**Advance Power Electronics and Control**
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**Lecture - 40**
**Application and Conclusion**

Okay. Welcome to our final lecture of the Advanced Power Electronics and Control. Today we are going to discuss basically the applications and we shall conclude this course formally. Now, we had detailed discussions about different kind of topology and we find that actually power electronics finds its application for the industrial usage. This is basically the switch mode power supply; mostly it is in DC to DC converter.

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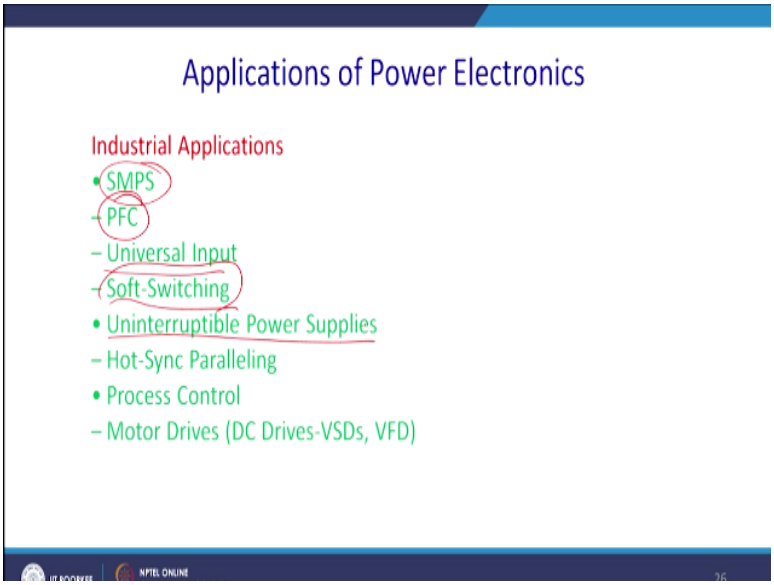


And this Power Factor Connection Technique it is used in case of the AC to DC conversion. And Universal Input is used basically also in a industrial applications for the AC to DC or DC to AC applications. Thereafter, to increase the efficiency of the converter we go for the Soft-Switching and that leads to the equation in this area also actually the area where lot of people investigate and contribute and thus increase the more reliable product, more reliable efficiency.

Uninterruptible Power Supplies that is we all our computers are fitted with the UPS and UPS is one of the major application of the power electronics. Hot-Sync Paralleling also something it is

been used for the process control and the Motor Drives application, it is a huge application most 80% of the energy consume in basically the Motor Drive applications.

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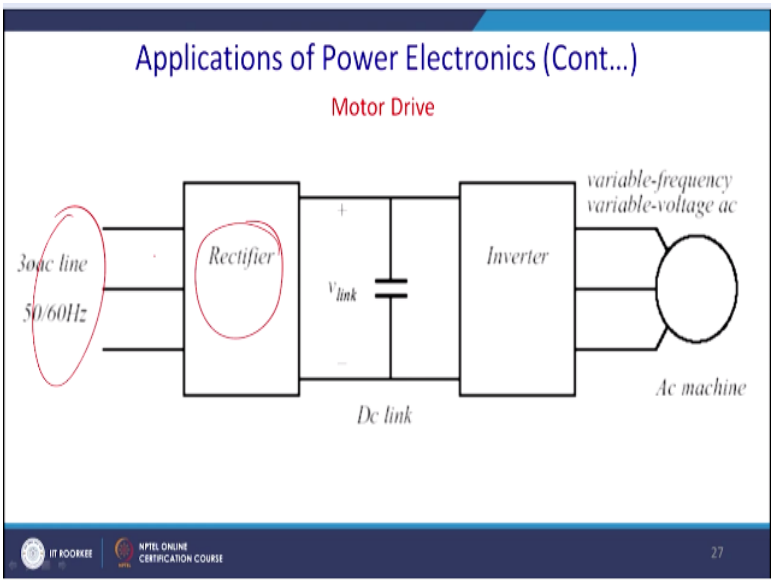


Now, let us take a Motor Drive applications, this is essentially a you have a 3-phase systems. And generally we will find that actually we have seen the rectifier a different kind of rectifier converters, dual converters and followed by actually inverter this is a incent kind of thing and from that we have a so many thing that is metric converter, all those topology has been discussed. So these are basically the derivative from the; this kind of DC to AC conversion techniques.

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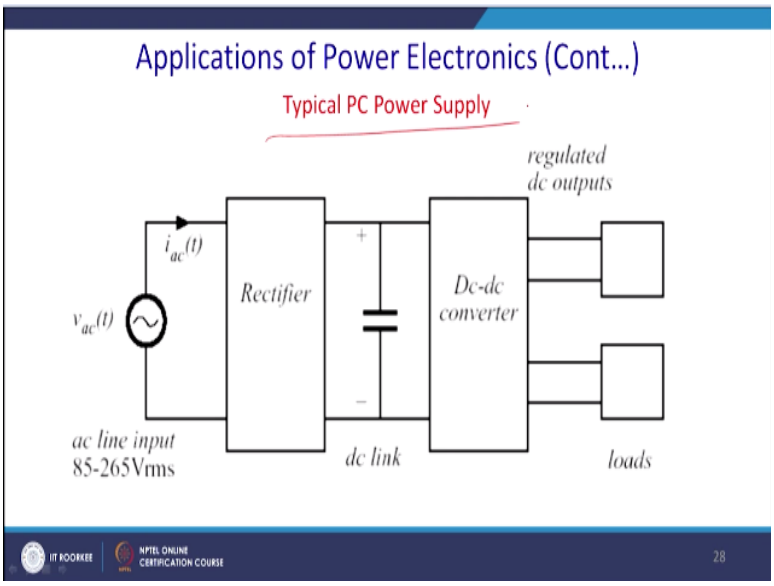

Now we essentially have typical PC Power Supply that is in UPS or maybe actually you have huge Data banks and you may have a actually different kind of AC supply, or rectifier, DC to DC converter and you may have a DC loads and these are maybe the storage element, data storage element and huge power supply DC supply is require. So this is one of the applications of the Power Electronics.

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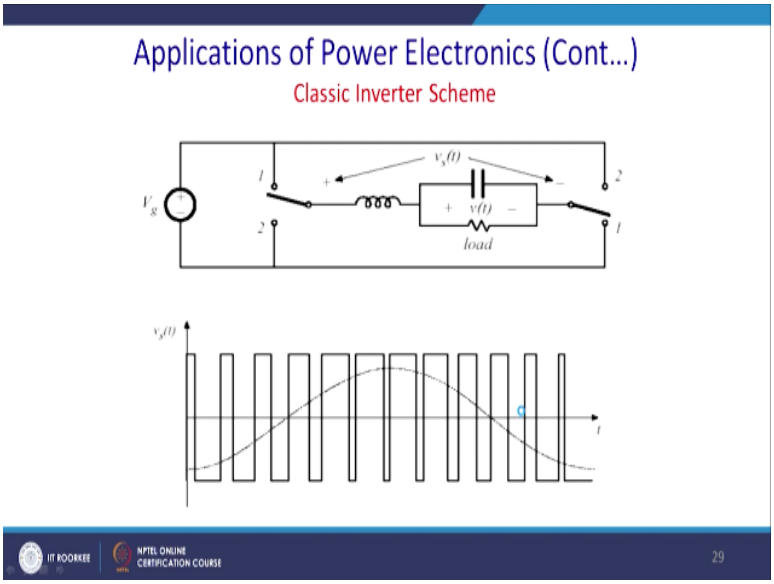


Another application is definitely is that Classic Inverter Scheme with the PWM and from AC to DC applications and we require a desirable DC thus we go for the direct to indirect AC to; DC to AC conversion. Now broadly what we have actually fitted in we can categorize application specific area.

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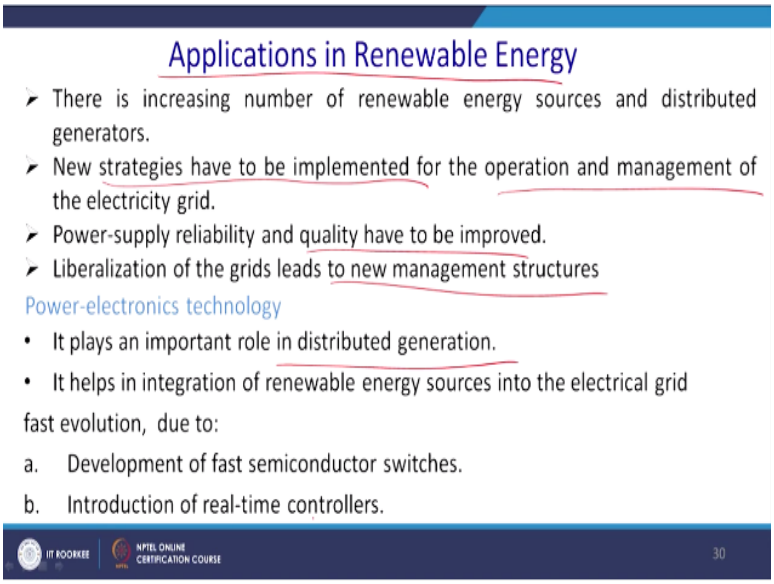


These are the renewable energy. Renewable energy actually benefited very much with the support of the control system and power electronics. With the increasing number of the renewable energy sources and the distributed generators the new strategies have to be implemented for the operation and the management of the electric grid. Thus, we have let us say nowadays actually except I believe the north is whole India is connected by a single grid.

And thus, you know it has got a huge inertia. But our solar inverters has got 0 inertia almost or very low inertia compare to this actually alternate. So once you incorporate the very low inertia system with the high inertia system we require to have a grid validity and all those things. So we require to have proper operations and the management of the electricity grid.

This is one of the challenge is involving. And ultimately we require to provide solution to the control and the power electronics. Power-supply reliability and quality have to be improved, because problem of the power quality basically due to the switching of the power electronics converter and thus power electronics has to clear out the mess and it should clear it out. And definitely liberalization of the grids leads to the new management structures, because there is a many stakeholders of a grid.

Because one maybe actually the agent who is selling the actually the renewable energy, one may be a selling; one maybe a consume; another maybe the protocol monitors there are many

stakeholders. And ultimately a grid has to accommodate all of them. Power-electronics technology plays an important role in distributed generation.

Nowadays the penetration at the renewable energy in a distributed network power electronics plays a very important role and its role and those actually solar inverters are essentially a bulk of the power electronic device. It helps to integration of the renewable energy source with the electric grid fast evolution due to development of the semiconductor switches and introduction of the real-time controller.

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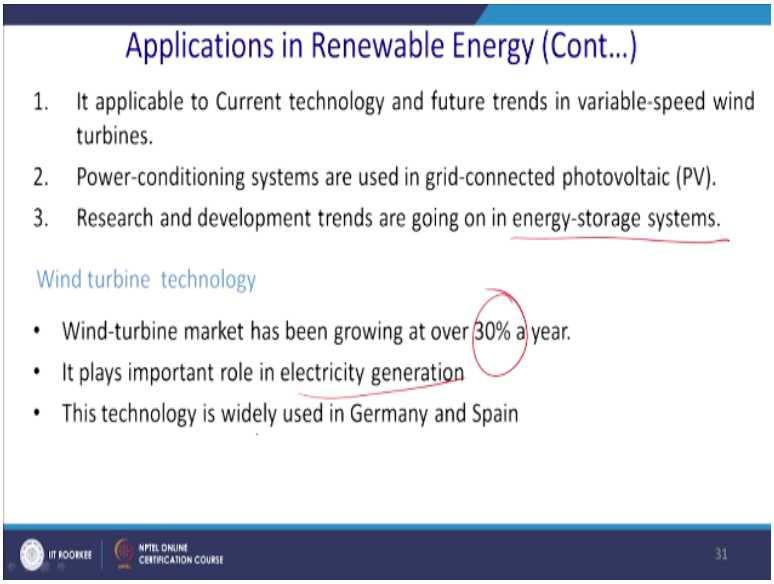


It is the application to the current technology and the future trend in the variable-speed or wind also has to be featured in. Power-conditioning systems are used in grid-connected PV. Research and the development trends are going on with the energy-storage systems. Because one of the problem like countries like India that actually pick power problem, because have a pick shortage, but unfortunately average power in most of the India is more than that.

So for this reason actually we require to have a actually efficient storage element to actually shift the pick of the system. Wind-turbine technology, the turbine market has been growing over the 30% over a year worldwide as well as India. It plays a important role in electricity generations. This technology is widely used in Germany and Spain. And the rate of penetration in India is also coming high.

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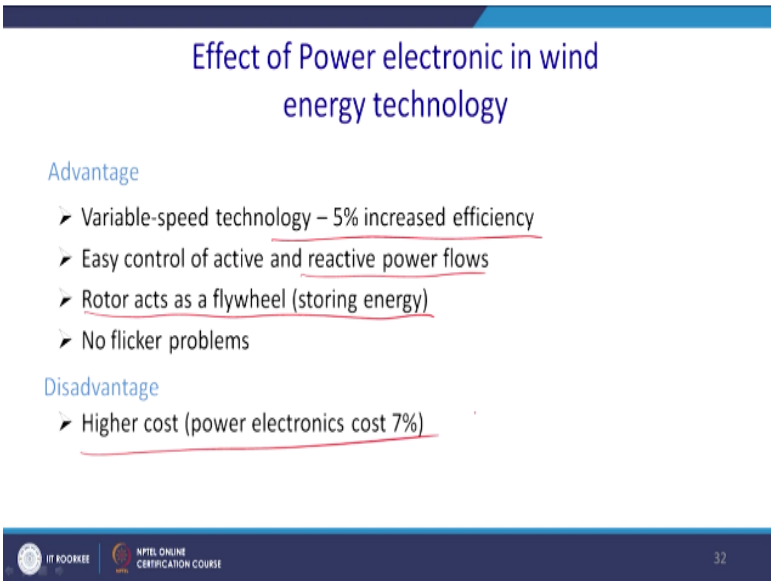


The Variable-speed technology that is 5% increased in efficiency is quite possible because of the Soft-Switching and the other power and power devices. Easy control of the active and reactive powerful because we may have actually the fax devices that can control basically the flow of reactive power and real power through the transmission line, so this facts ensure that easy control of the active and the reactive power flow.

And where, Rotors acts a flywheel as a storage energy and it has no flickers problem but it has a higher cost and most of the power electronics part actually constitutes actually 70% of the below material.

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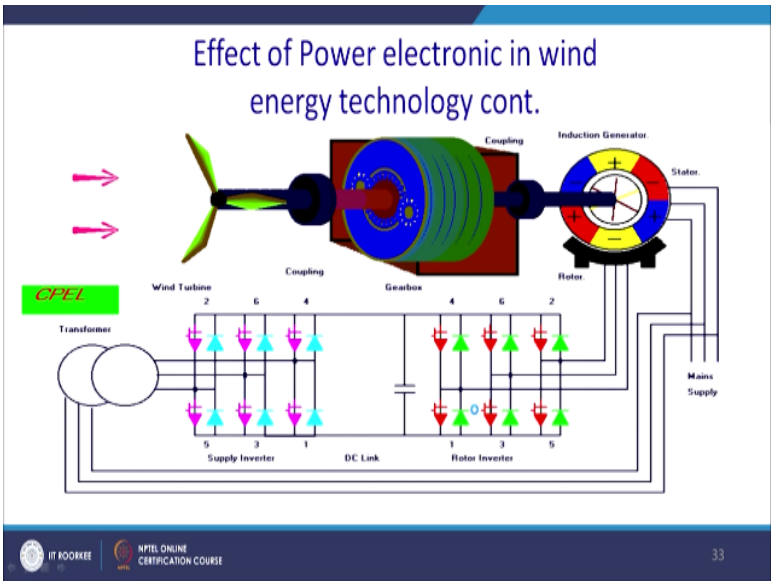


So this is the typical example of the Wind-turbine. You know, actually it is basically fitted to the gearbox and you will have a double effect induction machine where you will feed from the Stator as well as Rotor and thus you have a; you may actually feed is rotate, evap the synchronous speed then both Stator and Rotor actually fix power to the grid and if it is below the synchronic speed generally power is taken to the rotor by the rotor and ultimately you get the difference of the power from the Stator into the grid.

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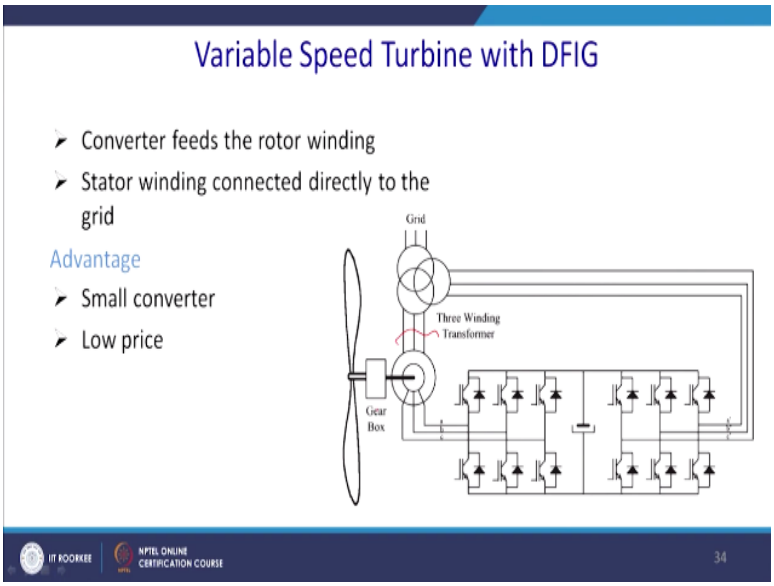


So this is the overall diagram of it. So this is you can see that there is a gearbox that it fits the power to the stator as well as the rotor so this is a rotor-side converter as well as the stator side

converter. This is basically the stator side converter and this is a rotor side converter. It can inject power or it can actually take away power.

It can inject the power into the rotor in a subsequent speed and it can actually take out the power for the evap (()) (09:38) speed and this is the function of the dual converter. So this is called double affect induction motor for actually or DFIG in case of the wind challenging application. So converter feeds to the rotor winding.

Stator winding connected really to the great and what happen basically more and more advantage of this topology is that since it seems only the rating of the rotor and thus its rating is quite low; converter rating is quite low, small converter and thus price of this converter also low and we can effectively control the power through this small converter.

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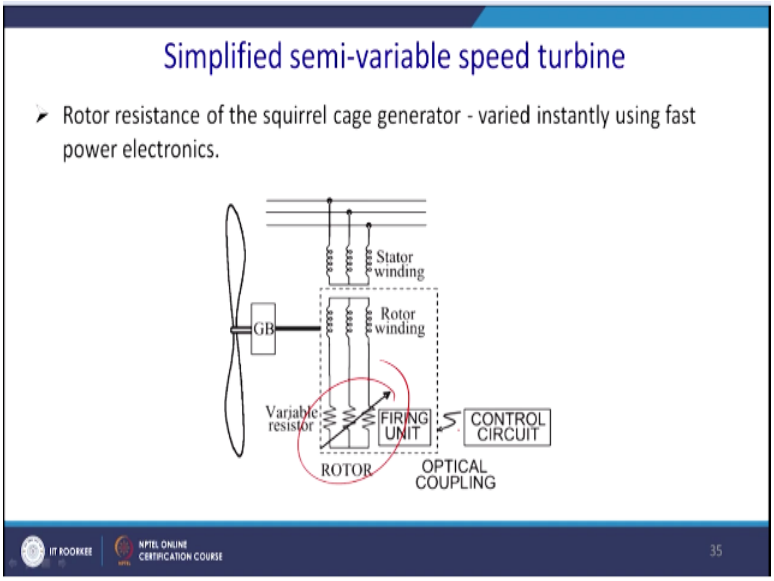


Another example maybe actually Simplified semi-variable speed turbine. So we may have actually Rotor resistance of the squirrel cage generator varied instantly using the fast power electronics control and there basically the resistances can be controlled by this fire electric circuit but since you are actually increasing this resistance losses so previous one is more suitable for the wind energy application.

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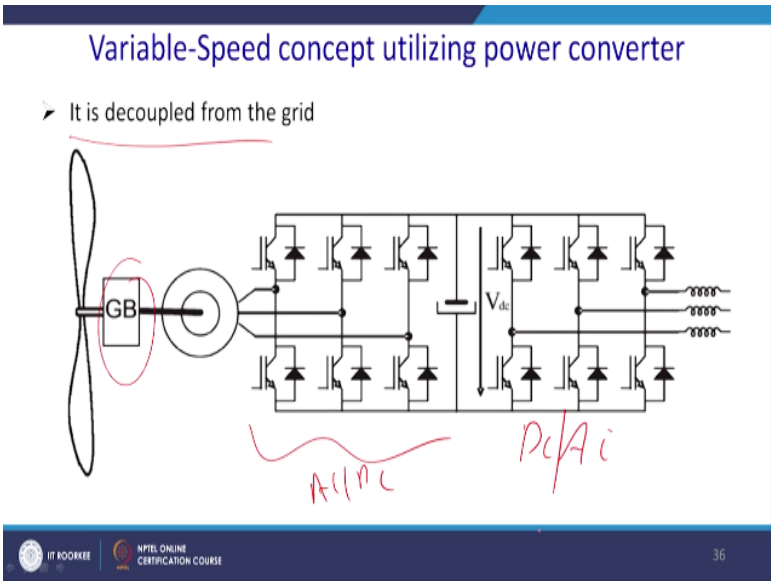


This is decoupled from the grid. And we may have; this is basically used for t he permanent magnet synchronies generator and or we may have a Gearbox also. You state the power from the grid from the stator and there the rectifier state because if may generate the voltage at any frequency which may not be suitable for practical applications, ultimately you have AC to DC application followed by DC to AC application.

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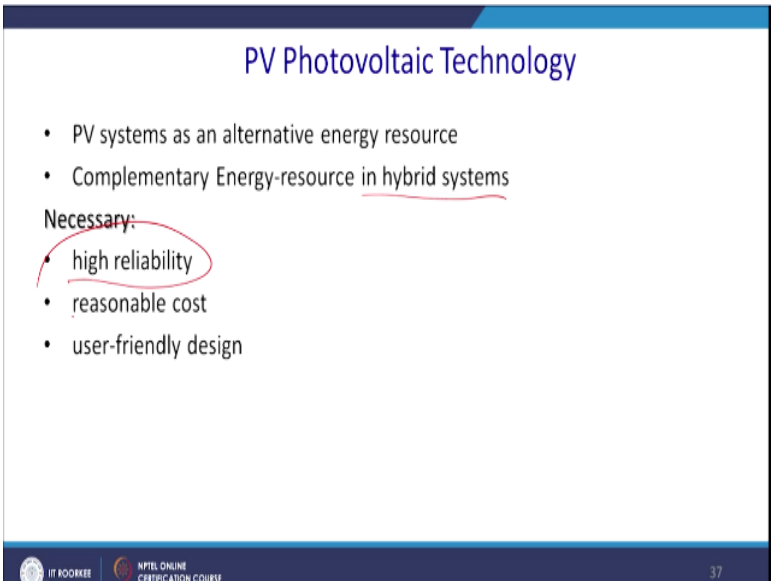


And thereafter, anther application is definitely the system as a alternate energy sources and complimentary energy resources in hybrid system. So this will ensure Power electronic ensure that it is a highly reliable system and at a reasonable cost because you know we require to get a

power from the solar and the rate of this actually the fossil fuels, so for this reason actually cost has to be the reason and we require to put it in some places where solar is available.

And for this reason there is a challenge of put it to because if you are actually taking lent for putting the solar plate then actually (()) (12:16). So for this reason we have a, we should user-friendly design to incorporate it.

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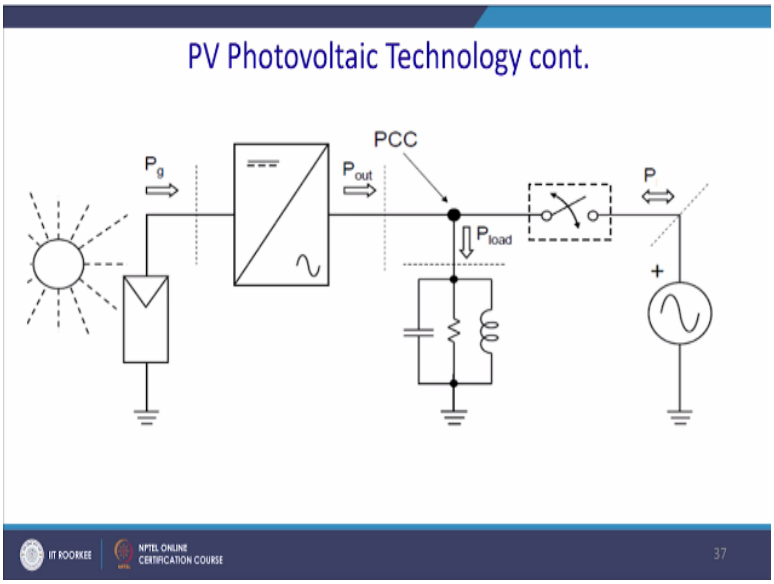


So this is the example of the Solar Photovoltaic technology. So there will be there it will have a DC to AC conversion; this is a point of common coupling; this is and this is the filter that will actually filter out the high frequency ripple and ultimately current can once actually will see that actually this grid power can be synchronize with the solar power, we close that switch and then power is transmitted.

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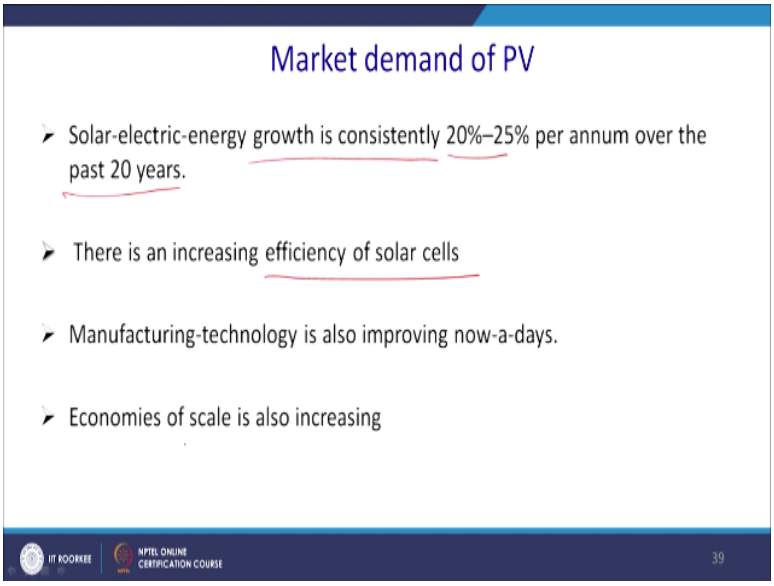


Solar-electric-energy has a few features of the solar market and for this reason we require huge demand for the solar inverters and thus the power electronic engineers. The solar-electric-energy growth is constantly 20-25% per annum, over past 20 years we have seen.

Especially, now European union has saturated now it is turns to the actually the developing country like India, Bangladesh and all those countries to actually catch up and we should harvest as much as power for the solar. There is a increasing efficiency of the solar cell also, this is actually going on and ultimately we get a solar cell as a high efficiency. Manufacturing technology is improving nowadays. Economies of scale is also increasing very fast.

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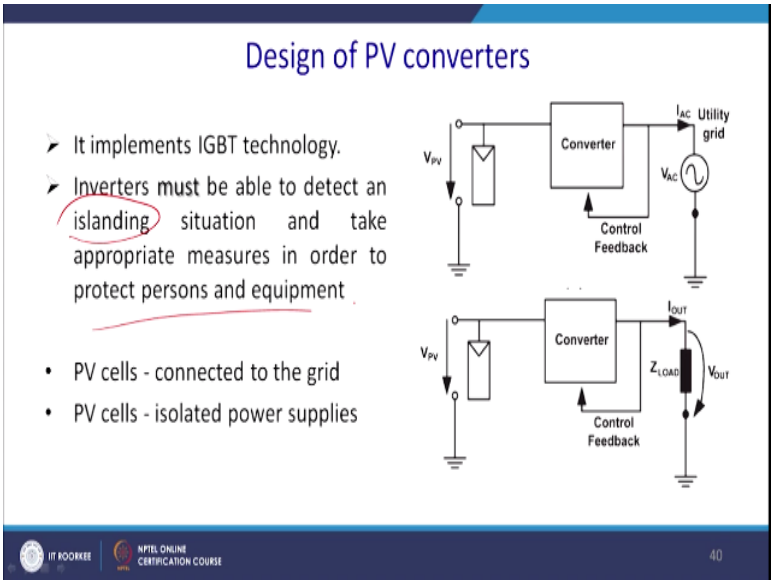

It implements actually IGBT technology because it is in a level actually 10 to 100 kilovolt. Inverter must be able to detect the sliding; islanding that is one of the features that is require otherwise actually user can get a shock because what happen you know grid is removed that due to the presence of the inductor capacitance there might be oscillation set into this actually great and ultimately solar inverter try to pump the energy in the open heat.

And ultimately you know that when it is open circuit then wave will be reflected back and may damage the inverter as well operator who is thought that actually grid is off. And for this reason actually we require to detect the islanding and will be stop walking the solar energy for the purpose of this actually maintenance situation and take the appropriate measures in order to protect them protect persons and equipment (()) (14:43). So previous cells connected to the grid and previous cells isolated power supplies can be given.

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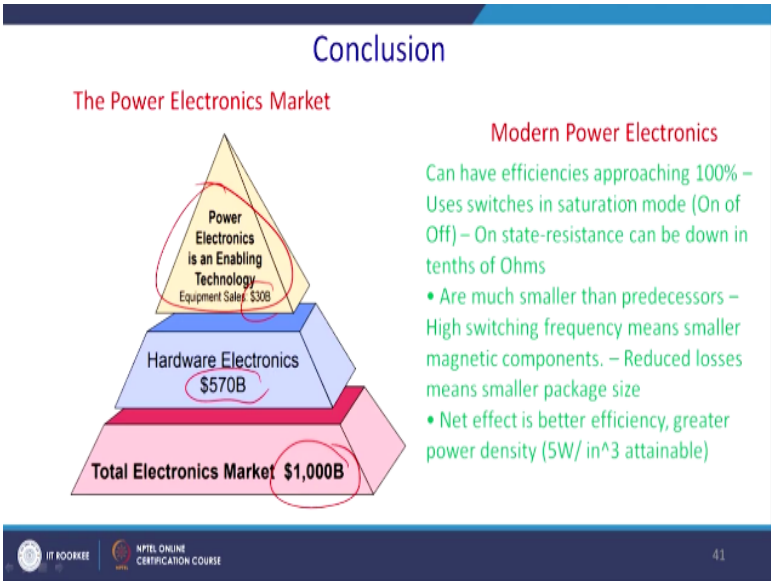


So you know actually little bit of the power electronics where it is actually featured in. Now total economy worldwide economy and may chunk now actually this is the US data of course Indian data are not available but can dig it out and find it out actually the practical later. So total electronics market is about actually 1,000 billion that is a quite few chunk of money, and hardware electronic is basically you know is about 570 billion.

And unfortunately you can see that this has a very low component of it and we expect that huge catch up on this portion of it. So power electronic is an enabling technology and components is just you know 30 billion. So there is a huge gap in between this hardware electronics and the power electronics.

And we believe that soon this gap will be merge and more contribution previous decade actually decade of the communication so we had a mobile communications has been followed and this is the power of the communication electronic believe that strongly that power electronics will actually contribute in a coming decade.

We have efficiency now because of approaching around 100% using the Soft-Switching and uses a switches statured mode on or off, constant resistance can be known to the tenths of Ohms and are much smaller than the predecessors. High switching frequency means smaller magnetic component and with the invention of the actually SIC and the Gallium Arsenide Devices we can actually manufacture it for the higher frequency as well as high power densities.

It reduces the losses and winds actually smaller package and size and that is very much suitable for the Avionics industry but they can cut down the operating cost if we can manage to reduce the weight of the flying object. The net effect is actually better efficiency, greater power density and now actually we are looking for actually 5 Watt per spark courage is attainable.

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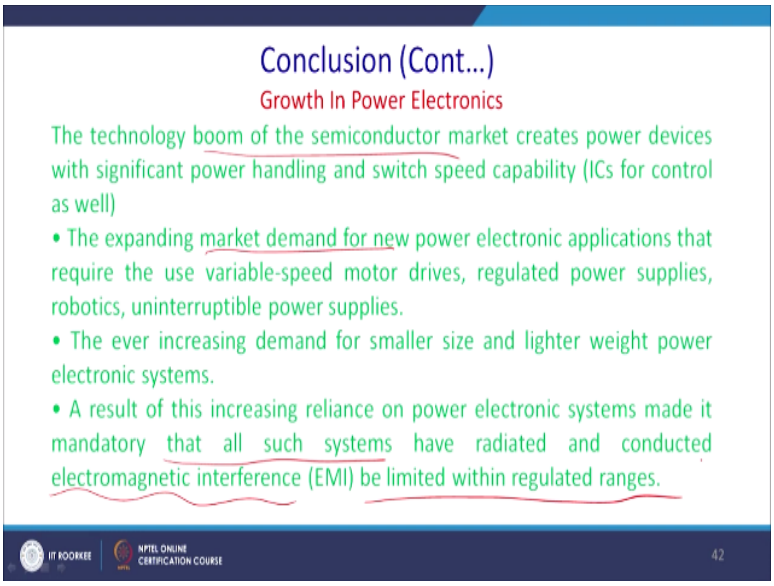


So now actually let us talk about the growth of the power electronics. The technology boom of the semi-conductor markets create power devices with the significant power handling and the switching split capability. This is for the ICs as well as. Expanding the market demand for a new power electronics application that require the use of the variable drive regulated power supply robotics, uninterruptible power supplies etcetera.

The ever increasing demand for the small size and the lighter weight power electronic systems, so that system become compact and high power density. As a results of this increasing reliance on power electronic systems made it mandatory that all such systems have radiated or conducted the magnetic interference that is the problem on EMI/EMC and that may lead to this basically the communication error and we require to suppress that, so with the limited regulated ranges.

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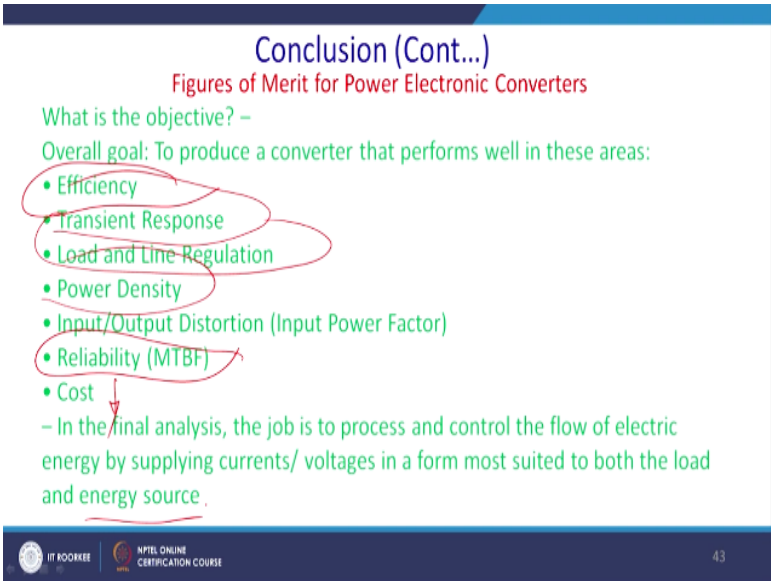


So, what are the objectives of this power electronics converter, overall go to produce converter that performs well in the areas actually should have a high efficiency. Very transient response, very fast and load and line regulation, very high power density, very low input and output distortion that in power factor as well as THD, very high reliability or in terms of you define the reliability in terms of mean breakdown time, so that is basically you know it is just like half life create of the devices and we try to increase and enhance that MTBF.

So that actually so many devices can last long. For example, you know if you have transformer placed in front of you that can be as old as 40 years, so can we have a power electronics of that kind of reliability, so that is the challenge that, that actually present engineers are facing. And we can replace then this actually bulky transformer with the solid state transformer.

And of course actually we are facing a cathode competition and thus we require to reduce the cost and that becomes actually affordable to the many of the masses. So in the final analysis the job to process and control the flow of electric energy by supplying current and voltage in a form most suited to both the load and the energy source. This is basically the; we want something from this power electronics. So this is the; and how you have done it we try to explain over on our classes. Now what is the feature trend of the power electronics?

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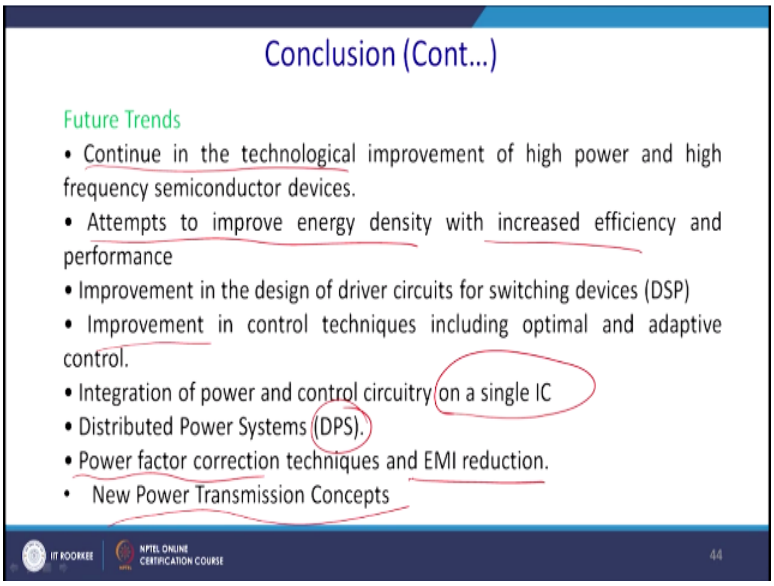


And so continue with the technological development of high power and the high frequency semiconductor device like GAN devices or SIC devices. We shall try to improve the energy density with the increasing efficiency and performance. Improvement in the design of the driver circuit for the switching devices that is DSP based driver or APJ based driver may be featured in. Improvement in the control techniques including adapt non-linear control, adaptive control, sliding more control or any other modern predictive control can be used to enhance the performance of the power electronics or the electronic system.

Integration of the power electronics and control circuit in a single IC, so this is the area of the embedded system, we are trying to do that and this definitely Distributed Power Systems is a area that is revolving and it has got a really lot challenges. Previously, you know we had only consumer that nowadays actually the consumer can be a producer.

So this change of this actually the criterion and that leads to the lot of control of the grid in locally and thus we have a distributed power system. And also power electronics posses lot of threats because of the DC to AC rectification and all those things. Power factor correction techniques has been actually required to be incorporated, power factor as well as THD minimization. And also we require to actually reduce the problem of the Electromagnetic Interference and Variations.

A new factor transmission concepts and also evolved with the fax devices. So these are actually feature trend of the power electronics that we require to talk about. Thank you for your attention. I hope that you find this course to be suitable for your practical applications. Students preparing for actually competitive exam like GATE and other and will find this courses is very useful, apart from the practice in engineering industry also find this course to be very useful.

We will free to write in the forum and we should be in a touch also in a interactive sessions. We are looking forward for a excellent course. Again, thanks for your support of team NPTEL. Thank you.