations and major substations, ensuring that electricity is generated and distributed everywhere. Even though the power losses across the country are comparatively low, there is still scope for further improvement. The losses in electric supply differ significantly for customers connected at different voltages. While the losses for people connected at higher voltage is significantly low, the amount goes up significantly at low voltages.

The UK government has recently proposed measures to encourage homes and the industry to cut down on power consumption in order to reduce the over-



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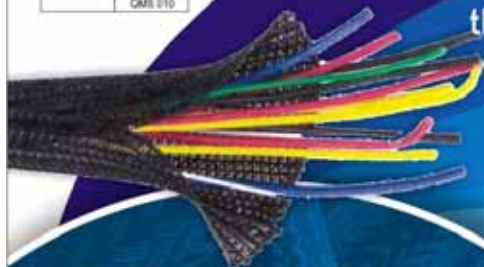
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all power loss and also to do away with the need for new plants.

Best Practices by developed countries

Developed countries have increasingly shown that power transmission and distribution can be done in a more organised manner and with the help of new and innovative technologies. Simultaneously, they have also come out with modes and instruments to curb wasting of energy besides using renewable sources in order to preserve energy.

Here is a list of alternative sources for power generation as well as their usage –

Fossil Fuel

At the end of 2011, fossil fuels like coal produced almost 42 percent of the 4 trillion kilowatt-hours of electricity generated throughout the US. In addition, natural gas is used to burn water to form steam. It can also be burned to produce hot combustion gases that are passed directly through turbine, helping to turn the turbine wheel while creating electricity.

Petroleum can also be burned to produce hot combustion gases that can turn turbines. Residual fuel oil, which is a product from crude oil, is often used as the petroleum product used in electric plants that use petroleum to produce steam.

Nuclear Energy

As already mentioned, nuclear energy is widely used across the world to produce electricity. In a nuclear power station, a reactor is used, which contains a core nuclear fuel, primarily uranium. Uranium fuel atoms while being hit by neutrons create fission, releasing heat and more neutrons. The continuous fission that takes place creates a chain reaction releasing heat. This heat is used to turn water into steam, which in turn spins the turbine, producing electricity.

Virtual Power

Countries like Germany have come up with another crucial technology called virtual power plants, in which the soft-

ware can control a vast number of small power sources that allows them to coordinate their output for sale on energy markets. The goal is to transform the various renewable energies, which while being operated individually can turn out to be vulnerable.

Solar Energy

Solar energy is the most abundant energy used on this planet. The interception rate of solar energy by earth is 10,000 times higher than any other source. It has the ability of providing heat, cooling, electricity, lighting and fuel for a host of applications. With the mitigation of climate change being a top priority, the use of solar energy as gone up significantly.

Problems faced by developing countries and addressing them

The major problems in developing countries like India, China and Brazil are mostly related to wrong government policies, uncertainty regarding investment, administrative roadblocks, power theft, lack of infrastructure and a few other problems. There are further concerns regarding how a sustainable reliability level is to be achieved, which will be able to guarantee a continuous power flow at an affordable cost.

Countries like China have come a long way in improving the situation from where it was even a few years earlier. Being the world's second largest electricity consumer after the US, the growth of the power sector in the country is not surprising.

Coal is the biggest source of electricity in the country. In fact, the material contributed about 78 percent of the total electricity production in the country during the year 2010 and 79 percent during the period between 2004 and 2010. However, the transmission and distribution continue to be a problem with most coal mines being sited in the north of the country.

The Indian Scenario

The T&D losses in India amount to more than 32 percent of the installed gener-

ating capacity. Even though the figure is alarming, the government plans to cut down the amount to 14 percent by the end of the Thirteenth Five-Year Plan (2017-2022). Various plans have been undertaken in order to curb the losses and increase the range of supply. The plans include:

- » Launch of Accelerated Power Development and reform Program (APDRP) in 2001 to reduce T&D losses to 15 percent in urban and high density areas
- » Freedom to captive generation
- » Recognising trading as an independent activity
- » Open access to transmission already in place

Conclusion

Even though the implementation of these policies continues to remain a concern, the steps undertaken prove that the governments of developing countries are also looking into the matter more seriously. With the demand for electricity being high, adoption of technologies like smart grid is not far behind. Combining newer technologies with the older ones to attain positive results is always a key and once countries start to do that, power distribution will no longer remain a challenge ■



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