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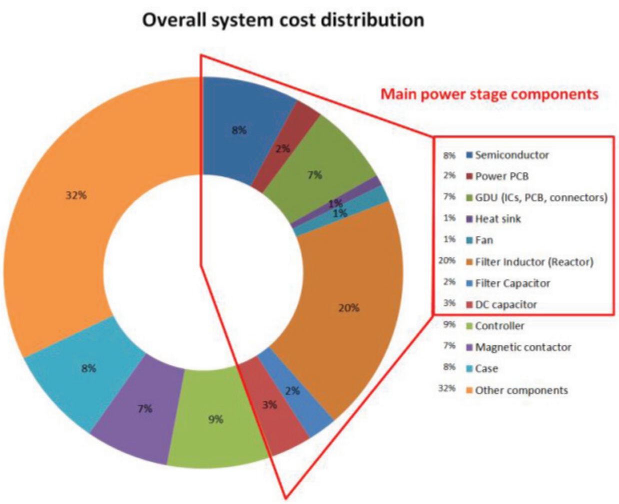
Technological changes and challenges in power electronics

In earlier days, Mercury Arc Rectifiers were used to convert AC into DC for various applications, be it to charge a battery or to drive a motor. The size of these systems was large, inefficient and dangerous which led the researchers to develop much better devices. Their efforts led to the development of solid state devices like Mosfet, SiC, GaN, IGBT, SCR, GTO etc.

The invention of MosFET had been the turning point in power electronics. The technology has made great strides and the recent addition to it is the Super Junction MosFET. This has made the power density of systems to increase, by increasing the switching frequency, which enabled penetration of power electronics to every aspect of day to day life. Most of the PE Systems consist of Silicon MosFET and it has been helping PE engineers to develop efficient cost-effective systems. But SiMosFET comes with its own drawbacks of low turn ON/Off speed, higher Rds ON etc.To overcome these challenges, improvements were made in the topologies. The recent developments in this are the Vienna Converters, Synchronous converters Soft Switched LLC converters, Phases Shifted Converters and a variety of others that works on the principle of resonance. Along with the topological advances, the same reflected in switches as well. With the new Wide Band Gap Semi-conductors, namely SiC and GaN, has made the systems faster, smaller and efficient. With the use of better topology and improved switches, efficiency of the systems which was around 94% has increased to 96-97%. Needless to say the cost of cooling, heat sinks and size of the PCB has been reduced. The use of GaN and SiC has applications where high efficiency is needed particularly in the new field of electric vehicles, telecom systems, military applications and space technology.



Power electronics has made great advances in the past decades and if we are to continue forward with this the bottlenecks in power electronics needs to be addressed as well. In high power applications mainly IGBT/thyristorare used. The rise and fall time limits the switching frequency of the device and hence the size of the system. New devices, such as GaN, have been identified for working in low to medium power and hence are not suitable. Research is going on in this field but no concrete results are present. Along with this is the limitation in packaging of the devices. Better Rth is needed to dissipate the heat generated. Next is the magnetics used in power electronics. Material science has not been improving in this field enough to give us new materials that have got a higher flux density and a thinner BH curve. The BH curve of the above materials has got a very high dependency on frequency, magnetic force, flux density and temperature. Another issue in hand is the gap between the industry and educational institutions. Application knowledge cannot be a substitute for simulations. Even though simulations help us very much in understanding the theory but practical hardware help us in facing the issues that are not seen in simulations. Of all the above limitations, the cost is the most important priority for an industry but it is a lost cause in University research. These issues need to be addressed and policies should be formulated to bridge the gap.

Power electronics has come far and will propel us forward into the future. The next decade is the age of EV and BMS. Internal combustion engine is being replaced by far efficient electrical motors. Grid connected solar panel is decentralising the grid so that losses of transmission and distribution is lowered. FACTS is solving the issues of long distance T&D one by one. Power electronics has given you fast chargers, wireless charging, drones and better battery utilization in mobiles. Needless to say power electronics have made our lives easier and helped us in every step of the way and it will continue to do so in years to come.