Power Electronics and Distributed Generation
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Lecture - 3
Distributed Storage Technologies

Welcome to the third class in this course, in the last class we are talking about DG technology trends especially related to power electronic applications and the content of power electronics in DG technology. We are talking about internal combustion engines, combined heat and power, then micro turbines that was where we left.

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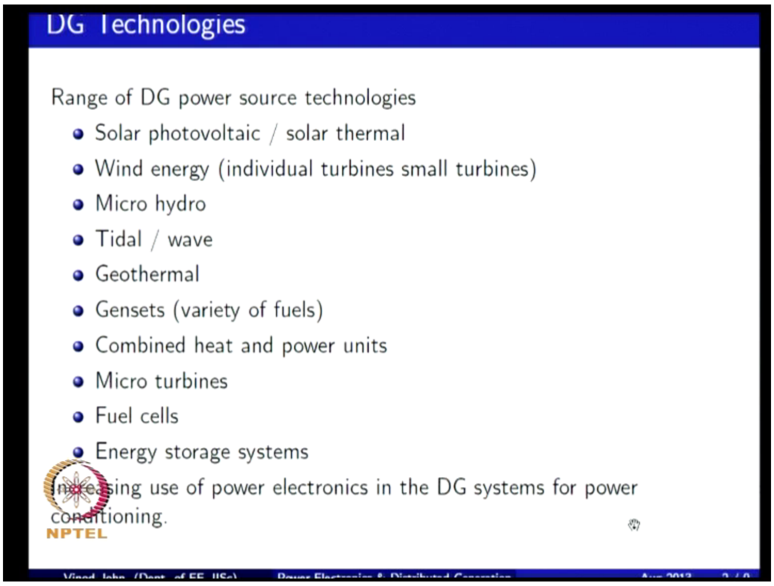

And so today we will complete that particular discussion we had, we will look at a fuel cells and energy storage elements and take it from there.

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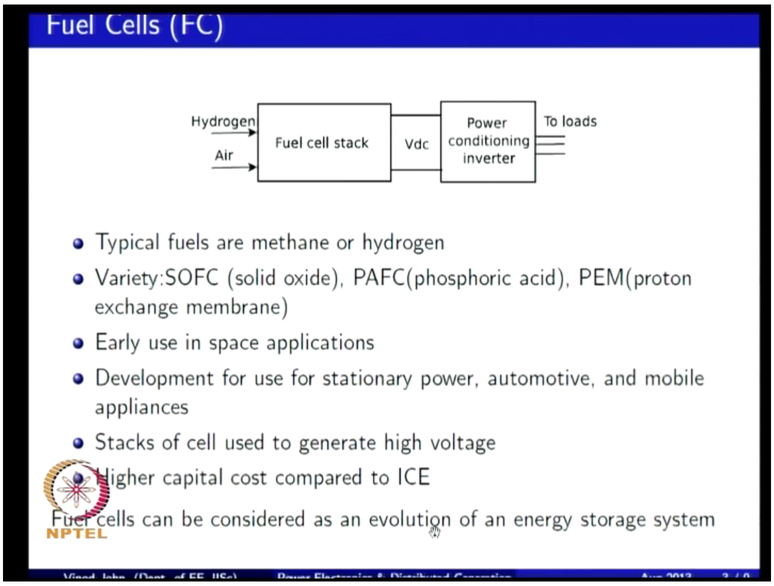

So, if you look at this the systems in general both the sources, such as what we discussed in the last class. And also storage elements are important, especially in distributed generation, where both the load and source can potentially be intermittent and not just that we need sources do not have very high band width to track the instantaneous power requirement by loads.

So, the storage part of it is also a important aspect of distributed generation, if you look at fuel cells, fuel input for the cell stag is typically hydrogen and at a times could be other gases such as methane. There variety of fuel cells depending on the material technology that goes in, you have solid oxide fuel cells that operate at high temperature, you have phosphoric acid these fuel cells, then proton exchange membrane, which operates at a comparatively lower temperature. For example, people are looking at PEM variety for transportation type of application where the temperature is not very high.

Whereas, for stationary applications having something hot can be more easily handled in a stationary systems, so people have looked at higher temperatures to get the benefits of the system such as solid oxide. If you look at the early applications of fuel cells they have been used in space applications for generating power. And they are the cost was not that much of a constraint in applications such as space, but when you bring it to the distributed generation or transportation type of application, then cost is extremely critical.

And as we discussed in a earlier class the life time of power generation equipment has to be quite long, if you want to compete with existing systems. So, people are developing fuel cells for stationary power application for automotive and also fuel cells for mobile type of application. Where the amount of power that would be available on a fuel cell based mobile phone or a laptop, would be much longer than what you could have from a battery based mobile computing platform.

If you look at the fuel cell itself the individual cells are low voltage and they need to be staged to get the higher voltage this. So, similar to what you would do in a battery, the fuel cell today is in a transportation application is not cost competitive with the I C engine technology, but people are working on issues related to fuel cells.

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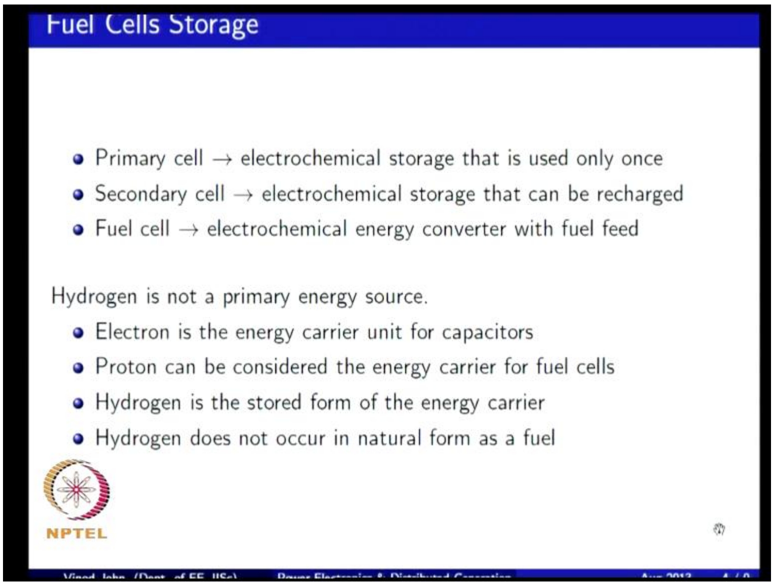

If you look at the fuel cell you can think of it as a evolution of a energy storage system, if you look at a primary cell it is a electrochemical energy storage system that can be used once. So, when it is dead you throughout the primary cell battery and you buy and replace it with a new cell. If you look at a secondary cell it is a electrochemical storage device that can be recharged. So, your rechargeable battery is a secondary cell, but used once and throw is a primary cell.

If you look at a fuel cell it is a electrochemical energy converter with fuel of as a feed rather than having to electrically recharge. If you think of hydrogen it is not a primary energy source, in the sense that hydrogen is not freely available as a element. So, you have to generate hydrogen out of something and you would have to do could do say electrolysis of water or you could reform natural gas to get hydrogen.

If you look at the energy storage the fundamental element of it, if you look at what is there in something like a capacitor, the electron is unit of energy, which carries a energy in a capacitor. If you think of what fuel cell, you could think of a proton being the carrier of the energy and it is the proton flowing through the membrane through the cell, which actually generates the net electrical power in the fuel cell stack. Also you can think of the hydrogen then to be the stored form of a energy carrier which is the proton, also the hydrogen does not occur in the natural form, so it has to be converted from other elements.

So, these are things that become important how efficient is each part of this conversion process to actually get your useful electricity or useful energy out of such a fuel cell. If you look at the common energy storage components, today electrical energy storage at the scale of distributed generation level.

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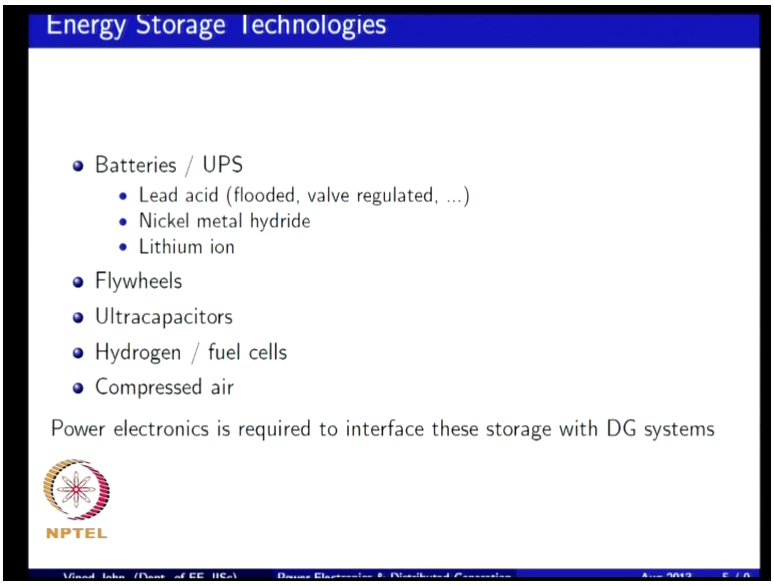

You have batteries the most common application of a battery is a nuclear system and you can have a variety of batteries depending on the chemistry, you have lead acid, which has been around for a long time, you have the flooded lead acids source you have the maintenance batteries, which need less maintenance like the valve regulated source you have tubular batteries, etcetera those are all lead acid based chemistry. The initial electric vehicles had you looked at nickel metal hydroid as an option, because it has higher cycle life compared to the lead acid cells and people are later focusing on the lithium ion technology.

Other ways of storing energy in at a distribution level would be of could be flywheels people have looked at flywheels, ultra capacitors. Again if you have a system where you could produce hydrogen and consume hydrogen you could think of the fuel cell as a energy storages element; where the storage capacity depends on your storage capacity of hydrogen. People have also looked at other methods like compressed air etcetera and for all these systems you are you would require power electronics to interface the storage element with the A C electric grid.

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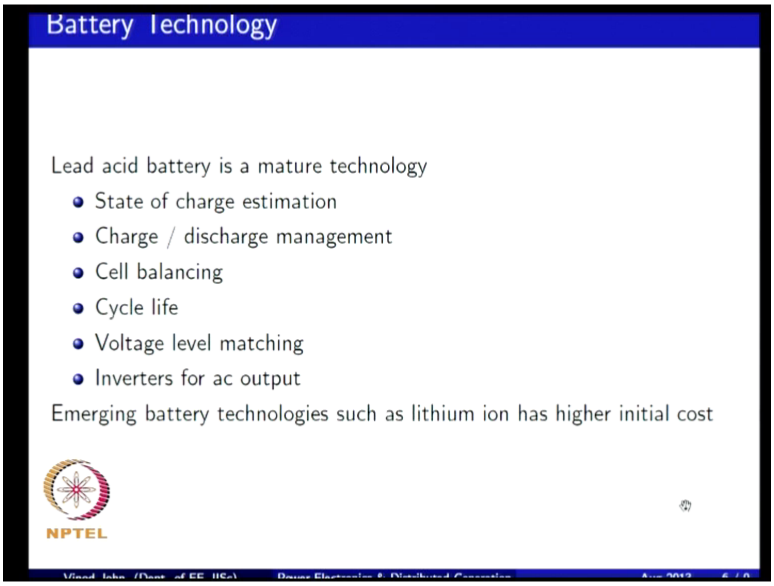

If you look at specifically the battery technology there are many challenges in batteries the lead acid is a mature technology today and cost wise it is quite competitive compared to the other challenging battery technologies. However they are challenges of how to estimate the state of charge for example, if you are using it in a vehicle application you would like to know when your fuel gauge is empty or whether its full.

You would also like to know how much charge or how much discharging can be done on a from the battery, it depends on aspects like, the state of charge, your temperature, what is expected cycle life that you are targeting etcetera, so that can be a challenge in a battery. If you have typical application you might not have single source, but you might have a bank of a batteries. And cell balancing become say, important issue because you do not want to be constrained by the weakest cell in the overall bank you want to actually make the maximum use of your cells in the bank and so cell balancing becomes a important issue.

If you look at cycle life, a cycle life is a challenge in a battery especially if you are looking at lead acid type of batteries. You all are looking at 100 of cycles in something like lithium ion your you might be able to get 1000 or 2000 range, but the cycle life is something that is important in a battery application. Also voltage matching is important if you look at typical 230 volts or 450 volt A C systems without a transformer; if you want to connect a battery to the a c grid you will need a fairly large number of cells to be connected in series. So, the method to get the voltage matching between you are AC and DC side is it is important concern and of course,, the inverter for generating the AC output.

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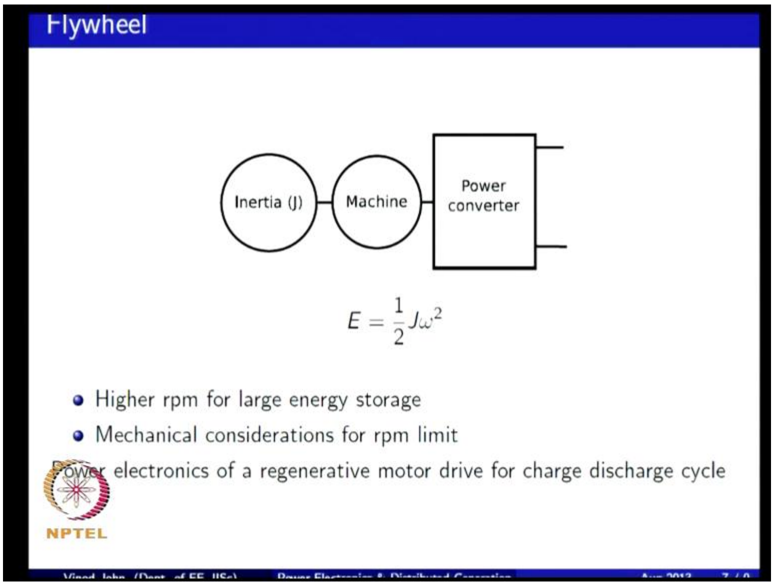

If you look at the a emerging battery technology such as lithium ion, it is having much higher initial cost compared to the led acid cells that are available today. If you look at fly wheels today, fly wheels are a machines that are operate at fairly high speeds, if you look at the amount of energy stored in fly wheel, it is proportional to the square of it is speed. So, you typically try to apply as large an RPM as possible.

So, people use it in 10’s of 1000’s of RPM to 100’s of 1000’s of RPM recent papers and journal of mechanical engineering journals, show that people have done prototype fly wheels go even up to million RPM. So, that the technology required to actually hold a mechanical structure without falling apart those high RPM’s actually a big challenge. So, the mechanical consideration is a big issue.

So, if you look at the energy stored just increasing the inertia of the fly wheel give you a linear dependence with the inertia whereas if you look at RPM it is quadratic. So, pushing the RPM can actually have benefits and if you look at the power electronics required for a controlling a fly wheel system it is essentially a regenerating motor drive. So, you are sending power out to the machine you are actually driving the machine and when you want to take power out you are actually regenerating and taking power from in your stored energy in the inertia and putting it back into your electrical system.

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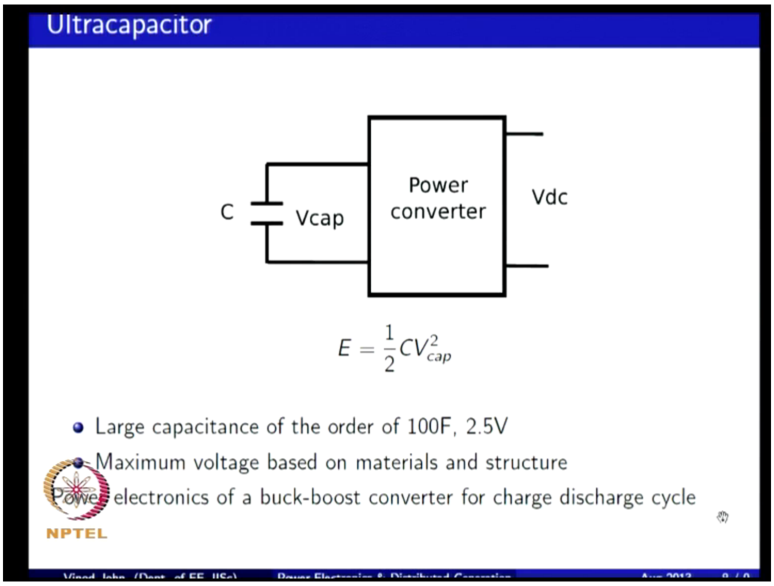

If you look at the ultra capacitor as a energy storage element people are looking at ultra capacitor closely today, because its ability to charge and discharge much higher than a battery. So, people are looking at possible combinations of ultra capacitors and batteries to be able to rapidly charge and discharge energy. So, compared to a regular capacitor these ultra capacitors would can have, much higher value of a capacitance.

So, you are talking about device that can have 100’s Farads capacitance or, so many, many Farads compared to the micro Farads range that you would typically deal with a say polypropylene capacitors or even milli Farads in electrolytic capacitors, but it is not typical to have Farads of capacitance and ordinary capacitor. So, there is also lot of work going on in the material technology the type of porous carbon to increase the surface area to get higher capacitance, people are looking at things like a nano tubes to increase the value of the capacitance.

So, there is a range of a material and structural properties that people are looking at on the actual ultra capacitor the device point of view. If you are looking at it from the power electronic converter what you would essentially need is a bidirectional DC to DC converter. So, to charge the ultra capacitor may be you would use a bug converter to send energy from your DC voltage to your ultra capacitor. And maybe you would use a voltage converter to send the energy from your ultra capacitor backed to your DC side. So, essentially you would typically use a power electronic system as a integral component of a ultra capacitor system.

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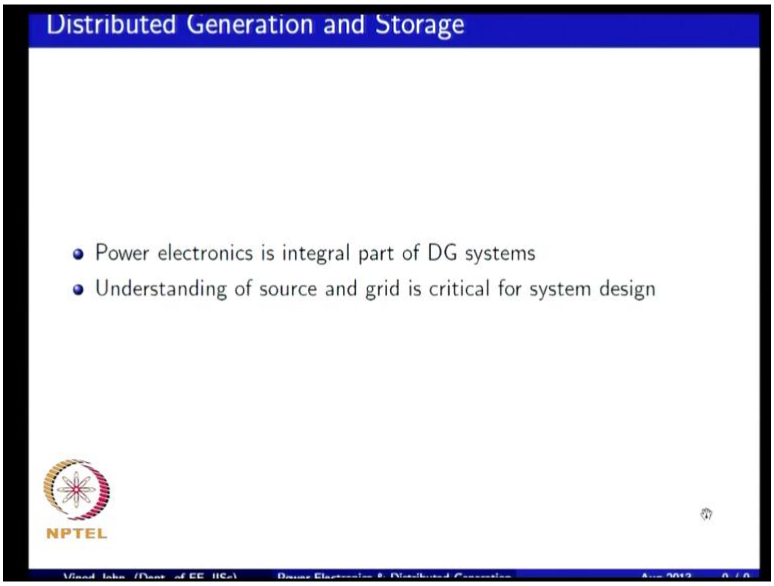

So, if you look at the distributed generation and storage a devices people called them distributed resources to indicate it is both generation and storage. The power electronics from a integral part of many of the systems and understanding both the source element and the grid to which it is connected is important for successful design of the overall distributed energy resource system.

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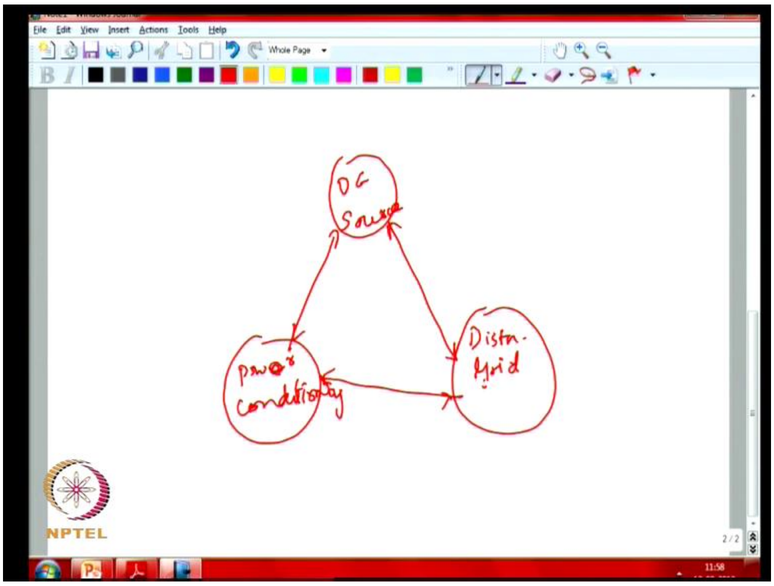

So, if you look at the overall distributed energy system, you might think about three elements the DG source, you might have your power conditioning, you might have your grid, it might be a distribution grid. And a if you look at these three, these are three critical elements of a your overall DG system; the source there are a varieties as we just discussed right now and in the last class. If you look at the other aspect of the DG system you are looking at the power conditioning, which might be a machine or a inverter and you are looking at the distribution grid.

And overall the distribution grid and the power conditioning system faults clearly and the electrical domain. So, we could look at these two aspects more closely and try to keep it technology neutral respective of the type of source what aspects of power conditioning, what aspects of the grid are critical for DG technology. And the DG source going to the DG source you will have to look at the materials the construction fabrication process. So, the focus of our course would be in the first part will look at the grid and then in the second part will look at the power conditioning in terms of the inverter. So, next we will look at the grid aspects now.

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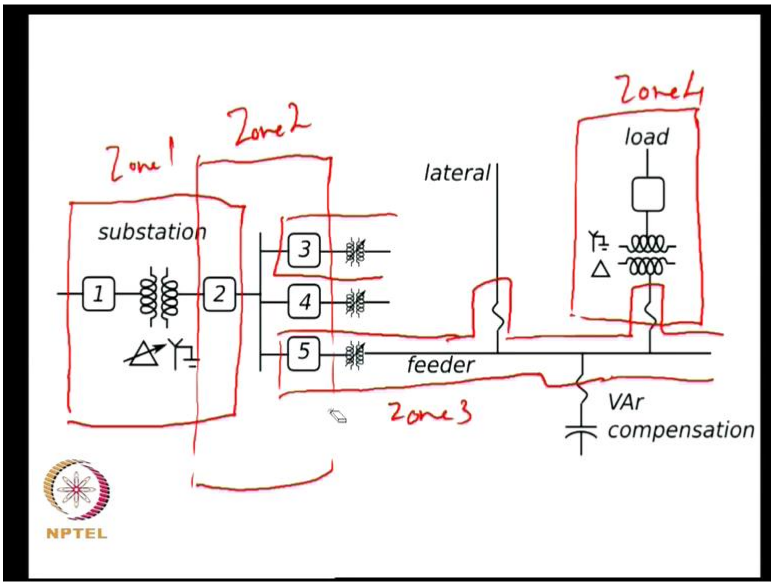

So, if you look at a typical distribution system, you are having a wide range of components, if you look at the typical system you might start off from the substation before the substation you have the transmission system, the sub-transmission system etcetera. So, the what comes to the substation is the high voltage aspects and then you would have the transformer at the substation followed by the low voltage bus and then would have feeders going out from your substation to your actual consumption points.

So, the substation would consists of say your transformer you might have tap changers to ensure that your feeder voltage stay constant with respective of the voltage, which might go up and down at the transmission level, you would have the substation bus. You might have breakers at individual feeders, you might have some line voltage regulators sometimes the line voltage regulators might be located further down in the line.

So, essentially these constraints form the main portions of the substation, if you look at the distribution line itself the feeder you have the circuit breakers at the substation point. You would have the actual line and you might have branches of the line you may or laterals, branching out in a radial form and radial feeder is quite common. You might have a capacitors for compensation of reactive power, you would have a individual loads spread through distribution transformers, that you would see a on the streets.

So, you would have the loads which might be connected through the transformers would be protected with uses you would have the consumption point the loads might be at the low level voltage 230 Volts. So, you might have a transformer for may be a set of homes on the streets and at the individual homes you would have meters and fuses entering to the home or if it is a commercial establishment you might have a transformer for the commercial establishment.

So, you could have a variety of combinations of the distribution feeder system, the transformers can be of different configurations you can have different grounding, the feeders could be over headlines, it might be bunched conductors in cables, it might be underground cables. There might be different varieties of grounding depending on your grounding philosophy at the transformers, so that can be variations of on this nominal system.

If you look at the typical configuration of this system it is radial and you would define areas of protection for such a system. So, you might say going to have zone for protecting, so you might have a zone for say protection of your substation transformer. So, you might have a zone for say low voltage bus at the substation, you can have zones for your individual feeders, you might have zones of your consumption, which might be at the loads towards the loads or it might be towards a laterals etcetera.

So, you have areas of protection that are defined for your feeder and these areas of protection are overlapping, so that you do not leave any particular point vulnerable in the system. So, every part of the system is protected and you give priority for different zones for protection. So, a zone closer up towards the stem of the tree would have higher priority something closer to the end branch on the leaves would have lower priority. So, something, which is at higher priority would have more sophisticated protection systems etcetera.

So, for example, you might be put a high end, protection, relay with circuit breakers etcetera, in a higher zone whereas you might want to look at something more cost effective may be just a fuse and some a resistor for low voltage protection at the other end of the zone of protection. So, you have priority for the zones of protection and you also need coordinated protection.

So, for example, if you have fault in particular load you would like the closest protective device to actually open and you want to minimize the balance, the disturbance that you the fault creates to the balance or the system. So, for example, if fault is there in zone four of this particular system you would, like this particular may be breaker or fuse to open. And you do not want the remaining a portions of the feeder or even the adjacent feeders to get disturb by the fault that you have fault somewhere there.

Also you would like to have backup protection in the sense that say for example, if you one device fails you would like to have if possible the closest upstream protection device operate actually provide a back up, so that the fault descent spread further up into the system. So, these aspects are quite important for the distribution system. So, if you then look at what are the protective devices that can be used in such a distribution system you have relays and circuit breakers.

So, a relay would be you could think of relay as a brain behind the operation of a protective switch and the switch is the breakers. So, essentially the relay would come and the switch to be on or to be off. So, you might use sophisticated relays at the substation level, you might have sugersters distributed through the system to prevent voltage, you have fuses especially out on the feeder and also as backup components in many or many of the protection devices. So, the fuses are combatively a cost effective devices for protection.

You have circuit breakers, so here I have indicated a two breakers at the substation transformer the actual transformer configuration would depend on your individual substation, you would have a breakers feedings individual feeders that radiate out from the substation. So, you would be able to say operate or disconnect or protect on a individual feeder bases, you also have devices such as reclosers, recloser and sectionalizers.

Recloses are essentially you can think it as a breaker, which has the ability to actually close again after opening. The reason why people would like to use recloses is that most faults are actually temporary and so once the fault is cleared you can actually rearranges the line.

So, people considering using recloser rather than some line maintenance person later on coming manually turning on the line, the recloser can actually able can actually clear a temporary fault if the fault is continuing eventually the recloser will lock out. Sectionalizers are devices that are meant to operate with reclosers and we will see later on in the course how sectionalizers and reclosers can be used together for the protection of the feeder.

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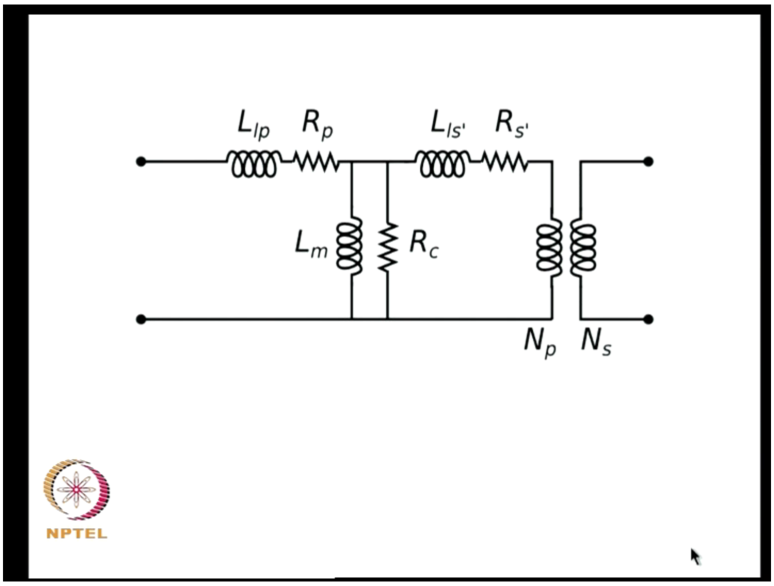

If you look at a what exactly constitutes a fault, a fault could be essentially something that is not working. So, what would you think of as a fault, say it could be a say a short circuit somewhere, it could be a different scenarios.

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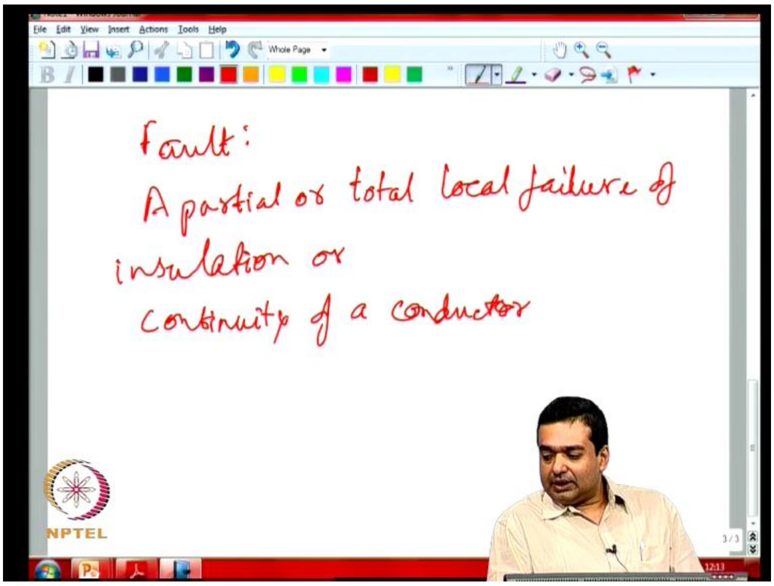

A general way of describing of fault is a partial or total local failure of insulation or continuity. So, essentially you could think about electrical systems as essentially consisting of parts, which conduct electricity or parts which would prevent the conduction of electricity, so those are a insulating components. So, component which is supposed to insulate, if it face to insulate you could have essentially failure in the electrical system or if a component which is expected to conduct electricity fails to conduct you would have a essentially a fault in the system.

So, this is fairly broad definition and if you look at a say for example, a O voltage, the volt voltage can happen variety of reasons a O voltage can actually lead to insulation failure. So, that even an o voltage can actually lead to a faults, so you want to prevent the o voltages in systems. So, a definition like this is fairly broad rather than just looking at short circuits as the only possible fault for example, if you look at a O voltage that are commonly would we would think of that comes to a mind would be a lightening striking a line.

But the interesting thing about a lightening striking the line is that say, if it strikes a section of the line, then you end up having O voltage in a small section of the line or the feeder and you would have. So, resistor you would have O voltage protection components, which are situated close by you would have exposed line you would have insulators on the electric poles and they might arc over. So, often the O voltage caused by lightening is then followed by arcing or a essentially short circuit.

And once you have a short circuit, then essentially what people would see is actually the voltage collapsing rather than O voltage. So, immediate in the immediate neighborhood of the lightening you might have seen O voltage, but further away in this system what you would see is actually under voltage, because you now have a lines that arcing over and then a abstain breaker would open. So, may be on a section of the feeder you would see o voltage, but on the adjacent feeders and in the further may be on the feeder what would you actually see is a under voltage.

So, you will have to look at a combination of a what can happen when you look at a fault even on a typical distribution feeder, if you look at a the nature of what happens when you have a fault say you have arcing of insulators, etcetera. Ceramic insulators on a line, if a arching is starts on a line essentially to stop the arching you have to actually disconnect your d energize the line by opening a abstract breaker. So, you can think of it as a stopping fuel supply to that particular fault point.

Once the arc is cleared then the insulator can recover and actually go back to the normal mode, which is one of the reason why any of the faults actually temporary faults. So, you have a system where you are feeding energy, you have a fault then you stop providing energy to that particular point, then the fault clears the way and the system recovers then you can actually reenergizes the line. Or also you can have situations where may be scrawls coming on the line or a tree branch is touching the line, if the branch say for example, burnt out then it would stop causing a fault.

So, the many reasons where why you can have say temporary faults, if you look at continuity of a conductor, what could be the situations where you would have discontinuity of conductors. We just had the monsoon season you have heavy rains say a tree falls on the line it will snap the line, you can have say a vehicle going and hitting a pole, you can have heavy wind or in northern regions, you would have ice depositing on lines increasing the weight causing lines to snap.

So, for a variety of reasons you would also have discontinuity of loss of continuity of conductor, which can actually be considered a fault and anything which prevents normal operation is something which is un decidable. And you would like to actually have a system where you are actually doing is what intended which is delivering power to the loads.

So, if you look at a the models of the component that go into a system you want to actually calculate what is a response of a typical system of faults. So, you want to actually model the system which means that you are looking at how to model the components that we just discussed, which are transformers your line, you might have protective devices. So, how should we actually model these components.

So, the most common model that you would be or you would have already studied in your under graduate classes is the T model of the transformer. You could have variations on this depending on the type of transformer could be y delta, zigzag type of windings you can have a different types of grounding of the transformer. So, there might be variations on that particular transformer and but the basic model essentially consists of a t section where you would have a leakage inductance from the primary.

You would have the primary winding resistance you would have leakages of the secondary you could reflect back that back to the primary side, you would have magnetizing inductance, you might have core loss resistance terms and the question is what could be a typical value that you could take for such a transformer. So, if you look at a the power rating of a transformer say for an as an example may be if you are looking at transformer at sample power rating of a say four M V A.

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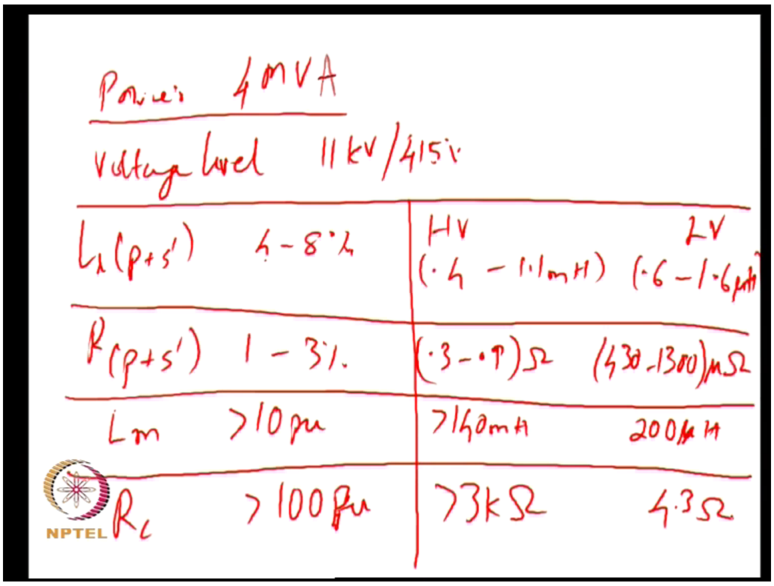

And say your turns ratio would correspond to your actual voltage, so we are talking about 11 k v slash say 415 Volt device. So, if you look at your leakage inductance L l from your primary plus reflected secondary, you might be talking in terms of a say 4 to 8 percent. If you look at in terms of what this particular value is on your high voltage side you are talking about say 0.4 to 1.1 Milli Henry on your high voltage side on your low voltage you are talking about say 0.6 to 1.6 micro Henry of a inductance.

If you look at a the resistance of a winding a primary plus reflected secondary you are talking about one to may be 3 percent depending on how much copper is used in the winding. So, you are talking about say 0.3 to 0.9 Ohms on your high voltage side where as you are talking about somewhere like 430 to 1300 micro ohms on the low voltage side. If you look at something like your magnetizing inductance, you are talking something much greater than 10 per unit.

And so here you are talking greater than 140 milli Henry on the high voltage side or you are talking about 200 micro Henries on the low voltage side. You are looking at the core loss term, you are talking or something which is greater than 100 per unit. So, you are talking of something greater than 3 kilo ohms on your high voltage side or 4.3 Ohms on the low voltage side. So, you can see that if you take a typical parameters of such a transformer.

If you look at the physical values of inductance, resistance etcetera, you do not know when someone says I have something which is a 1 Milli Henry, you might think it is a high inductance whereas a 2 micro henries you might think it is a small, but if you say it is 8 percent it is the same with respect whether you are talking about high voltage or low voltage.

So, it needs a lot more sense talk in percentages or per unit compared to the actual physical unit, because then you would have to look at with the actual physical unit, what the power rating is what the voltage level is etcetera. Whereas talking in terms of percentages or on a per unit bases gives you a more intuitive feel of what typically to expect when you are dealing with a component. Similarly if you look at the winding resistance, if someone says that the winding resistance is 0.9 ohms or 430 micro Ohms, you might think that 430 micro Ohms is really small, but it depends on the voltage level.

So, if you say that the resistance is 1 percent then you might say, that might be a reasonable value if someone says resistance is 10 percent you would immediately realize that maybe it is not reasonable it is too large for the winding. So, again the value in percentage is gives you a better gut feel of what to expect in the system rather than the physical units; you might actually make use of the physical units in your actual design procedure, but to convey it in a more general manner the percentage or per unit is a good way of doing it.

Again if you look at say the magnetizing inductance say for example, if someone says if magnetizing inductance is just a 2 per unit, I would say you can immediately say that, transformer draws a lot of magnetizing reactive wars, because that would correspond to 50 percent of it is rating would be its new led wars. Where as if it is 10 per unit it means that the no load current is 10 percent of your rating which might be reasonable. So, again just looking at a these components for example, if you look at your core loss resistance if it is a 10 per unit it means that immediately the core losses is 10 percent of your.

So, your no lead losses would be ten percent which might be immediately considered as unacceptable if you say it is 100 per unit it means that your core loss resistance is 1 per unit which means that your core loss cell is 1 percent, when you have 100 per unit, which might be more reasonable. So, again parameters defined on a percentage basis can give you a feel for what is a considered acceptable or reasonable.

And what can be expected on a typical system, because often you may not have access to actual data and you want to make estimates of what to expect based on estimated information. So, if you look at the next important element in our particular system it would be say the actual line. So, for the line you would have studied in the power system course there are different models lumped models, distributed parameter models, etcetera the distribution line is a fairly short compared to long transmission lines, etcetera.

So, lumped parameter models are actually a can often be sufficient in your analysis, if you are actually using cables rather than over headlines. Then may be capacity effect also become important or rather than just a modeling R L sections or R L components in your distribution line, your resistance of your conductor depends on formula for resistance, conductor is proportional to length inversely proportional to the area of section.

So, depending on your ampacity of the line you would decide your cross sectional area of the conductor and based on that you can get resistance per unit length of the line it can be a of the range of talking of a 100 milli Ohms to half ohm per kilo meter; again depending on under ampacity of the conductors in a range such as that.

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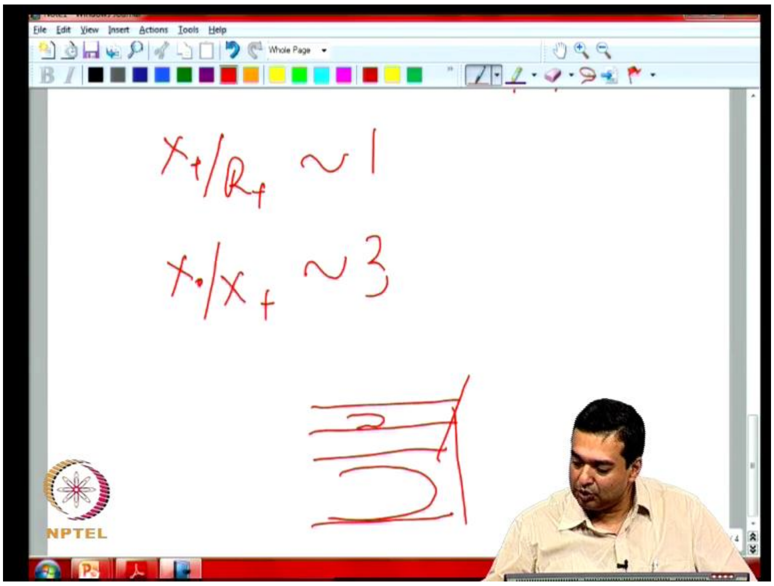

If you look at X by R ratios of a line you are talking about a distribution line, where the impedance the reactance to resistance ratio is of the order of 1, distribution system is typically much more resistive than a transmission system. So, if you look at a X by R ratios of transmission line it might get such numbers 3, but distribution lines tend to be much more resistive; also if you look at the X 0 by X plus this is typically of. So, this is typically around 3 for these lines, if you look at what contributes to the inductance of a of a line its essentially you are looking at how much a flux is leaned by a loop.

So, if you look at the loop for the conductors of a your lines, you are talking about loop areas which are smaller where as if you looking at the conductors sitting on a line and the loop are when you are thinking about the return path through earth, you are looking at a much larger loop, for a situation such as earth faults. So, you would have higher X naught compared to your X plus in a typical system.

So, many of these things you can actually link it to the physical lines to determine what the what are reasonable range of parameters of a typical line. Also you will have to look at the length of the line if you are looking at a typical urban feeders, you are looking at shorter distances, you are talking about may be 2 to 4 kilo meters where as in rural feeders you will have much typically much longer length. So, you are talking about it something of the could be 10 kilo meters or much larger in a really long growing feeders.

So, if you look at the power quality that you would see in a urban system, you would see a lower voltage drops along the line in a urban scenario. Whereas in often in a village you might encounter that there is a the lights are not growing lightly just quite them, it is because the physical lines actually situated physically, so far away and the impedance of that entered line is causing larger voltage drops when people are drawing power.

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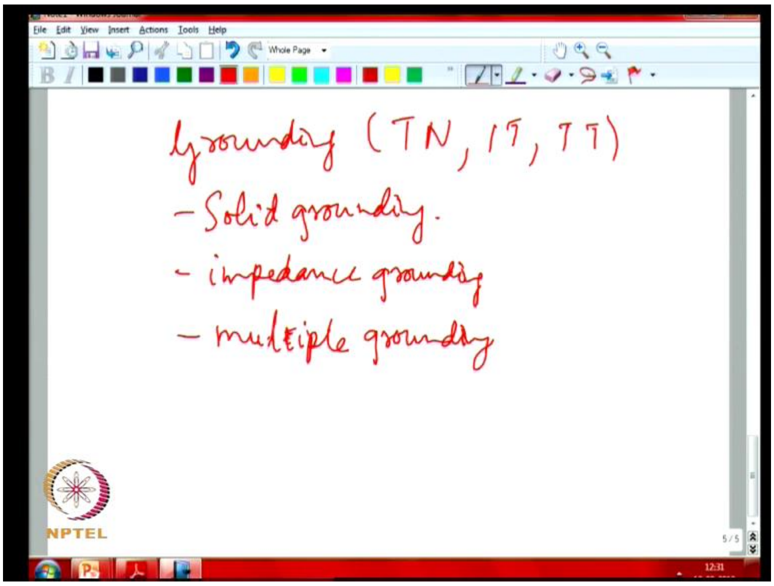

If you look at a typical distribution system there are variety of ways of grounding you can have solid grounding of the transformer. So, people talk about T N network etcetera T stands for Terra, where your neutral is solidly connected to ground, you can have a impedance grounding. People sometimes talk about I T networks where your neutral is connected to terra through a impedance. So, people look at things like you might see terms like T N, I T, T T etcetera, so there are various ways of grounding you can have more multiple grounding.

So, in a systems where may be each distribution transformer pour you have explicit grounding for your feeder and such systems are common in other parts of the world like in North America, Japan, etcetera. So, there are variety of grounding method ways for the transformer and in the course we will actually look at the impact of these different grounding approaches on a the systems.

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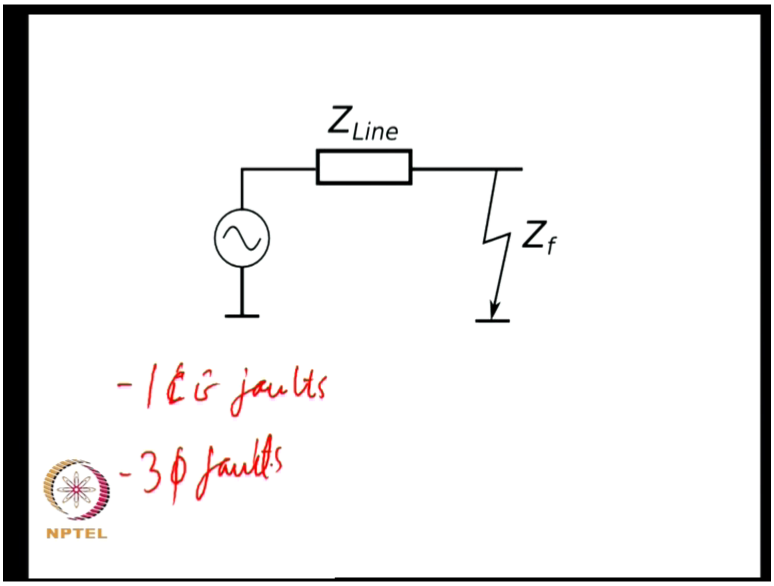

If you look at the model for a typical line this is what we just discussed and if you look at what happens during a fault such as a insulation fault or some sort of short circuit fault you can have different varieties of fault depending on a fault impedance. So, the question is you what numbered you use for typical values of say the fault impedance inner fault scenario.

So, would it you have Z f to be 1 per unit that would not be reasonable, because it means that your current that is drawing actually a just rated current, again you have to look at the section in which you are doing the calculation and normalized to that particular section. But, if you are looking at say over current you would say your device capable of 20 percent over load or may be a 50 percent over load, but it is not often that you might put two twice the rating overload capability.

So, your fault impedance might be 0.5 per unit or can be 0 per unit 0 for solid fault. So, you could typically also look at range of fault impedance is depending on what you would consider the fault current level in that particular system. So, if you look at the type of faults that are occurring in typical systems, you would have similar single line to ground faults. So in fact, 80 percent of all faults people have collected statistics and they are actually single line to ground type of faults, if you look at.

So, the single line to ground is most common variety, if you look at your solid 3 phase faults they are much more rare I mean it is typically around 5 percent of faults might be a

3 phase faults, but the main benefit of 3 phase faults in your calculations is that your calculations are simple and it is something that you could readily calculate. And then based on what would be the ratio for the different varieties of fault type single line to ground line to line etcetera.

You could look at what variations can happen around the solid 3 phase fault, if you in the next class what will look at is will also look at the DG models and based on that we could then go forward. And actually look at some more issues before we start looking at what the fault current levels are in the system and how to actually do coordination and the objective of looking at coordination. In this class is from the perspective of not to actually implement coordination, which can coordination can be taught in entire course are perspective is to look at how coordination gets effected when you add a distributed generation system into your network.

Thank you.