Power System Generation, Transmission and Distribution

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Lecture No. #01

Electrical Energy Systems- A Perspective

So, today is the lecture, the first lecture of this class this course, and the title of the lecture is electrical energy systems a perspective.

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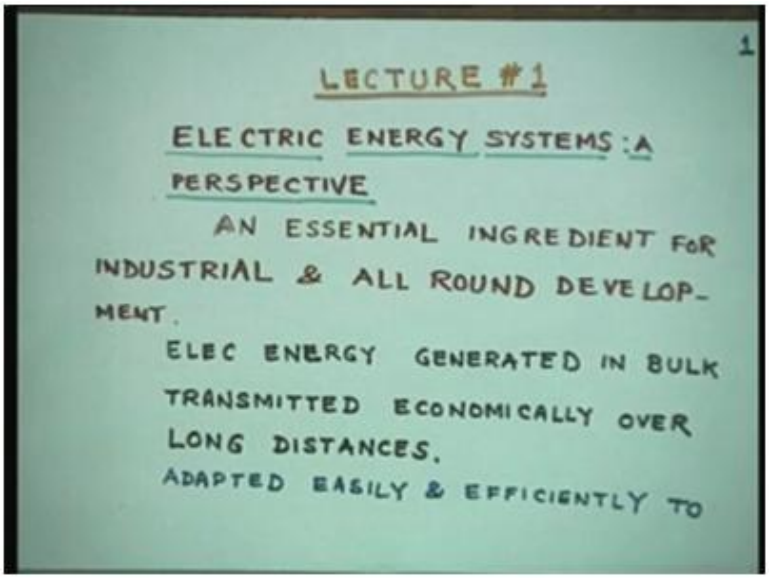

All of you know that electric energy is an essential ingredient for anything what do you want to do? Any industrial activity all round development of any country, any society, because whatever you may do, since morning to the evening, you practically consume electric energy. Be it geyser, the water heating in winter for taking bath or breakfast toaster or you know for anything, the cleaning of the house you need vacuum cleaner, any industry, lighting commercial activity.

So, need we need to electrical energy, even in computers, without electric energy no computer can work for all time. How much UPS will help you? So, then we need to generate electric energy in bulk. After generation, you have to transmit it also, because as

you know, load may not be close to the generating station, and transmit economically, because anything whatever you may say, cost remains a main factor in any activity. And we may have to transmit over long distances. It so happens the coal or any fuel may not be available close to the load. For example, in UP the generation is in eastern UP, and the load is in western UP; the industries are in western UP, so but the generation is in Singroli, the first super thermal station in India.

So, you have to transmit power over long distances. In electric energy, the beauty is it can be adapted easily, and efficiently to domestic, and industrial applications. For example, lighting; just you to put the switch on unlike other means.

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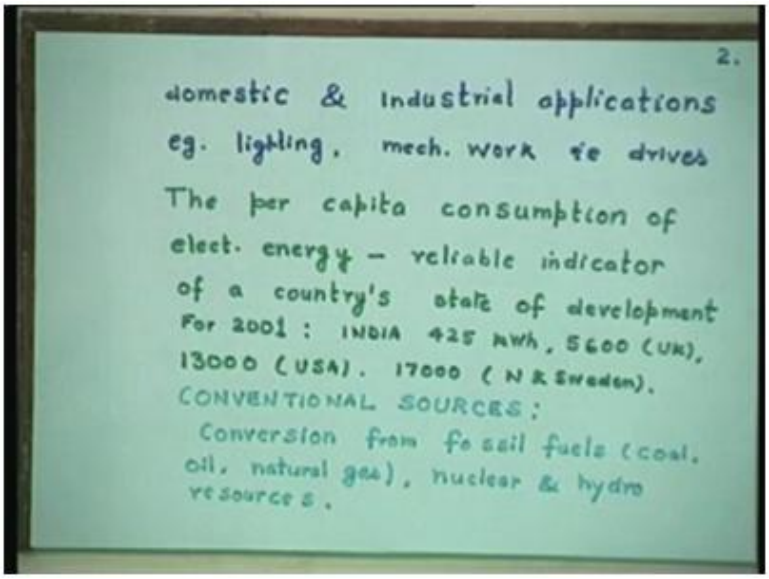

Say may be candle, may be a kerosene lamp. You have to do lot of effort, mechanical work, drives just you to start a motor. The per capita energy consumption is a very reliable indicator of any country how much progress it has done. There are other indicators, For example, how many people own telephones? How many people own cars? How many people have the houses of their own? Australia is number one in this category. Two third of Australians own their own houses. Our teledensity was very bad; tell about, 10 to 15 years back. Even today, only in urban areas this 3.6, in rural continuous 2.5. Thanks to the revolution of mobile phones, etcetera. Now it is very easy to talk to anybody. Now, today we are of course, talking about electric energy. So, we will restrict ourselves to the electric energy. Now, how do you say the per capita energy

consumption is a reliable indicator; if we had no activity, if we had no industry, we do not need electric energy.

Unfortunately or fortunately, our population is so large. We are only second to China, second largest populous country in the world. We have already crossed 100 core in 2000 a d, and we are likely to over take China by 2020. Now because of that, our per capita energy consumption comes to just 425 mega watt kilo watt power. How what UK 5600, Australia 4000, HongKong 4000, US 13000, and the highest in the world is Norway and Sweden with about 17000. I just said we try to blame population for whatever is wrong in this country, because it is so easy, and it is so visible, but that is not correct.

If you look at China, which as I just said has a higher population, their per capita energy consumption is higher than US- 500. Only perhaps, Bangladesh is lower than us in the world. Now we come to conventional sources. Conversion from fossil fuels, that is coal, oil, natural gas these are the three main fuels, which can be used, which can be burnt to produce heat energy, which can later on be converted into mechanical energy and subsequently electric energy.

So, there are two conversions involved in any conventional way of generation of power. All of you must know, any number of conversions, efficiency goes down. We have been taught in our earliest stages of a life that, eta is equal to eta 1 into eta 2, in that case eta will be lower of the 2. The value of total efficiency will be lower of eta 1 or eta 2. Now, we can have nuclear power, we can have hydro resources. These three are basically the conventional way of generating power in the world; and the fact remains even by 2020, the total power generation in the world will be 80 percent by conventional energy only. But renewable energy will take 20 percent of the total generation, which is a very good percentage. Today in 2003, it has not crossed even 5 percent mark, in India, it is highly varies from 2 to 3 percent.

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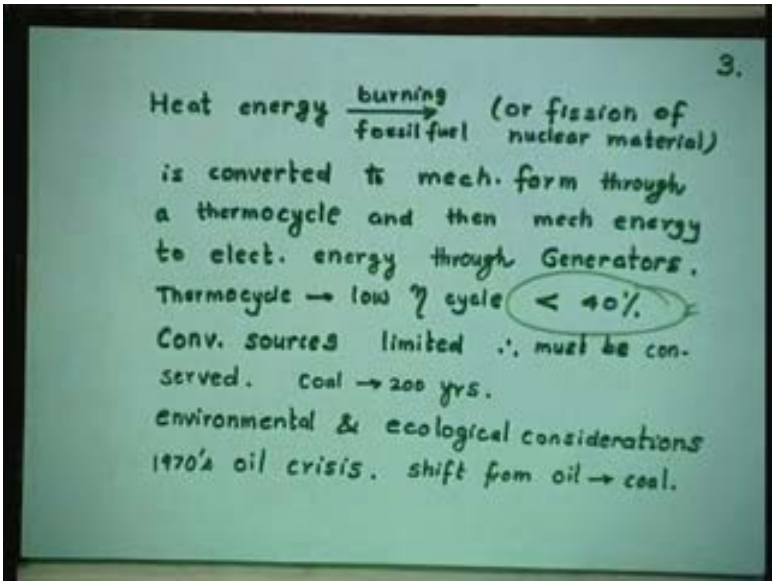

And I just said that heat energy by burning fossil fuel or fission of nuclear material, fusion still belongs to the realm of theoretical studies. It is a delight of theoreticians. You can only produce papers on fusions there is no in practice so far, fusion is not been a success. Though, for your information, let me tell you in 1989, the time magazine published in US in April issue, carried a news item that, two American scientists were successful in producing the fusion, later on it proved to be a coal one, just like our Ramar Pillay, who claimed that we can produce a coal from water.

But one day, who knows as telling earlier on that it it will be a reality. Once it is a reality, there will be no need of no dearth of electrical energy. No energy conservation will be required, no energy management will be required, but let us see when that day comes. Now, heat energy is converted to mechanical form through a thermo cycle. Those of you, who are mechanical engineers, you know what is a thermocycle. Even electrical engineers do read certain courses of mechanical engineering and then, mechanical engineering mechanical energy to electrical energy through generators. A thermocycle, as all of you know is a low efficiency cycle, one minus t 2 upon t 1; that is efficiency.

And efficiency is normally less than 40 percent. In India, the highest is 30 percent. The best maintained government plant is in Vijayawada, and the private plants as Birla is in Gujarat and Tata is in Bombay. In fact, Bombay has not experienced any shortages, any outages, any blackouts, brownouts, thanks to the private companies. As you know the

partly Delhi is also in the hands of Tata now, and let us hope thing will improve further. Conventional sources, though I just now said, 80 percent in 2020, we cannot go on in on using conventional energy sources forever, because they are limited. When I was a student is sixties, my teachers used to tell me the coal is there for another 200 years. Today I also tell you that the coal is therefore 200 years, why I am able to tell that, because we always get explore we explore newer and newer places, where you get coal, but that does not mean you should burn all the available coal. Why? These two things are entirely different- availability, and affordability. A Mercedes car is available in the market. Can we afford it? Can all of us afford it? Very populous Minority of Indians can only afford it.

So, though coal may be available for 200 years, we cannot afford to burn it. And as you all know our Indian ethos, we leave things for our future generations. Why do we have provident fund? Why do we have pension schemes? If you ask anyone why are you building house for children. So, why cannot you leave coal also for your children, and your children's children? So, that is why there is a need to conserve to economize, minimize on burning of coal. And hence, we need to take the help of other sources of energy, which are perennial, that is renewable, the green energy, the natural energy, the new energy sources. There are it is not only the availability, it is a question of environmental and ecological considerations; and that is why, about energy and environment we talk in the same breath. You may be having couple of courses in environmental engineering in energy studies, and tech program.

Let me take you back it to 70s. In fact, till 70's there was no problem of any electrical energy throughout the world. The 70's saw three steep crises in oil prices, and that was really a show the world, and it was a wake up alarm, and people started shifting from oil to coal. In fact, as far as we are concerned, in India we have no choice. Our indigenous oil production is only 40 percent of our requirement. And then, secondly do not think that oil and coal is only for power production, there are so many other things, which we do with coal and the oil. Coal is still being used in many Indian homes for cooking, coal is still being used in steam engines though in very very limited way now, for shuttling services, or few trains like palace on wheels. You know, they want to retain that old flavor, and and and glamour, and so on.

What is important today is on one hand I said we should increase our per capita energy consumption, because that will show the world how much progress, we have done. Please remember our president Dr. Kalam says that by 2020, we should be a developed country; and if that dream has to be converted into reality, next we will have to generate energy, and we have to use the energy. So, that per capita energy consumption goes up, as I said that is one indicator of your prosperity.

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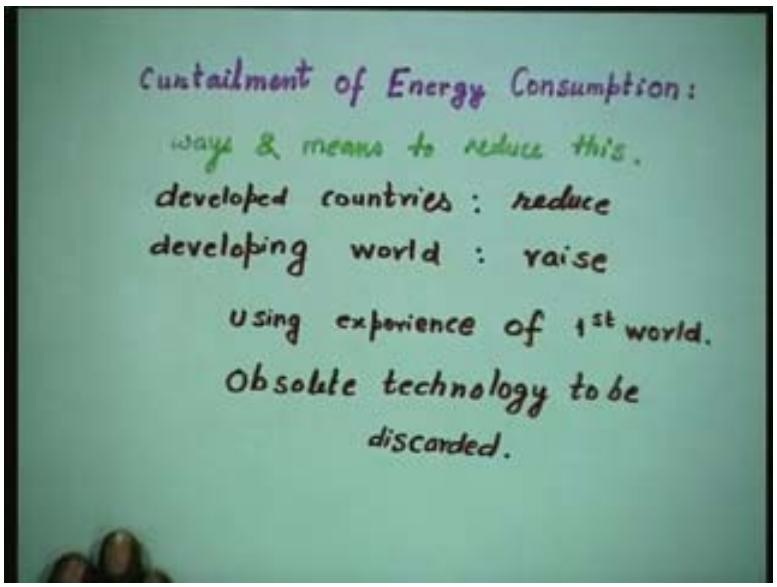

However, when I write here, curtailment of energy consumption is what? We are talking for the whole world; the developed world has already reached a level beyond which they cannot afford to consume energy. So, already maximum, because whatever the do in life they consume electrical energy. And so, beyond that what else they can do? And they will have to learn to curtail, in fact as soon as the energy consumption of the particular house goes beyond a limit, the rate becomes double. The housewife runs throughout the house, and starts closing various switches. You know, so that there is no wastage of energy, and it comes back within that zone, where the cost of energy is a normal one, and not a panel one, and not at double one.

So, the developed world has to reduce the energy consumption, the developing world has to increase. As this well known proverb someone's food is poison for somebody else. So, what prescription is good for developed world is not necessarily good for the developing world. That does not mean that you have got a sanction of wastage of energy. We still

have to conserve energy. Using the experience of the first world that is developed world, we should not try to raise it so much that, you have to further reduce it.

It should be sustainable. Now, sustainable word is being used everywhere in any title of the thesis, project, sustainable development. Everybody is now talking of sustainable development, whether it is a countries development, whether it is an institute's development, a department's development, or your own development. Absolute technology have to be discarded it. You should not go through the same bad experience, I wish the US or any other developed country has gone. You should learn lessons from others. If someone has gone for some route, and there is a problem on that route, we will warn other people, hey do not go that way, there is a problem there. So, he is merely transferring his experience to somebody else. So that, he does not have to unnecessarily go through the same bad experience, right.

So, we should learn, we should keep our eyes, and ears open, and see what has gone wrong there. For example, you should learn from Chernobyl accident accident from 3 mile Island accident, nuclear accident, I am talking. 3 Mile Island was in 70's, and Chernobyl was again 80's in mid 80's. So, we should be we may have a nuclear power we do have nuclear power generation, but guard against those factors which led to those two accidents, as far as possible.

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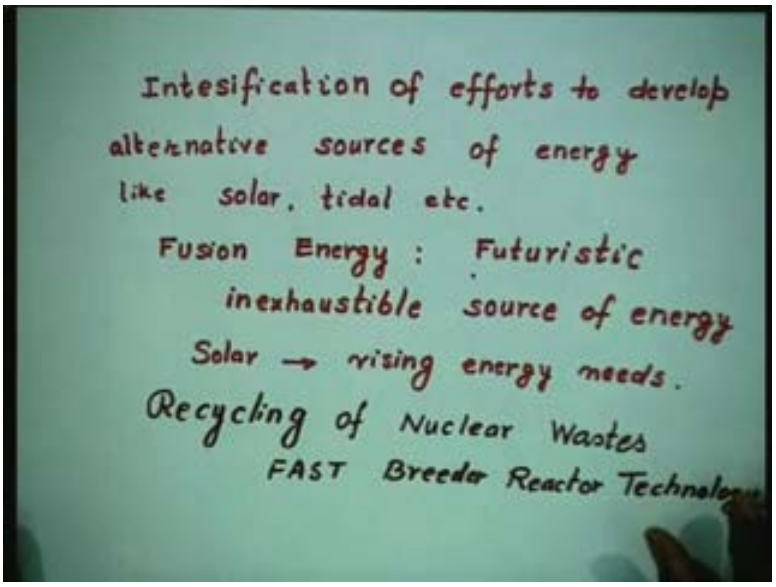

We have to intensify the efforts to develop alternate sources of energy. That is what your and that is why you are doing and I am taking energy studies. Most of the courses are renewable energy. Why because, we have to slowly, but surely replace the need of conventional power generation, by non conventional sources. Why? They are sustainable; they are perennial sources. When nobody will ask you money if the wind is blowing, no government can tax hey, you are enjoying free breeze of air, give me two rupees or sunlight you are getting, it is free. Nobody can nobody can charge you for getting sunlight in your house, if you have properly built the house. Solar, tidal, wind, biomass, waste, C, MSD, geothermal, and so on.

We just talked few minutes back about fusion energy, which is futuristic, but once successful, it will give you inexhaustible source of energy. Today, solar we are looking towards for meeting our rising energy needs; our needs are rising. I remember I did not purchase the fridge till I was 42. Today the boy gets a job later, he gets the fridge first, because the times have changed. We did not have television till I was you know 35. Now the, three are boys also, girls also watch television. If you switch it off, he or she will make an annoying fight with the parents. So, there is that addiction is there are right from the birth almost, because the mother is watching, the child is also watching.

Recycling of nuclear waste, anything this is an era of recycling. In fact, the waste has become a primary source, and the new material has become a secondary source. You know, waste management has become a very important course. There are a couple of universities, which have started waste I am taking waste management, because let us not throw waste anymore. A waste is no more a waste, it is a valuable resource. In fact, in foreign countries, if you want to purchase a coalgate or any toothpaste - all these are international brands, you get coalgate everywhere, coalgate commonly. You have to give the earlier used one tube, if you want the new one, you cannot just throw it.

So the waste same nuclear is no exception. You should recycle the nuclear waste, and that is why the fast breeder reactor technology has come; and there is a research station near Madras or Chennai, in the place called Kalpakkam, where we do have a nuclear power station also right. So why fast breeder reactor technology is becoming popular, because you can use their this recycled fuel. Earlier when the Nehru and Baba the combined vision, the two visionaries in India, whatever Nehru did, one of the best

success stories IIT system, as you are able to see that, we just live into 50 years of IIT system in US. The Koragpur IIT was started somewhere in 1951 also.

So, similarly Nehru started this industries industrialization. Not even in was being manufactured in India before we got freedom. So, these started the nuclear power station - the first station was 69, Tarapur, Trombay. Unfortunately or fortunately, the fuel use was uranium; enriched uranium- u 2 32, I hope you are not forgetting chemistry. Now, what was the unfortunate part in it, it was not available in India. We had to import it from where? From USA, and our relationship with USA was not quite good. ((Barring)) Kennedy's era, which was very brief. Unfortunately, it was smashed away by some terrorists. Do not think terrorist is recent origin, terrorists are always there. Even Ravanan act you can term as terrorism is taking away Sita, What else it was?

So, terrorism has been there in this world right from the first day, the D-day. So, Monday, Wednesday, and Friday our relation with US was good. On Tuesday, Thursday, Friday, Saturday were not good. So, whenever enriched uranium has to come, we run the plant. Whenever it was not coming, we close the shop. So, they third the Indian scientists thought, this is no good, this is not sustainable to use the phrase. So, they started, second nuclear power plant in Kotta. Kotta is the only place in India, where you have all the three plants; there is a thermal power plant, there is a hydro power plant, and there is a nuclear power plant. And Kotta is the only place from where atleast 500 IIT entrance are coming. The big industries there, how to you know, help people to enter IIT. Anyway, that is not the topic of today's lecture.

So, there they started using Canadian help, where they we wanted. And the third Kalpakkam was totally indigenous nuclear power plant, where we used our own petroleum, and thorium, and we are having the largest deposits of thorium in the world 45000 tons in Kerala, and Orissa.

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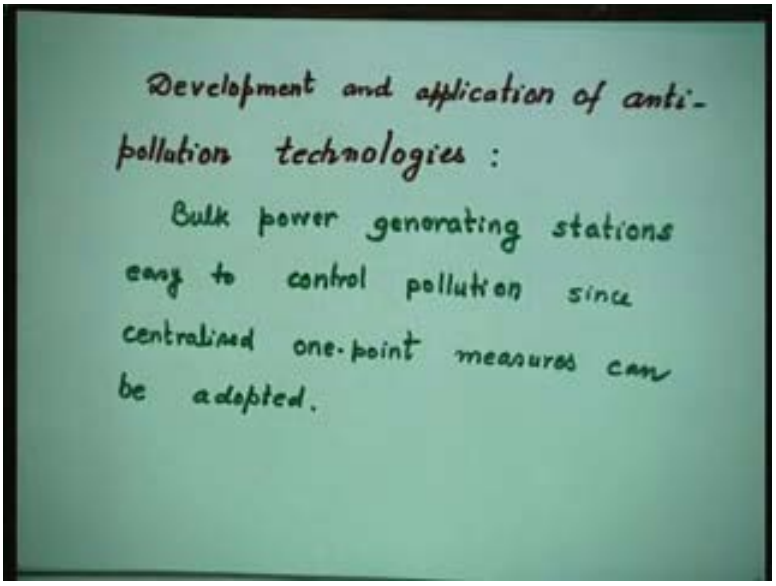

Development and application of anti-pollution technologies, as I said environment has become very very important. You know how much fuel crib was raised in Delhi in the last few years, and then they have to the Supreme Court had to, and all buses were converted almost overnight, to c n g. Now, Delhi has become one of the cleanest cities in India, otherwise it was the fourth most polluted cities in the world.

So, you have to develop and apply anti-pollution technologies. You cannot afford to have pollution; it affects everybody, not only human beings, it affects vegetation, it affects buildings. You know, in Delhi out of every five children, two are asthmatic. If you want to know why, just go and stand near any red light square, and see that those cars, what sort of fumes are coming out - the blackish, the whitish, please remember the white one is more harmful than black, because the combustion is not complete, and CO comes out.

So, all these anti-pollution technologies have to be studied, there has to be a course, a subject full fledged. Bulk power generating stations are easy to control pollution, because centralized one point measures can be adopted, it is very easy. See, all of you are in the one place, it is easy to control. If all of you are standing in different places, different corners, it is not easy to monitor. So, the bulk power stations the India thought is the best way to generate power. So, super thermal stations started.

So, the first super thermal power station in India was Singroli on UP and MP border. As I said, coal we had ample coal, and the coal is mostly in Bihar, the eastern part of India.

So, earlier days we used to have load based power plants. Wherever load is there, we have a power plant, like Bhangalpur in cities. And, coal has to travel all the way from Bihar to Delhi. I remember the headlines of those days in Hindustan times, or times of India or whichever paper you read, Bhagalpur coal only left for 8 hours, and there used to be panic, because three ministries have to be coordinate - the power ministry, the steel ministry, and the coal ministry, and railways, because it is railways which have to carry this coal. Sometimes wagons were not available.

So, the government of India took the decision not to have anymore load based power plants. So, they said let us have the coal based power; that means, wherever coal is, we go there, and have a big power plant- super thermal. Super thermal means anything more 2000 mega watts. We have many super thermal power plants- Corba, Obra, Chandarpore, Ramagundam, Singroli, and so on, Neyveli. What was the advantage? Cost wise, it was cheaper per mega watt or per kilo watt power power generated cost used to come cheaper. As you know, 100 volts bulb is cheaper than to 60 watt per. There are plus and minus. The 60 volts bulb you can put in two different places, you can have perhaps, more uniform illumination.

So, there is plus and minus in whatever you do. You must have done this lighting or illumination in your under graduate final year or somewhere. Utilization of electric power, Taylor's book, or book, or books, or book, whichever book you might have read. So, there is a plus and minus. What is minus here? You have to carry that power generated in a jungle near those mines to load sectors, because there is nobody to use that power there, barring a locality, or you know a campus where the people were working in that power plant are living, and that may be 300 persons or 400 persons, or 1000 persons, not more than that.

So, most of the power has to be evacuated, transmitted, transported to far of distances. So, you need to build your transmission network, which we started with 33 k v, 66 k v, 132 k v, 220 k v, 400 k v - 400 k v came in 1970. That was a mistake, we should have gone to 500 k v then and there, why the power transmission is proportional to v square e v by x into sine delta; e and v are roughly the same, so, v square x by sine power transmission. You must have done that, you will do it again in our future lectures. Since power is generated in bulk, it has to be transmitted in bulk. So, transmission line

capability should be there, so 500 k v. Now there is a talk of having 765 k v transmission line in our country.

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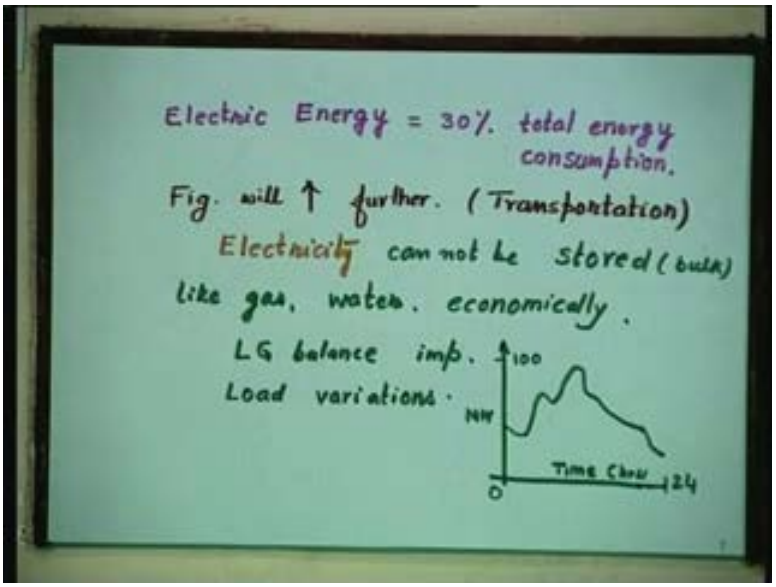

Electric energy used today in the world is 30 percent of the total energy consumption. Please understand, 70 percent energy which we consume is non-electric form. This figure was only 20 percent, when I was a student in 60's. It has become 10 percent more, figure will further go up rise further. Thanks to one particular sector, if I want to name is transportation.

In sixties when I was studying, throughout India, there were steam engines, run by coal, steam. Today it is hardly, and you have to go to that museum - railway museum to see the steam work model, or those two or three places, which I mentioned earlier on this lecture- Palace on wheels or Simla or Calcutta to Simla or whatever. I do not know whether that has also been converted into diesel. What is the main problem with electricity? Unlike water and gas, it cannot be stored economically. The word economically is very important, because immediately you can say well sir, in the battery form we do a store electricity.

There other ways of you know electric storages become a very important R and D topic, Compressed air storage, hydrogen, pump storage plants, you must have heard about pump storage plants. These are the ways in which you can you can store energy; but they are not fuel sales are coming, and they are not so economical. The first fuel sale car,

which has come in Japan, costs two crores of rupees. Tomorrow it may be two million, but that is tomorrow, not today. Gas and water, just open a tap, you get water.

It is not that easy. So, you have to generate power as in when you need. So, the situation is more complex. Why complex? All the time you have to maintain this LG balance. What is this LG? LG is not that company, Korean company. I am talking in load and generation balance. You have to constantly estimate, forecast load. So, the load forecasting has become a very important topic in power systems, and in electric energy systems. Even in renewable energy you have got to forecast, how much wind power can be consumed, how much solar energy can be used, because there are no users, why have why produce power? It will be a losing game, if you start shop somewhere in general, there will be no customers.

So, feasibility report as as you call it in the industry, before you start a industry you have to get a consultant, who will prepare a feasibility report. There after all you are opening industry to earn profit. It is not a charity. So, LG balance has got to be maintained all the time. LG is total generation must be equal to total load plus losses if any, because losses is also a load. It is very important, but the load is a very naughty fellow. It is a random variable. I am sure you must have learnt enough mathematics to understand that, there is something called probability theory, the statistics. The populis is the best book on random variables.

I do not know whether you have done that course in mathematics, if not you can read that book if you have time. The load is a random variable when will you feel hot enough to start a fan, cooler, or or AC? Nobody knows; each person will behave in a different way, when will you say, stop it is enough cold. The air conditioning is too much, reduce it. So, each person is free to feel hot enough or cool enough to start a fan or a heater or a fridge or or AC, whatever.

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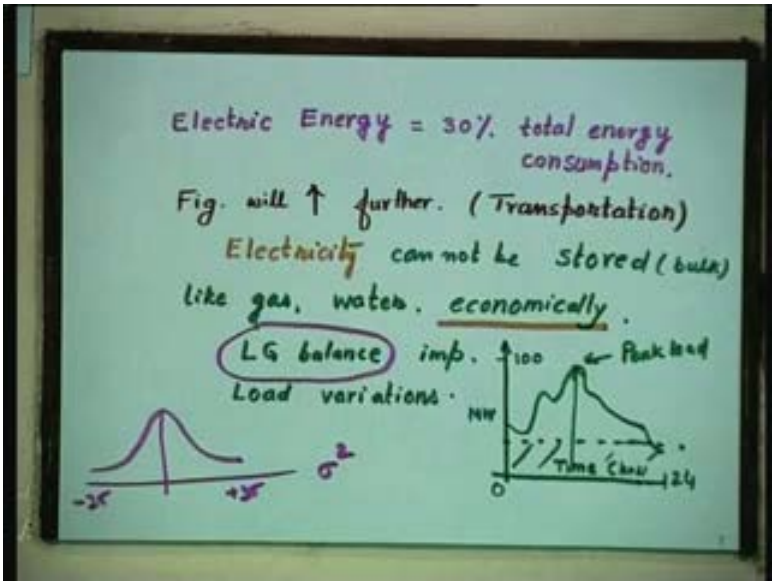

So, it is a random variable; it varies randomly. I do not know how many of you know normal distribution or Gaussian distribution, which is this - varying from minus three sigma to plus three sigma. How many of you know? Are you aware of this figure? Some of you yes. This is a normal or a Gaussian distribution. The beauty of this distribution is it gets completely described by first two moments. Namely, expectation, expected value or mean value, and second is standard variation or variance sigma square. Sigma is the standard variation, variance. Sigma square is the variance.

So, you have to forecast the load, you have to keep load variation in mind. Hence there is a figure drawn here, which is called a typical load curve. This is forecasting by energy control centre. The idea of energy control centre was given for the first time in the world by a fellow called DeLiac, he gave it for the first time. What is an energy control centre? The energy control centre in Delhi is in .

So, please ask your energy forum person or M.Tech coordinator, to arrange a visit, which is across the road. In fact, walk and see what is happening there, that controls first monitors and then controls, the electric power system in a real time, online monitoring and control. How many of you have heard of Scada? supervisory control, and data acquisition system, that is Scada. We have just purchased an equipment which 700000 in our downstairs power system labs. You can go there, and have a look at it. Now this particular curve, y axis is megawatt, x axis is time. If it is 24 hours, it is daily load curve.

If it is 7 days, it is weekly load curve, 30 days is monthly load curve, 12 months is yearly load curve, and so on.

Here, I have shown a daily load curve. As you can see, load is constantly varying, and the peak load comes at a particular time. This is a peak load, this is a time varying load, and this is the base load. This much load is there all the time. Now, you get scholarship, let us say it is 5000 rupees or whatever amount it is. You have to plan how to spend that. There is a certain basic expenses you cannot avoid it, fees, some books, the mess dues, the electricity bill, whatever way they get , they get added, like into mess bill or whatever way, that you cannot say you that you avoid it. You cannot postpone that.

But certain expenses are varying - visit to some picture hall, or restaurant. You can avoid, you can postpone, and you can forget about it. There is a peak- unfortunately you get sick, or brother's marriage, sister's marriage that go home with some gift, it is a peak , it will not come every time; but power station has to cater to this peak load. That is a job of an electric system engineer to provide electric power, they are obligated. It is an obligation on them to provide power as and when asked. So, your capacity of your power plant will be guided by peak load, and the average load will give you energy consumption.

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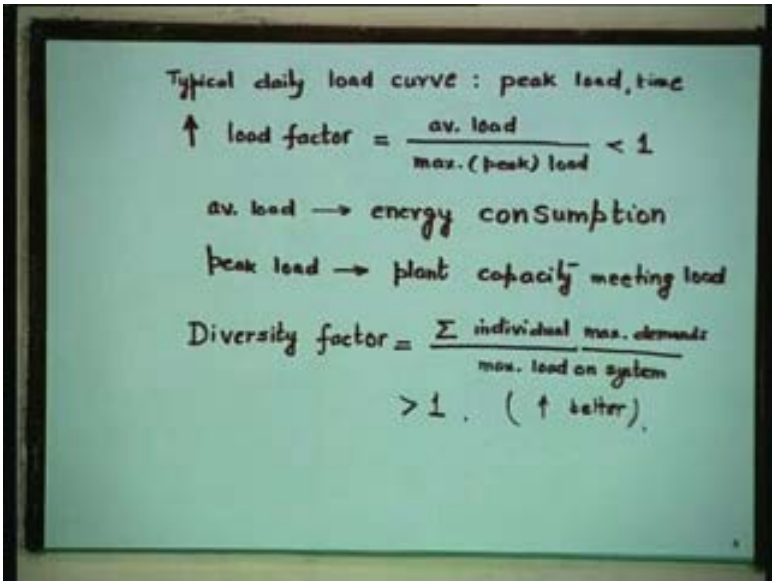

You have just seen the typical load curve, peak load, time of occurrence. Let us define the load factor, which is a very important factor in power system or electric energy

system or whatever you want to call it. Average load upon maximum of peak load is a definition of load factor. Naturally as anybody can see it with a even with ordinary intelligence, this factor has to be less than one. At the most it will be one, when your maximum load and average load are the same. That is a step function, which you must have learned in a control systems.

That is the lay load is same throughout. Then, load factor is one, but it is not normally so. Load factor is 0.6 or something like that. Your aim, your endeavor, your effort, should be to make load factor as close to one as possible. Why? Can anybody reply to this question? Why load factor should be as close to one as possible? So that, you can use your install capacity to the maximum. Why a director or a principal of a college asks his heads of department the utility factor? How many people visit library? How many people visit lab, and use that particular equipment, which is so costly?

If it is to be used once in ten years, why have it? So, the load factors should be made as close to one as possible. How do you do that? This itself is a PhD topic. People have written papers and papers in this topic. You must go to the library, and read papers from journals of your liking of your choice. If you are electrical engineers, read IEEE transactions, proceedings IEE UK, IEE US, our own Indian journal institution of engineers, then there are various journals. You can go to the library, and get yourself familiarized with those develop the habit of reading journals, habit of reading journals. It will help you while doing your project. You may like to do a PhD later on. You may like to join R and D organization. You do not know what you want to do. So, it will this will be helpful. Average load gives you energy consumption as I said, and peak load gives you plant capacity.

So, while planning the power plants, you need to survey that particular zone area to which that plant is going to cater to the load. Another important factor is diversity factor. What is diversity? You must have heard this word diversity, unity in diversity. In your house, you do not keep all the bulbs, all the fans, all the AC, and all the coolers on all the time, but you do have them. In case you shift from dining room to bed room, bed room to drawing room, drawing room to study room, you go and start that particular bulb, particular fan, particular tube, and so on.

So, summation of individual maximum demands, upon maximum load on the system is always more than one, because you are not going to have all maximum demand on all the time. At a given point of time maximum load on the system will be much less, may be only two tube lights are on, may be only two fans are on. You may have ten fans, even in your class room, there may be four fans, but if it is an empty class; only first two fans are on where you are sitting in first two tables, or benches, or chairs and tables. Why should you keep those fans on which are not going to serve any purpose, it will be wastage of energy, which you cannot afford. Higher this factor, better it is.

That means you are conserving energy. Higher factor will only show that you are not using all connected loads; you are conserving energies, you are waste avoiding wastages.

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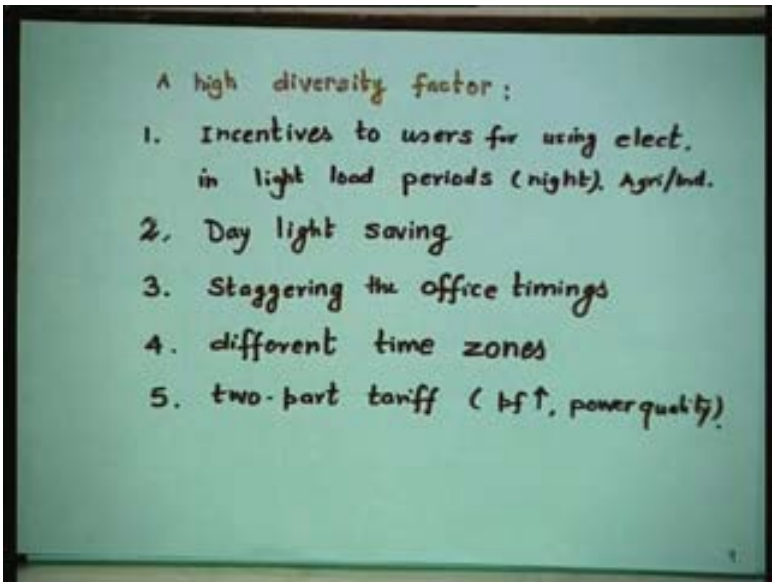

How do you achieve this high diversity factor? Having said that you must have a higher diversity factor, that means there should be ways and needs to increase it. There are five golden rules written here, and fortunately none of them cost you a penny. Whatever scheme you take to your boss, he will ask how much money is involved.

So, if you want to go and attend a conference, your head of department will immediately ask you, fine, you are going for the conference; but how much money you want from me? Or you take any proposal, the first question which any superior or a boss will ask you is, even your parent will ask you, you want to go for somewhere, but how much money you want? Is the next question immediately. None of them needs money.

So, there are five, and yet unfortunately the irony is we do not follow it. India being a poor country, we understand that you may not be able to follow methods, which needs money. Unfortunately none of them needs money, and it is not that our boss- the political people, do not know about that. That is a bigger irony when you are know a thing, and yet you are not able to do it. Let us start one by one. Incentives to users for electric electricity in light load periods- night periods.

All of you know that in night time, not many industries operate. Only those industries which are having three shifts will operate in the night. Normally they will have an off. Not many educational institutions will be having classes in night time. In agriculturists not many will like to irrigate their lands in the night time, but if a utility tells them, look if you use power in night time, I will charge only half the money. So, there is an incentive to shift the peak load to elsewhere. Peak saving techniques reduce that peak, so that your load factor goes up.

You must be knowing that Air India gives you half the price for a ticket from Bombay to Delhi if you travel at mid night or two a m. Why? A plane is coming from London, and some people have got down in Bombay. So, those seats are available to them. Ultimately plane is going to Delhi. So, they literally ask that those who interested in going to Delhi by air, it is half the price. It is a win-win situation. You gain provided if you are paying from your pocket, if the company is paying then you will like to travel in a convenient time.

Not only that, you are saving on air ticket, you are saving on hotel because you are not going to take a room in the hotel, you are going to sit in that airport, or Shivaji airport, or Indiragandhi airport, pass time and catch a flight at two a m. So, you are not only saving on the airfare, you are also saving on your hotel accommodation.

Day light saving: What is day light saving? Does anybody know? In summer days the days are longer. I do not know how many of you get up early; but if you get up early, at five a.m. there is sunlight in summer, whereas in winter we have get up at six thirty a.m. for sunlight. So, what you can do you can follow different timings in summer and winter. You can adjust your clock so that, though it is four p m it shows five p m so that the time has been advanced. What is the use? Your college is over at four p m, yours shops, your offices, you come out early, and there is enough daylight available.

So you shop, you swim, you play tennis without using electric energy, and that is why England had the first three world cups in their own land by telling others look, you do not have day light. We have up to nine p m. In fact, if you go to Norway and Sweden, the night is only for three hours or four hours. The sun is shining at midnight, in the country of sun at the midnight, and you have to literally have the thick curtains to simulate darkness, so that you can get sleep in Norway and Sweden.

So, why not use it in India? Of course, you have to change your timings, adjust your clocks from the third week of October, something else, third week of March, as the whole world does it. Why you do not want to do? It does not cost you anything. People will get accustomed to it. Well ladies and gentleman, we will do the remaining things tomorrow. So, today we have done let us revise, let us recapitulate.

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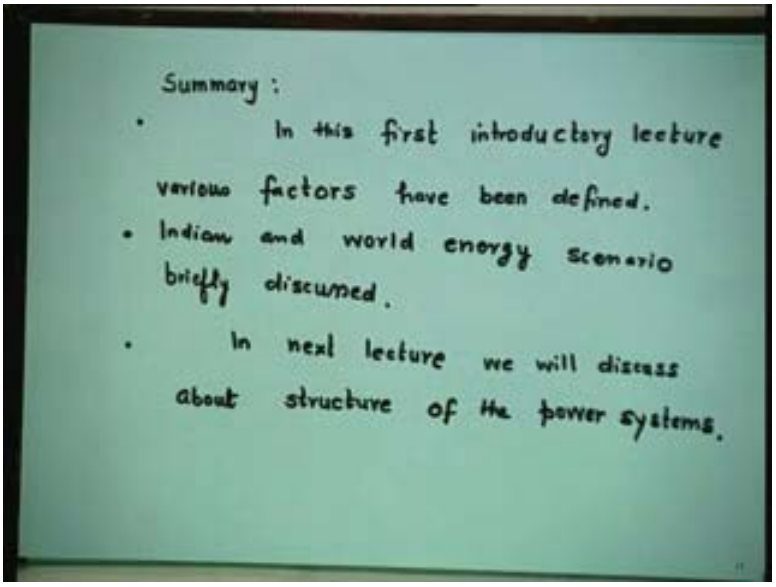

In the first introductory lecture, various factors have been defined - load factor, and diversity factor, Indian and world energy scenario was briefly discussed. And in the next lecture, we will discuss about the remaining ways in which we can improve the diversity factor, plus structure of power systems, how the power systems have been built, what is there. So, whatever we have done today if you have any questions, now there is the time I would like to answer them. If you have any anything you have you want to know any query, any suggestion or any point, which are not clear. As I said, we are following this book; and this is from chapter one, and you can read it.

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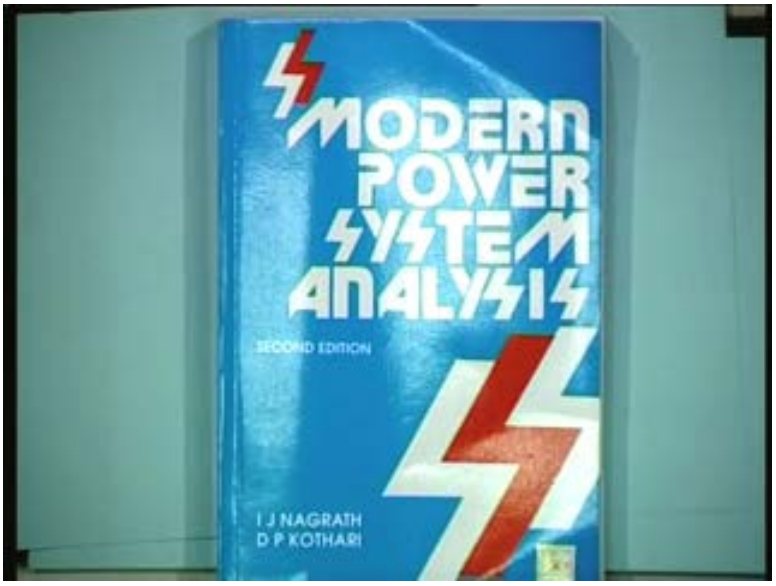

If you do not have a book, there are copies in central library, and centre's library-department library. You can read it, or you might have taken notes or whatever. And our first minor I understand is on fourth September onwards is something. So, start preparing right from day one. There is no relaxation here. So, in case there is no question or queries, so we will meet on Tuesday. The coming Tuesday, same time, same studio, same audience. So, thank you very much.