Introduction to Smart Grid
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Lecture - 16
Islanding Detection Techniques- I

Good morning to all of you. In this lecture we will discuss about the Islanding Detection of Microgrid System. And, we will just cover the passive Islanding Detection Technique. First we will see what is a micro grid?

So, we will see when we just connect different types of renewable sources, like solar, wind, or even also battery storage system to a distribution network that particular area is called as microgrid. It is a self-sustained system, where the generators loads are present and also sometimes this micro grid operates, either in grid connected mode or in islanded mode of operation.

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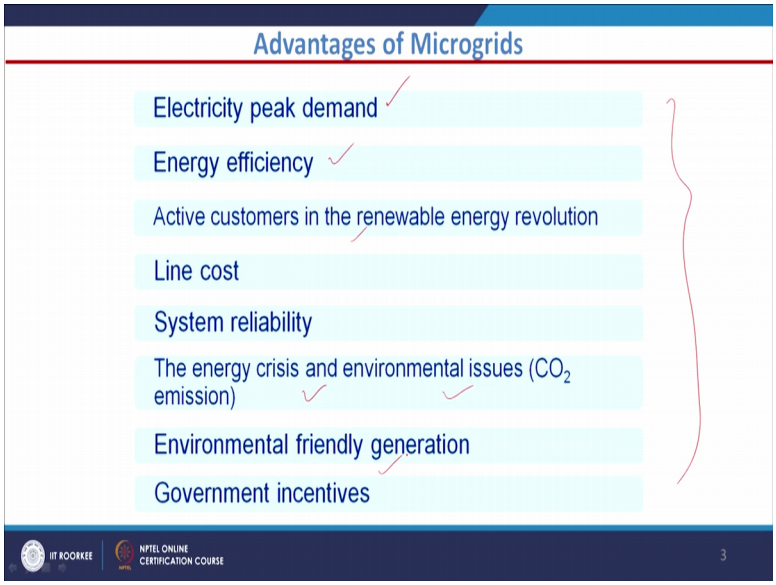

What are the advantages of a micro grid basically it has Electricity peak demand, energy efficiency active customers in the renewable energy revolution, line cost, system reliability and so on. If, you see all this advantages which are concerned with the microgrid system and that is why we are interested for smart grid environment. And in fact, we have integrated solar wind fail sell successfully to our distribution network, even

to some extent in the transmission system also or transmission network. And, also we are planning to have 100 percent whenever integration in our network.

Now, that is the reason I mean these are the points why we are interested for renewals or smart grid system. This is very important that the energy crisis and environmental issues like carbon dioxide emission. As our production our energy consumption comes from the coal based induction system and mostly 60 percent. So obviously, carbon dioxide emission is one concerned. So, reduce that particular carbon dioxide emission process, we have to generate more power from renewable sources like solar wind system.

And, also this is sources are environmental friendly because as we do not have this carbon dioxide emission process. So, it keeps the environment neat and clean and of course, for propagating this encouraging people to have access or to have generation from these renewable sources. The government is also providing incentives and lot of schemes are also going on like in RND activities or on government level different types of for schemes are coming to basically encourage people to have these renewable sources at their premises, if we will see this particular PPT here.

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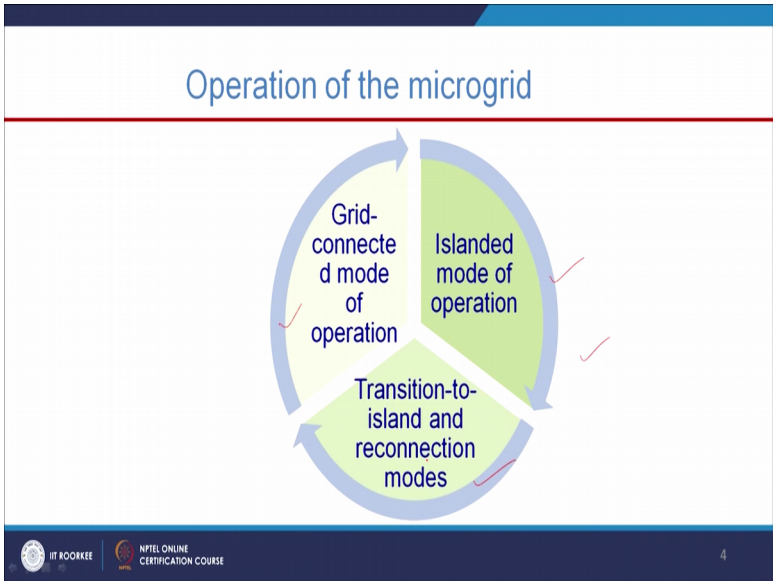

The operation of the grid may be in grid connected mode of operation, where the micro grid is connected to the grid system or main supply or main substation we can also call it and also it has this islanded mode of operation.

The micro grid can also operate in islanded mode. Islanded mode means when the main grid is disconnected due to certain fault at the main grid side then the microgrid system will operate in a islanded mode. Also, we have transition to island and reconnection modes. Transition to island and reconnection modes if it is islanded I mean if the micro grid is islanded from the main grid. Again this island can be connected to the main grid system, that is basically known as a restoration process of the smart grid system or micro grid system.

So, let us why based on this different mode of operation of microgrid or smart grid system basely; obviously, we are interested for islanding detection mode of operation. When this particular micro grid system is islanded and we have to basically detect the status of this main grid. Otherwise the system will be in trouble or different types of difficulties we will arise.

So, we will see what is this islanding system and what are the consequence consequences of this particular islanding system, we will discuss in detail. First of all we will define this islanding word, what in by this islanding occurring to I triple E standard.

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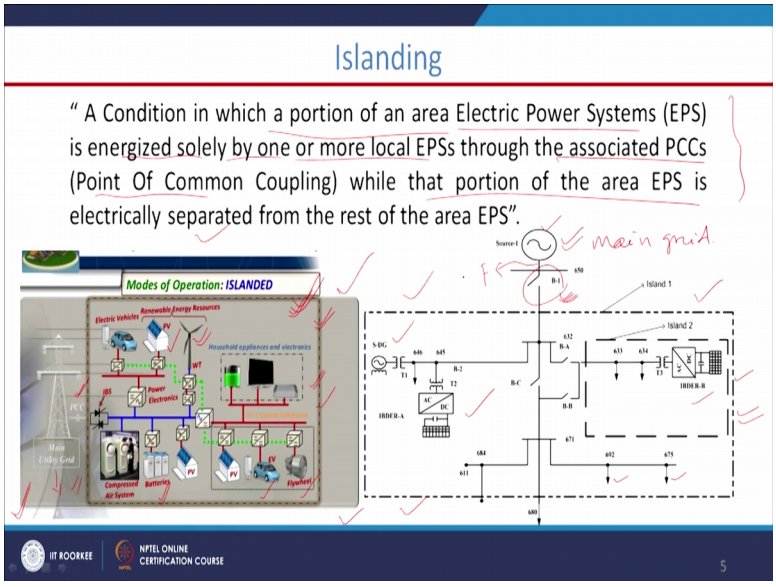

"A condition in which a person of an area electric power system that is EPS is energized solely by one or more local EPS, through the associated PCCs that is point of common coupling while that portion of the area EPS is electrically separated from the rest of the

are EPS" This particular statement you will understand from this particular 2 figures, this 2 figures will make us understand that what is this islanding.

Basically in simple word if you see this left side figure this is our grid this is our main grid and this particular system is our micro grid. And, this main grid and micro grid are connected together through this PCC that is the point of common coupling. And, if I could see here this microgrid system we have wind we have PV that is photovoltaic or solar system, and also we have batteries for the storage purpose. And also we have EV electric vehicle, flywheel also for the storage. And of course, we have like household appliances like a consumer loads.

And together basically this particular network is known as microgrid and this microgrid is connected to the main grid so, this point of common coupling. If this point of common coupling due to certain fault at the main grid side if the main grid is basically isolated or disconnected from the main I mean the micro grid using some circuit breaker system. Obviously, at that time this microgrid is going to be islanded from the main grid; that means the micro grid is not any more connected or not anymore getting power from the main substation or main supply.

That is for the meaning of this islanding some portion of this micro grid system is the islanded from the main grid on main grid is not supplying power to the micro grid that is known as islanding of the system. And, even if the second figure also says the same thing that we have here source one means this is the main grid the source one is our the main grid. And, this main grid is connected to the micro grid with help of B 1 B 1 is the circuit breaker we are naming this main grid side the breaker as B 1 B 1 is the main grid side circuit breaker.

This source one or the main grid is connected to the dotted line this dotted line source our micro grid system, where we have this solar and also we have synchronous based DG and also we have like here one solar, but yes of course, we can add the wind system also and loads. Now to give there this solar wind battery or synchronous based DG's loads. Constitute the micro grid system and this total micro grid system is connected to the main grid with help of this circuit breaker B 1. Let us say due to some fault if this at the grid side, if any fault is incepted.

Now, if the circuit breaker B one is basically is going to be opened, otherwise this fault current will penetrate to the micro grid system and it will damage the other equipment, which are present inside the micro grid. So, that is where we have to disconnect the faulty section basically the main grid system from the micro grid. And, this operation is known as islanded mode of operation of the microgrid system and this condition a situation is known as islanding.

We have different types of islanding depending on the system structure or you can tell it connection or you can say the planning of the system also decides different types of islanding, in with what manner this system is present.

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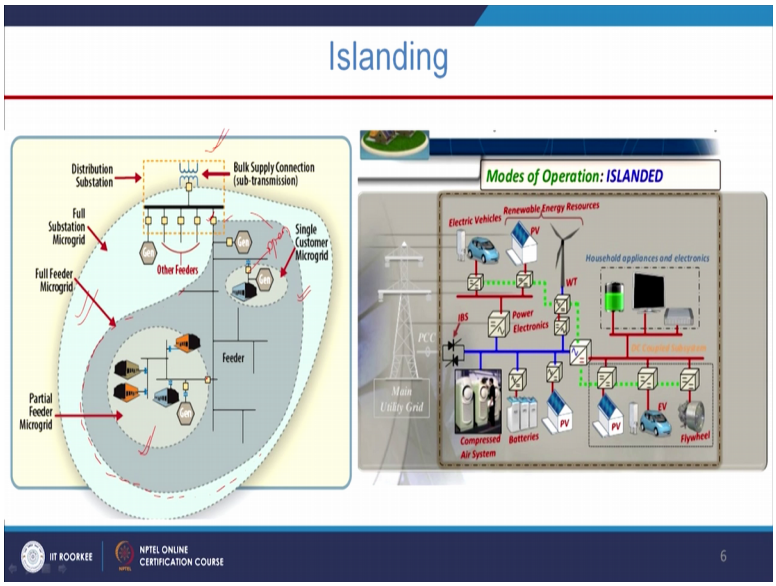

If, you could see here we this is known as the partial feeder micro grid because all the feeders are not present here. And, if you could see here we have like full feeder micro grid. Here all the feeders if you could see the inside box this one, this one is basically the full feeder micro grid system. Let us say due to certain reason this particular breaker is open so; that means, the total full feeder micro grid is now islanded from the main grid. Now this is our main grid these are the bulk supply generation or subtraction we can say.

And, we have also single customer micro grid, single customer micro grid means we have a single customer and near to the customer end we have DERs like distributed energy resources, which are supplying the power to the customer. Now, if these particular breakers if you could see here if this particular breaker is open, now the single customer

micro grid system is going to be isolated from the main grid. And, similarly if this particular breaker if you could see here, if this breaker is open, now the partial feeder micro grid system is going to be isolated from the main grid.

Depending on the structure or planning or layout of the distribution system or distributed energy resources network, then different types of islanding is going to be appeared. Now, what are the consequences? Why you are so, much interested to have this knowledge about this islanding status or I can say in other word we have to basically detect. So, islanding mode of operation of the microgrid system why it is so much necessary? Why it is necessary or we can say what are the consequences if you are not going to detect this islanded mode of operation.

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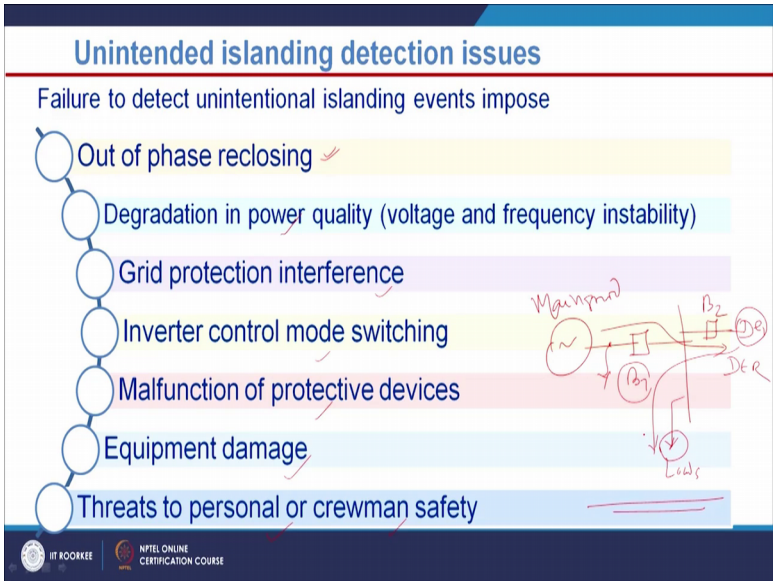

The first one is it will cause out of phase reclosing, we have the main grid and this main grid has certain voltage and frequency. And similarly we have the micro grid system where we have synchronous based DGS, and we have solar based D G S and also we have wind base D G S and that particular micro grid system has certain frequency.

And, when these 2 frequencies matches and match then only we can synchronize and the system will be stable. If the 2 frequencies basically do not match then the system will be in unstable mode, and that is what during the islanded mode of operation the frequency of islanding system may be different than the frequency of a grid system. Because in islanded mode of operation it is not necessary that the loads which are present inside the

micro grid is exactly matches with the our generation which is present inside the micro grid.

In other word I can say that the number of loads or load, which is present inside the micro grid should match perfectly with the generation, then only the frequency will be remain stable the frequency will be stable. Otherwise the frequency will vary. If the load does not match with the generation, then frequency will varying basically the active power I am talking about the active and reactive power part. So, that is why this due to the frequency mismatch this out of face the closing issue comes to picture. Second one is the degradation power quality as already we discussed that the frequency and voltage change with this islanded and mode of operation.

And that is what the basically the power quality issue the frequency does not remain at the nominal value and the voltage does not lie within this limit so; obviously, we will call it is a power quality thread due to this islanding mode of operation of the microgrid. And, also we have grid protection interfaces like different types of relays recruiters fuses we use. So, those protection equipments may all operated during this islanded mode of operation. Then, we have the inverter control mode switching because inside this micro grid we have solar wind system. So, those equipments like energy resources we use the inverters.

So, this inverters have some control strategy and if decides system is islanded if the micro grid is islanded from the main grid. So, the; that means, say the PCC voltage frequency are going to be changed and it is to mention that the control strategy which is running inside the inverter of the different types of a renewable sources, the inverters the control strategy takes the voltage and frequency feedback from the point of common coupling. In that case if the frequency and voltage of the PCC change service to the input to the control of the inverter is are going to be changed. So, that is why this inverter control mode switching may happen I mean this controller may go to some other mode of operation.

Then, we have it is yes we have discussed this small function of protective devices and equipment damage and if suppose we shall not going to shut down some DGS. Then of course, we will have some issues like if it is basically a synchronous based DG and the

router we will explain certain kind of damage issues, threads to personal and to man safety yes this is also important point.

Because, if suppose some loads which are connected at the grid side and the people who are working the grid side and this our micro grid system is disconnected from the main grid, but the notice is not given to those crew person that already the power is not coming from the this micro grid system, but; however, they are getting power from the main grid. The system is like this is our main grid this is our circuit breaker this is the point of common coupling and this is also circuit breaker for the DG. We can name it DG this we have to generation or we can name it also DER digital energy resource.

Now, this is our main grid this is our main grid. So, it because B 1 and this is B 2 due to certain fault if this circuit breaker B 1 is out of service, it is basically opened basically not out of service it is basically opened to just clear this particular fault. So, that, the fault current should not penetrate to the rest of the micro grid system.

And, what will happen? Let us say if you loads are here and those loads are basically the utility side loads or main grid side loads. And, this is loads we will get supply with help of the DG, which is present inside my micro grid system it is a very schematic very simple diagram I have shown here to say that how this threats to the personal or crewman occurs due to this say particular islanding of the micro grid system? And, if this information is not present to this crew person then; obviously, they will get some suck.

Now, these are some of the consequences or difficulties, which are associated with islanding detection issues if you are not going to detect this islanding mode of operation of the micro grid. So, these problems are going to occur. And, above all we are thinking for the smart grid system. In this particular slide we will discuss again that why this islanding detection is very very essential, that we have this smart grid environment, where we are looking for central controller or local controller.

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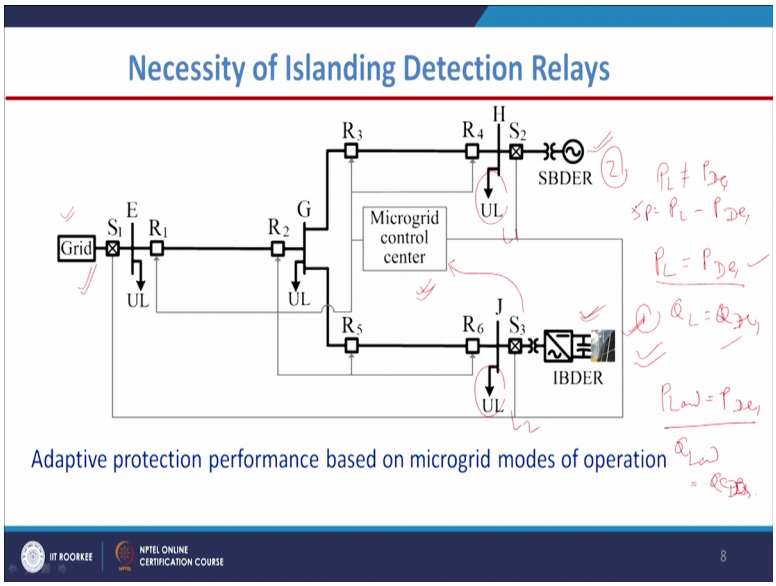

And, this central controller will gather all the information from all the circuit breakers all the renewable energy sources or loads from every corner of this micro grid or smart grid system the central controller will collect all the data. Now, if at any time suppose there is some fault there is some difficulty some disturbances than this particular central controller we will take care. Then, it will just initiate some trip signal or initiate some control action signal and it will just actuate corresponding devices, which are present inside the micro grid or smart grid system.

Now, the point here is if let us say one of my renewable energy source sources is basically, if one of my renewable energy sources is disconnected from the main grid or from the micro grid system. And, that particular status the status of this particular circuit breaker should be sent to the main control station.

Where the controller will take some decision? And more clearly I will just come to there are correct point like straight forward point that that is during the protection coordination of the directional over current relays. We have to basically know, whether the system is islanded mode of operation or the system is in grid connected mode of operation. So, in that case what will happen if you do not know; what is the mode of operation of the system?

Then; obviously, we cannot adopt our technique we cannot adopt our we cannot change our technology I mean the protection philosophy. So, change the philosophy sorry

protection philosophy we have to of course, we have to know the mode of operation of the micro grid, whether it is connected to the grid or whether it is not connected to the grid, whether it is connected to the one feeder or the switch circuit breaker is disconnected. So, all the information we need.

So, in that case this islanding detection is must the islanded detection algorithm or technique, basically we will detect and it will just send the message to the central controller that this particular area or this particular micro grid is disconnected from the main grid. Or we can say these are the (Refer Time: 19:34) and the resources, which are disconnected from the circuit. So, those information are very very essential at the central controller section, where we are going to take the final decision. Now, for this islanding detection one factor one point the power mismatch is very very important.

If, you could see here that let us say this is basically the grid the main grid and this is one renewable energy source this is second, the first and this is the second renewable energy source and these are my loads load 1 and this is load 2. Due to certain reason this grid is now disconnected.

So, rest of the micro grid system is now islanded, it does not mean that during the islanding mode of operation this P load is equal to P D Z not necessary. So, that particular condition is much power mismatch condition whether my this Q L is equal to Q D Z or my P L P load is equal to P D Z is it possible it may not be possible. And, also sometimes it is also possible it may also happens it happened that it happens that this load P load is equal to P D Z also perfectly power mismatch condition this is known as perfectly power mismatch condition. And also sometimes it may happen that this Q L Q load is equal to Q D Z.

So, it depends on the operating mode of operation of the micro grid, system how many loads are switched on how many loads are switched off, how many this D G S are work in condition, how many D G S are off so, it depends on the system operating condition? So, based on that we can say whether this P L is equal to P D Z or Q L is equal to Q Q D Z or not if suppose this P L is not equal to P D Z.

Then what will happen this P L minus P D Z, that is our delta P the active power mismatch.

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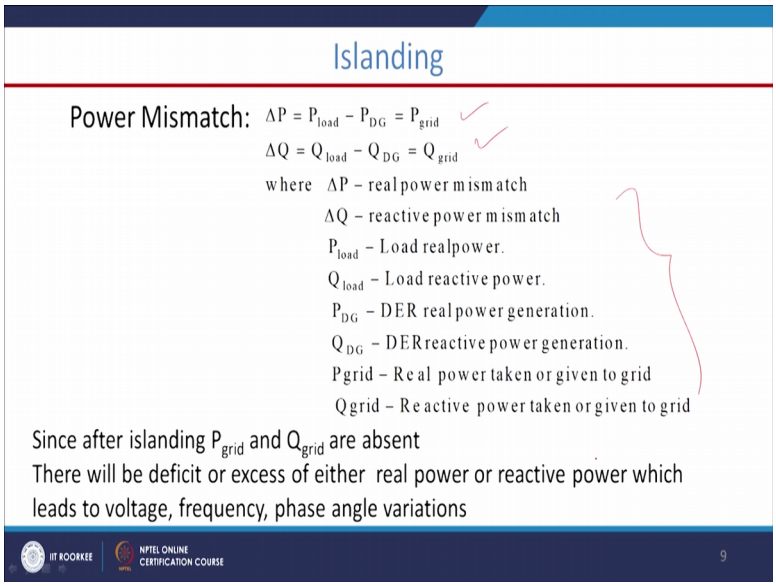

And, just I have shown here you could see here that del P is equal to P l minus P D Z that is P grid. And, this del Q is equal to P load minus Q D Z the difference between the load reactive power and the DG reactive power.

So, these are the terminology I just written here what are the words the definitions. Now, the question comes the why this power mismatch is also important as far as the islanding detection is concerned, we will discuss in this particular figure.

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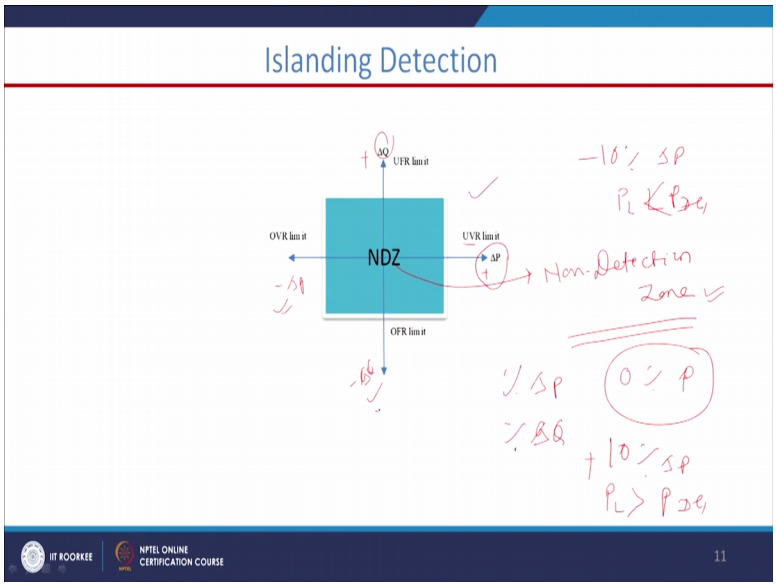

Let us say this is basically known as NDZ. NDZ means Non-Detection detection zone. This NDZ is defined that whether from what particular percentage of power mismatch, the islanding relay does not detect the islanding condition, very simple sentence, very simple definition. This NDZ is defined as the percentage of power mismatch for which the particular islanding relay it is not detect or it is not able to detect the islanding condition. So, that particular situation is known as NDZ non detection zone. What is this percentage of power mismatch? The L P percentage we have also del P, del Q percentage. The active power mismatch percentage and the ZT power percentage mismatch percentage, sometimes we start with call it 0 percent power mismatch.

What is the meaning of that? At that condition the load P load is equal to P D Z; that means, there is no difference between the load and the generation. So, that is known as 0 percent power mismatch active power mismatch or 0 percent reactive power mismatch. If it is 10 percent let us say plus 10 percent del P. So, what is the meaning of this, if it is plus and also minus. So, bother the cases it has certain meaning.

If it is plus 10 percent; that means, or P L is greater than P D Z c this is very very important, when you design basically we develop some detection algorithm to detect the islanding mode of operation of the micro grid. If, suppose this is minus if it is minus 10 percent P del P then what is the condition, it is like this P L is less than less than this P D Z right.

So, these are very important points we have to basically we will follow in the next class what are the impacts of this particular power mismatch conditions on the algorithms, the islanding detection algorithms. Coming to this particular NDZ picture along the X axis we have delta P plus delta P along this negative axis we have this minus delta P and here we have plus Q here we have minus delta Q.

Now, if suppose this delta P is higher; that means, I mean it is load power is more than the DG power so; that means, let it is a system is loaded the voltage is going to be reduced. So, we are here our under voltage relay this UVR means the under voltage relay is going to experience some trip signal. Now similarly for this case if you have this del Q you are load is more Q load is more than this frequency relay under voltage under frequency relay is going to be activated.

And, similarly for the other two conditions.

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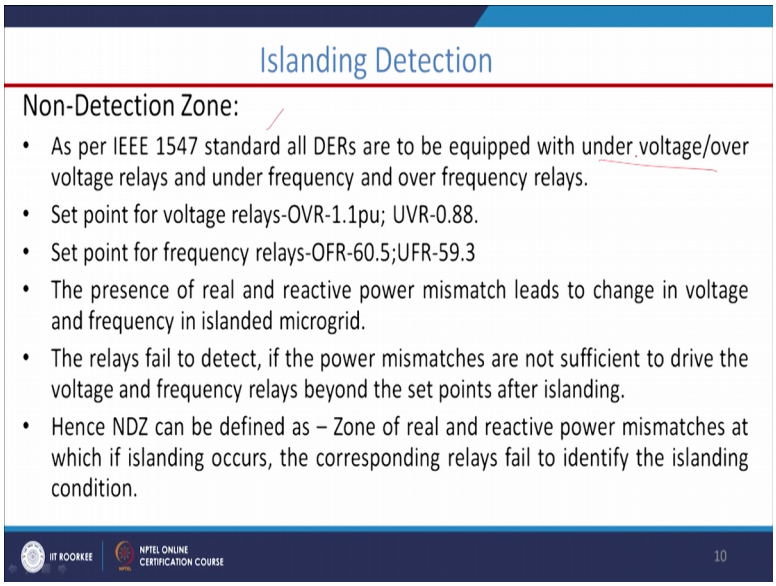

Now, according to this I triple E standard I triple E 1 5 4 7 standard basically during the islanding we have certain standards we have to follow it. What are the standards? What is the status of the frequency? What is status of the voltage? What is the time require to have take some decision? And, it remember, we are talking about this islanding this is basically on intentional islanding condition. You know the islanding is basically 2 types on intentional islanding and intentional islanding. So, we are talking about the on intentional islanding situation. So, where this if any islanding situation occurs so, we have to basically trip the D G S, the distributed generations or the distributed energy resources.

And, in case of intentional islanding, intentional if we are creating some islanding mode of operation of the micro grid, intentionally we are doing it. It is not require to basically trip now D G S. You know why this intentional islanding is coming to picture due to the huge power demand I mean at the customer side.

Now, we are not ready to trip the D G S anymore. So, that is the encouragement that is the issue basically, which is coming of we have to follow certainly this intentional islanding mode of operation of the micro grid system that is what? Now, we are just discussing the on intentional islanding this is particular course where discussing about the on intentional islanding situation. And, here I will discuss what are the I triple E standard like 1 5 4 7 standard. So, all the DERs are equipped with under voltage over

voltage and under frequency over frequency relays that is must. Because, when this DERs at disconnected from the main grid the voltage and frequency are going to be changed.

So, to basically detect whether, this frequency and voltage are within the limits or not. So, in that case the relays are the based equipment. So, the relays we will decide whether the DERs are connected or disconnected. So, all the decisions we can take from those relay points. Now, this is for the voltage relays or said point is within 1.1 per unit to 0.88 per unit low. We have lower limit this is the lower limit this is the upper limit.

Similarly, for the frequency relays we have like for sixty hertz system 60.5 and 59.3, similarly we have also 50 hertz system. And of course, we have different other standards another point I just want to mention here, this islanding detection should be within 1 to 2 seconds. So, we should not exceed more than this that is also one other point.

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I have tabulated all points what is the trip time required? Like, if you could see here this is if the voltage is below the 60, then it will the trip time is 6 cycle and this V is within 60 volt to 106 kilo volt the trip cycle is time is this much.

So, there are lot of standards are available in I triple E template. So, you can see it I triple E 1 5 this one 1 5 4 7, the islanded detection standards are mentioned there.

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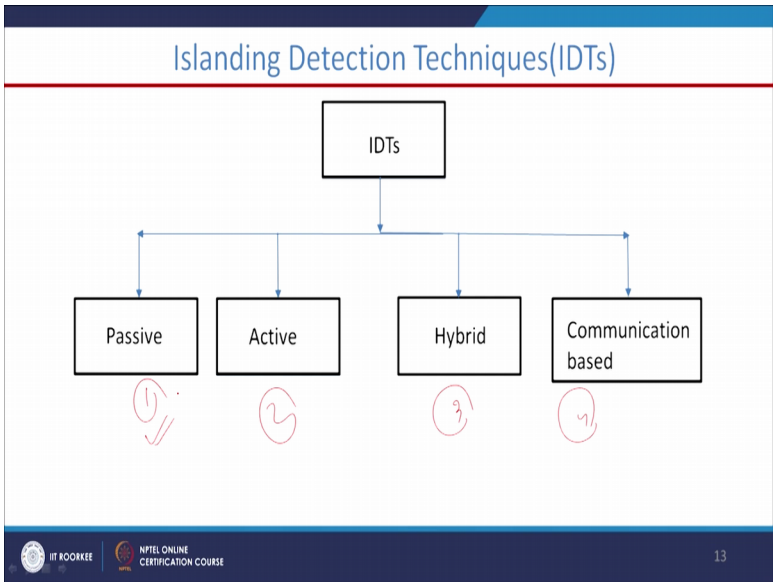

Now, coming types of islanded technique one is the passive, second one is active third one is hybrid and the fourth one is communication based technique.

In this particular class I will discuss little bit about this passive the basics, what are the basic techniques? Which are used for detecting the landing mode of operation using this passive technique, passive mode of operation? Passive means basically we are just estimating the parameters or signals or quantities at the terminal of the disturbance energy resources, and then we are deciding whether this micro grid is disconnected from main grid or not passive techniques.

Now, we have like very shortly just I will discuss that passive detection technique.

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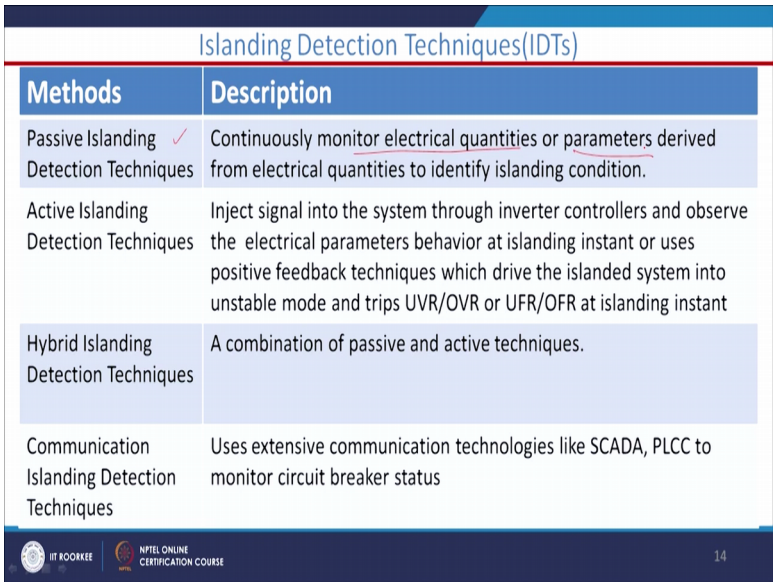

Use continuously basically monitor the electrical quantities are parameters, at the terminal of the DERs just I discussed before one in that. We, mainly measure this voltage or current or frequency power some sometimes. So, those parameters quantities are basically measured at the DG terminal to take further decision.

In case of active islanded detection techniques, we have like inject extra signal from the outside, that is called as the disturbance signal at the terminal of this controller for the inverter to see what is the impact at the PCC voltage or frequency or power even sometimes. And, hybrid means together we are adding this technique and active technique and that is why name is hybrid islanded detection technique. Only one of my class, I will discuss in detail this hybrid and communication based islanded detection technique. And, communication based islanding detection technique basically based on the communication infrastructure like we have ohms and also we have scada system.

So, those communication infrastructures can be utilized for islanding detection purpose. Now, as we discussed that this passive islanding detection that is based on measuring this quantities like voltage, current, and frequency or sometimes also we measure this power and also parameters. Like also we calculate the impedance or reactance or resistance variation at the PCC bus, by calculating I mean basically measuring the voltage and current at the PCC bus.

Now, we have different types of passive islanded detection techniques, we have power quality based islanded detection technique, we have impedance based islanding detection techniques, also we have rate of change of frequency that is called as ROCOF in abbreviation rate of change of frequency.

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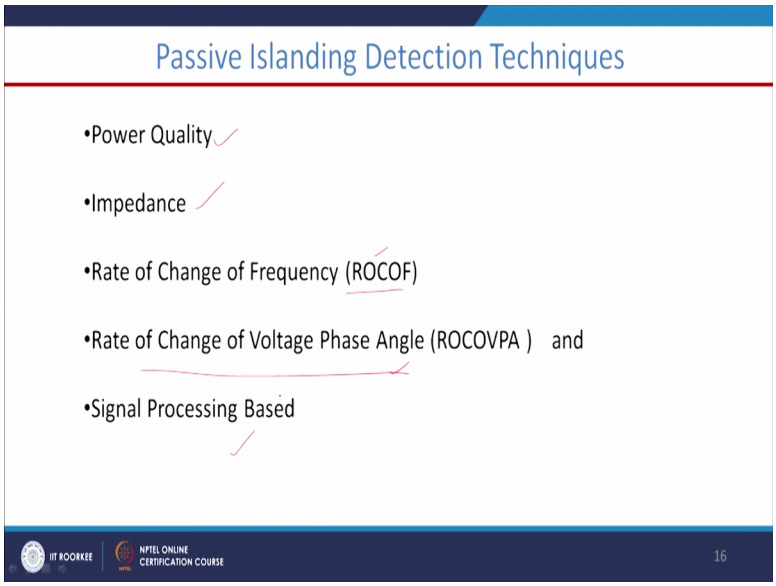

And, also we have rate of change of phase angle based technique. And, some signal processing based technique like artificially intelligence technique or we have wave let us based technique and neural network based technique. So, those techniques are also used for islanding detection. Now, coming to this power quality monitoring based passive islanding detection technique here what we do basically.

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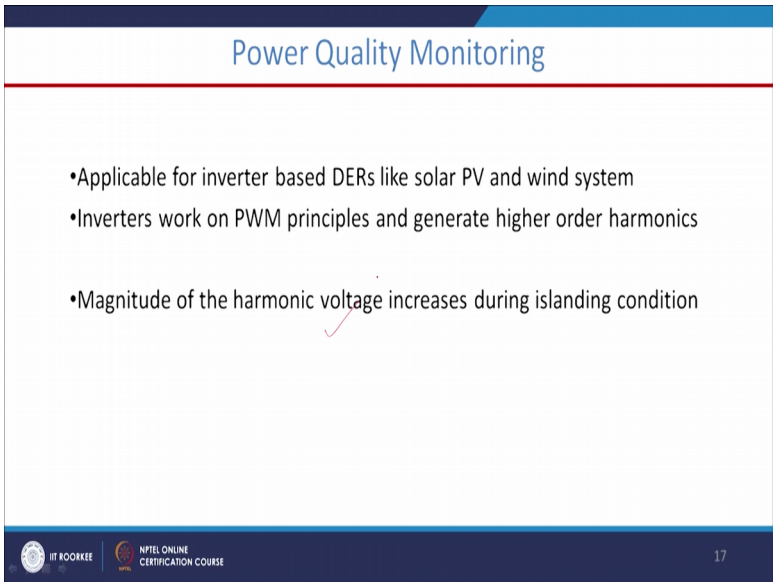

We measure the harmonic the voltage or some ripples, which are present inside the voltage. Based on that basically this is technique is going forward like let us say this particular block.

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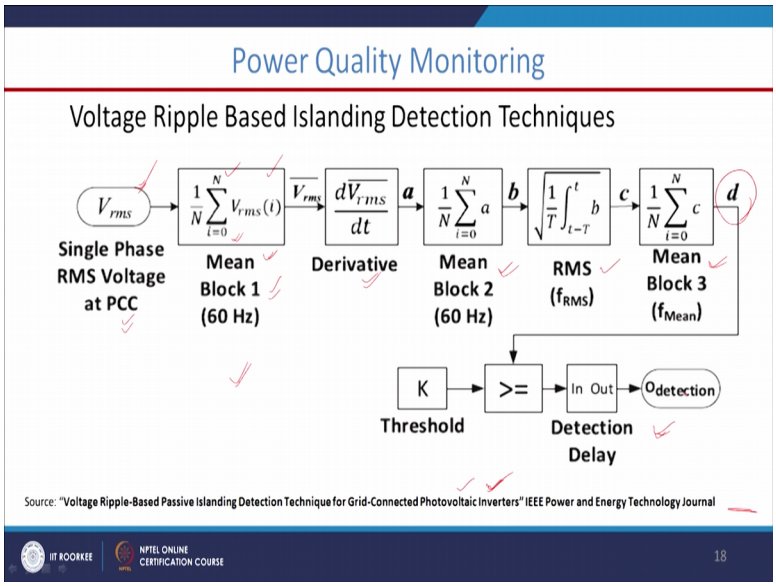

We have measured the single phase RMS voltage at the PCC PCC means the point of common coupling and by measuring this RMS voltage at the PCC. Then, we will take the mean of this particular voltage. This is not work this is this work is basically sighted in this particular paper, due to the space like I have not kept all the data point here, that is

voltage ripple based passive islanding detection technique for grid connected photovoltaic inverters. You can follow this particular paper where all the detail are present now details are present. By, measuring this V rms, we will take the mean of this particular voltage, that is one upon N summation of this V rms from i is equal to 0 to N we will just the average within a cycle.

Has already we have discussed that this N stands for number of samples per cycle, because in discrete domain we basically because we have to basically process within the processor. The processor will understand the discrete domain data 0 1 the status. Now, after taking this one cycle average of this particular V rms, then we will send to another block where we will take the derivative of this particular RMS voltage. And, then the mean and again we will take the integration and finally, again when will take this integration value. If after getting this final d, this d is greater than or equal to our certain threshold then we will declare that yes there is some islanding condition.

Now, some islanding is present. Otherwise, it is no if it is below the threshold then there is no islanding. See, I just want to this is one technique what we need just we discussed based on this power quality monitoring technique, where we are just taking this voltage ripple and we are just taking the mean and average. So, those tasks doing here that in that case what happens this threshold is a concern, because while deciding this threshold.

So, what could be the value? How could decide this threshold? You know so, that is the major concern as was the passive islanding detection is concerned. The every case almost in next we will go for the rate of change of frequency, there also you see this frequency rate of change is the threshold is also one important concern.

Now, this is how this particular technique goes?

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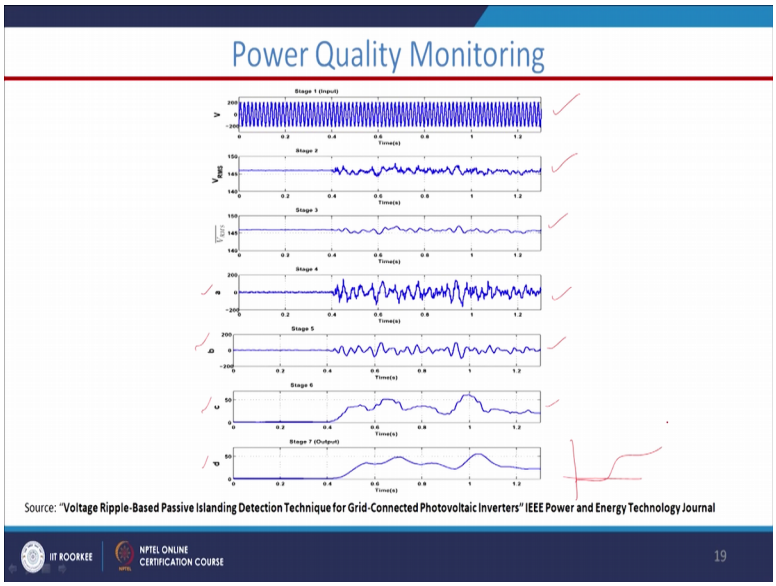

This is the voltage, this is V rms, this is different blocks whatever the parameters I mean the index, basically we can say bcd. And, this is a this is bcd and based on those indices final trip signal is going to be declared, that this is islanding situation.

Now, next one is the impedance monitoring the second one the second passive element the passive based technique that is based on the impedance monitoring.

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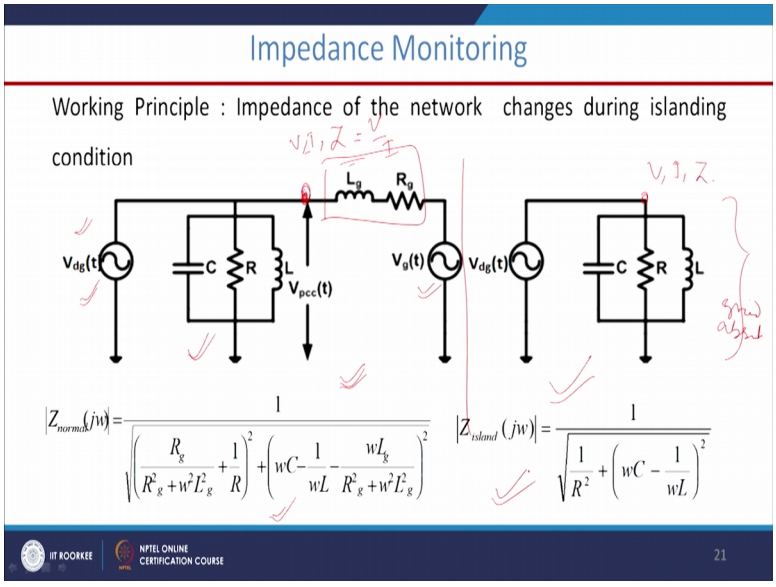

See, if you will see this particular picture that this is our DG system voltage and this is the grid voltage and this is the grid impedance. And this is the common coupling point

and this is the load R L C load. Let us say this particular mode of operation is grid connected mode, because this DG or the renewable energy is connected to the grid through this common coupling point. If, you will measure the at this point V and I and then the corresponding impedance we upon I, this impedance will be different I mean it is written here. And, if you will just isolate this grid in this second figure, if you could see a this second figure here the grid is not present absent grid is grid absent.

So, again we will measure this V and I and the corresponding impedance if will measure it will come like this. That means, due to the change in impedance values and change in the impedance then always we can declare whether this microgrid is in islanded mode or it is in grid connected mode that is where the meaning of this impedance monitoring based technique.

Now, we have rate of change of frequency you know at the point of common coupling.

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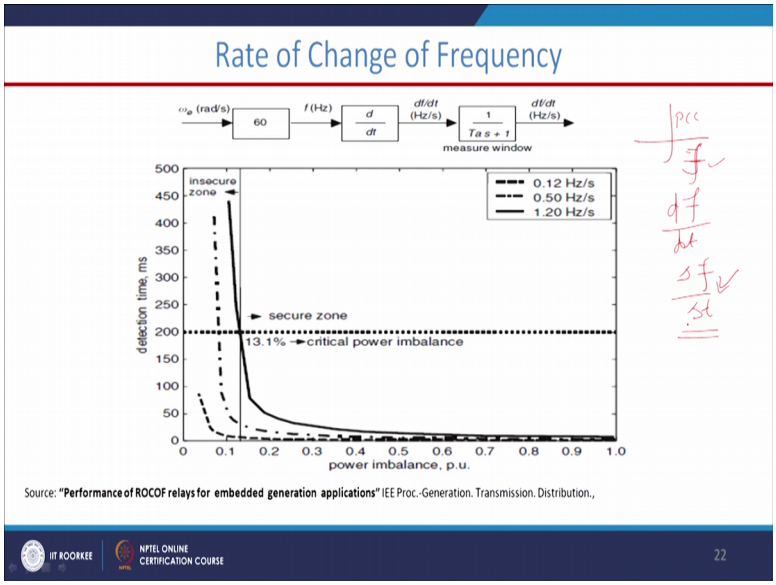

This PCC we can always measure the frequency, in one of my class I have just discussed how to basically estimate the frequency from the phasors or you can take the 0 crossing technique. So, by measuring this frequency and after that we will just take the df by dt or we can write it del f by del t.

This particular index del f by del t is known as rate of change of frequency. Due to this rate of change of frequency also we can say whether this micro grid is connected to the

main grid or it is disconnected from the main grid. Of course, here we have certain disadvantages like in case of rate of change of frequency the threshold I mean is also one concerned.

And, second point for 0 power mismatch situation, this rate of change of frequency does not work. Because, during 0 power mismatch situation if you are P load is equal to P D Z, then there is no variation in the frequency. And, that at that time this rate of change of frequency fails different type of study is like, where varying this inertia constant of the micro grid system like by varying this R X by X by ratio, feeder length different types of parameters are changed tie lines sampling frequency this particular technique basically analyzed.

Now, few figures are just presented here and we are taken from this particular article or these publications. We should always refer to the corresponding paper where the source basically this figures are taken. So, you can follow this particular paper. Due to lack of space we just keeping the title and the general name.

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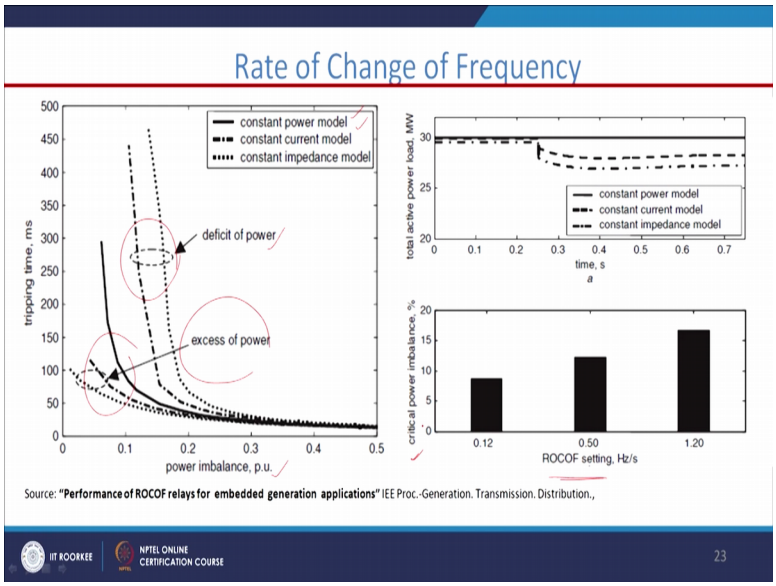

Now, if you will see here this is for different types of loads like constant power model or constant current in model or constant impedance model, there is our rate of change of frequency technique also vary that is also one of the demerit.

And, if you would see here for deficient of power is this is the variation of this tripping time. Where excess power this is a tripping time. And, this is power imbalance in per unit and this is the ROCOF settings hertz per second, and is the critical power imbalance at what percentage of power this particular technique is going to work fine? And, below certain percentage of power mismatch this technique is not going to work. That is not the critical power point.

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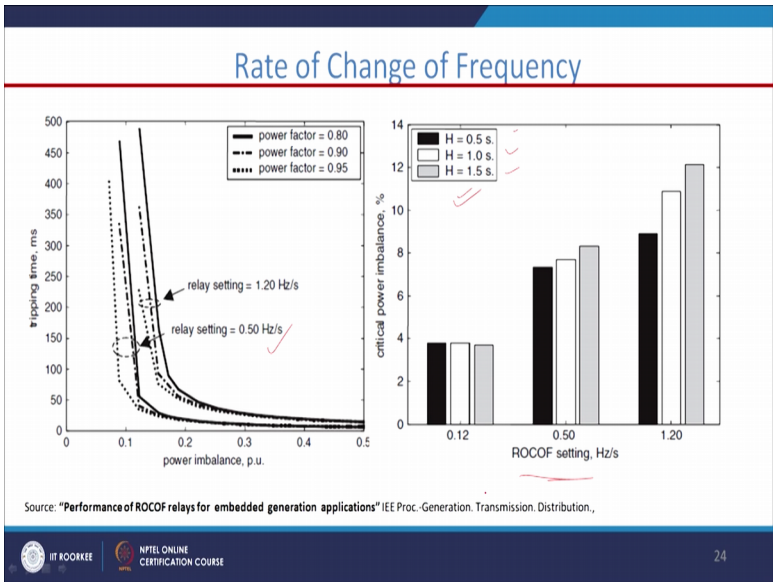

And, these are certain other issues like as I said a stands for the inertia a constant and if you will just varied this inertia constant like, 1.5 1.5 then also this critical power mismatch also percentage vary and the setting of the ROCF relay also should be followed accordingly.

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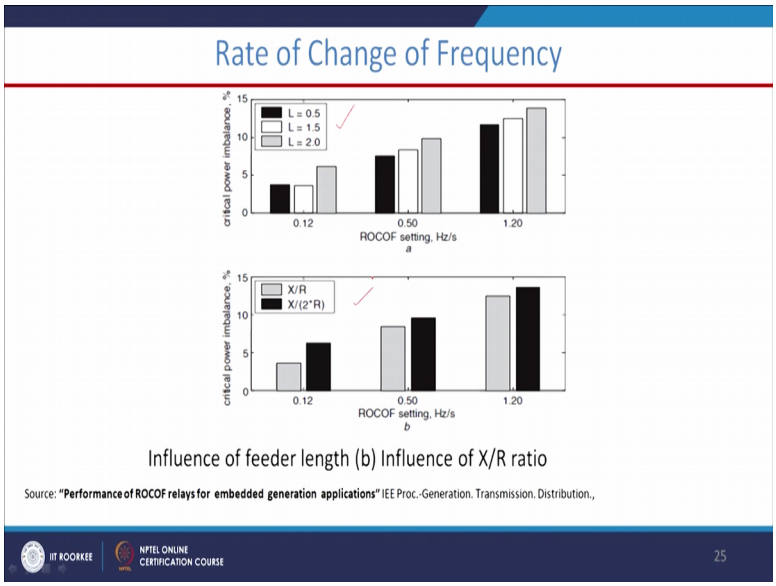

And, this is like l is length of this feeder and the X by R ratio of the line or feeder in the present inside the circuit. So, if it will vary those parameters also this particular technique is also affected.

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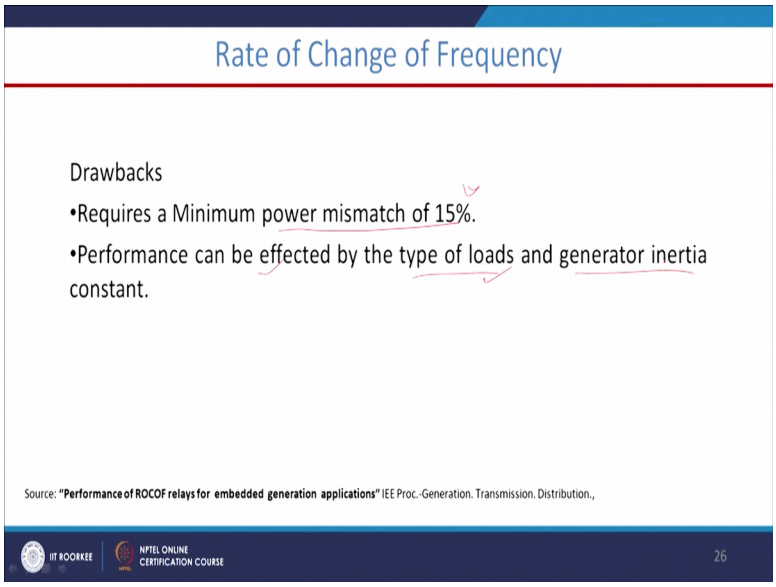

Now, the drawback already I have discussed requires a minimum power mismatch you know this below 15 percent power mismatch this ROCOF rate of change of frequency does not work, that is one disadvantage. Second one this performance can be affected

type of load and generator inertia constant. This particular technique is also affected due to this type of loads and generated inertia construct.

Another, technique is basically the rate of change of phase angle that is ROCPA.

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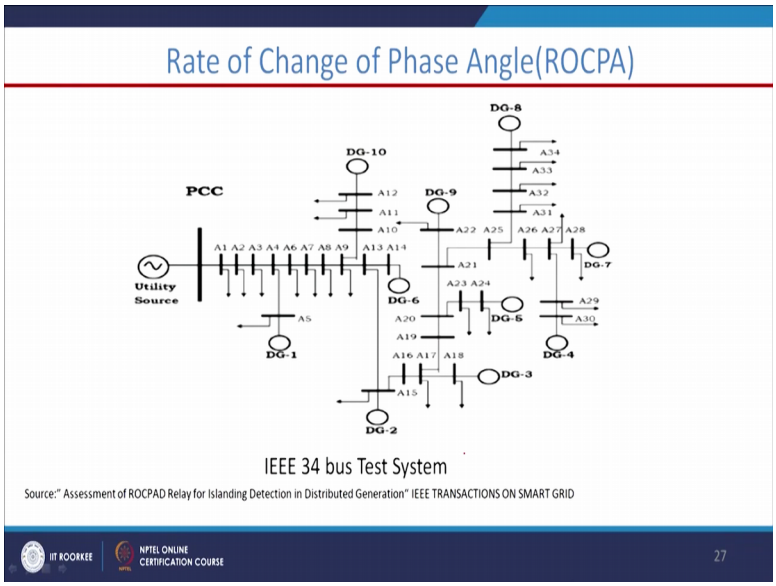

That is what here we do I will just go directly to this flow diagram.

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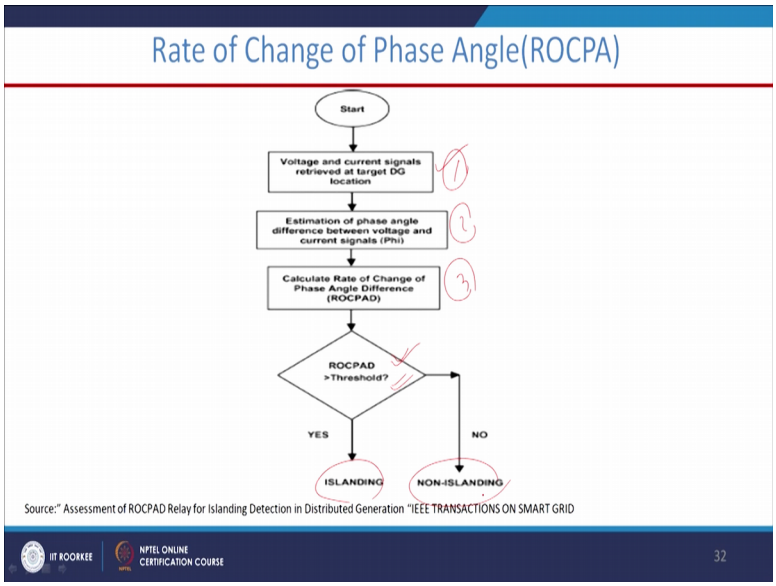

Here, the voltage and current signals are retrieved and the target DG location after getting this voltage current signal, that the phase angle between the voltage and current

signals are calculated. And, then the rates of change of phase angle difference are calculated. First this is step 1, step 2, step 3. If, this rate of change of the phase angle difference is the greater than certain threshold then yes, the islanding is present.

Otherwise, there is no islanding. This is how this particular technique works? These are very easy techniques and these are very easy to be implemented. But however, if these relays power mismatch condition like a 0 power mismatch condition or there is change in basically the network conditions may be this techniques are going to be effected. And the last one is the energy of rate of change of phase angle.

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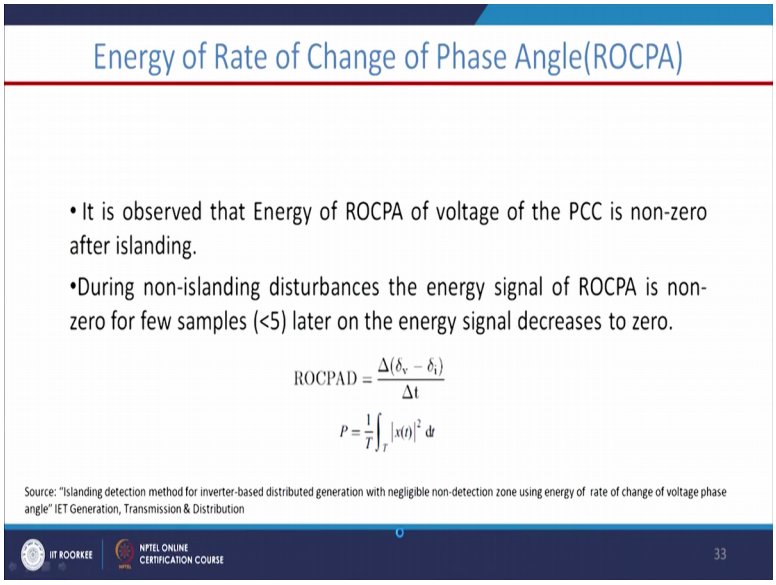

What is the energy content within this change of phase angle? If you can track the energy within that then also we can detect the islanding situation ok. So, in this class we have discussed that what is the islanding and why this islanding detection is very very essential. And what are the types of different types of islanding detection techniques. And, we have discussed passive islanding detection technique. The first one is basically the power quality monitoring based technique then we have discussed, the impedance based technique.

Because, during the islanding the impedance also varies and next also we have discussed the angle based information like rate of change of angle or energy present inside the rate of change of angle. If you can stress those information or parameters or quintiles, then

we can detect whether the micro grid is connected to the main grid or it is disconnected from the main grid.

Thank you.