Power System Generation Transmission and Distribution

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Lecture No. # 07

Energy Storage

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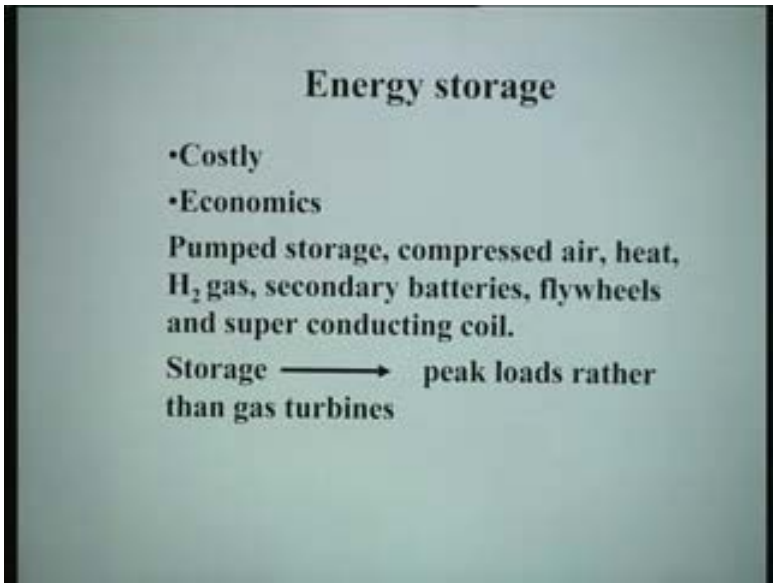

We will be starting lecture seven on energy storage. Now, I already explained you why do we need energy storage. Unfortunately, energy cannot be stored in a bulk. So, as and when you need it, you have to generate it. However, as we were talking about various renewable energy sources, since they are fluctuating all the time, and if there is any problem, so we need to have back up or storage. So, the work R and D started in right earnest way in energy storage area. In fact, there has been some PhD thesis, in our center of energy storage, especially in, hydrogen, chemical engineering department, fuel-cells, batteries etc.

However, the energy storage is always costly; it is not cheap. To store energy, it will cost money. So, economics have to be worked out. Whatever, you may do, you cannot ignore economics. Of course, we have already done pump storage and we have talked about it. All of you know that how pump storage plant works. It is generator, turbine,

motor and pump in reversible set. During off load, it will work like a motor and pump, and during peak load it works like a conventional hydro plant. Besides that we have compressed air storage in the form of compressed air. Well the detail, you can always read in any good energy book on how the various storage themes work. There is heat, hydrogen gas and in fact, hydrogen will be so popular slowly that even your scooters will run on hydrogen; you will have a cylinder along with your scooter with hydrogen gas and it may work out to be cheaper one day.

Second is the battery and this everyone knows what a battery is. In telephones, exchange or car batteries, even inverter it needs a battery. Each inverter, its half the cost is its Exide battery. Flywheel, I think flywheels, you have studied in your utilization of electric energy course in your undergraduate on how flywheels stores energy and those exponential curves you must have drawn these various cycles. Super conducting coils, of course, there is a magnetic storage as well, some Professor Mohan of Wisconsin University, has done lot of work in SMES. There are so many things; there is an explosion of knowledge.

In fact, this 35 hour or 40 hour course is not enough to tell you the full story about everything. That is why we are not going in detail, because we have to give you a general ideas, so that if you get interested in particular topic, then you can always take it as a minor project or major project are do a PhD later on. Now, when do you really need storage? Besides failure of a plant, we need storage when there is a shortage. When do you go far taking a loan, nobody likes to or everybody hates to take a loan, but sometimes in life you have to, when you have shortage of money, like you have daughters marriage, some medical urgency, something then only you go ask for a loan otherwise you do not. So, when do we draw from storage and that is your bank. We go when there is a shortage, otherwise why should we do that and shortage will come only during your peak loads, because at that time there may be a case for enough generation is not available.

Sometimes, you may be finding using gas turbine may be a costly option. I have already talked about gas turbine even of an earlier lectures and I have also told you why we need gas turbines. Though they are less efficient than conventional steel power station; 30 percent as against their 40 percent, but they are quick in starting. Here is a proposal that rather starting gas turbine we use as our storage. That is what these means; the storage

sometimes serves better purpose to serve the peak loads rather starting gas turbines. Of course, if you have both, you can always work out with economics. Now, in case of secondary batteries, this is really the oldest way of storing energy. All yours toys, your electronic goods, transistors, two in ones, walkman, calculators everywhere we use batteries and that is nothing but yours energy source now.

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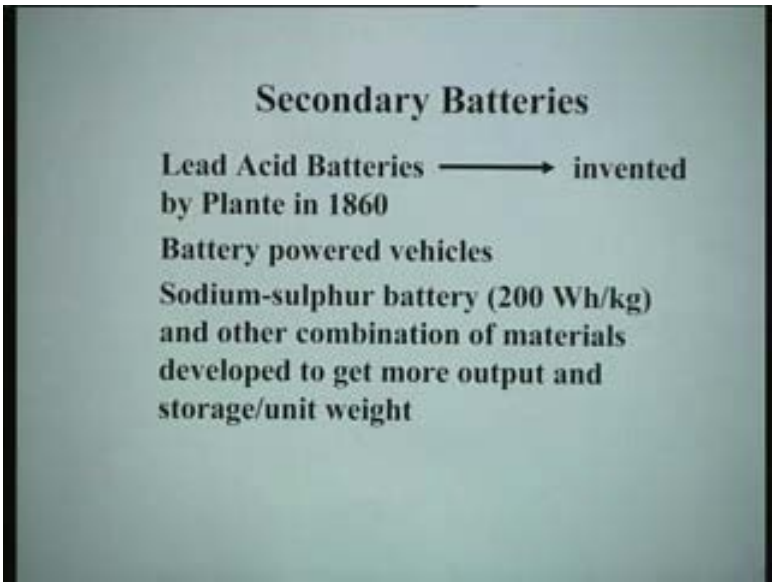

In fact, the lead acid batteries were invented by some scientist called Plante in 1860, almost 30 years before the electricity was generated in a bulk way by Edison. The first bulb was lit. Electricity is a very old story, you must have known through ebonite glass walls, static electricity; you must have read in a physics course. There are battery power vehicles. Already, I talked about it. In our IDRC center, Professor Salukhaswamy has done lot of R and D on a bus, which is electric bus. In fact there is electric bus service going on between Fathepur and Laal Quilla, and that is just to make people aware on how pollution can be avoided by using battery driven buses.

So, battery powered vehicles are available. They are running on the roads, even the electric car Riva, I have mentioned sometimes back been manufactured in Bangalore. It is also practically the batteries. Well the latest is sodium sulphur battery, which is 200 watt per kilogram and it is that much energy. And as I told you yesterday that materials science is one of those five important areas, which have done tremendous progress and have change the world. Just looking at how copper was replaced by aluminum as a

conductor and so on. The material science has made a lot of difference; it has made things quite cheap.

That is why we have material science centre also in IITs, and it is called polymer science. Its original name was material science. Now, the natural aim of any researcher, any scientist or any engineer will be to develop such a battery where you get more output and storage per unit rate. That is why each battery is different. Everybody claims that ours is good and you see their advertisement, where one battery fails and in between other batteries only reaches the victory point. So, everybody claims that his battery is better.

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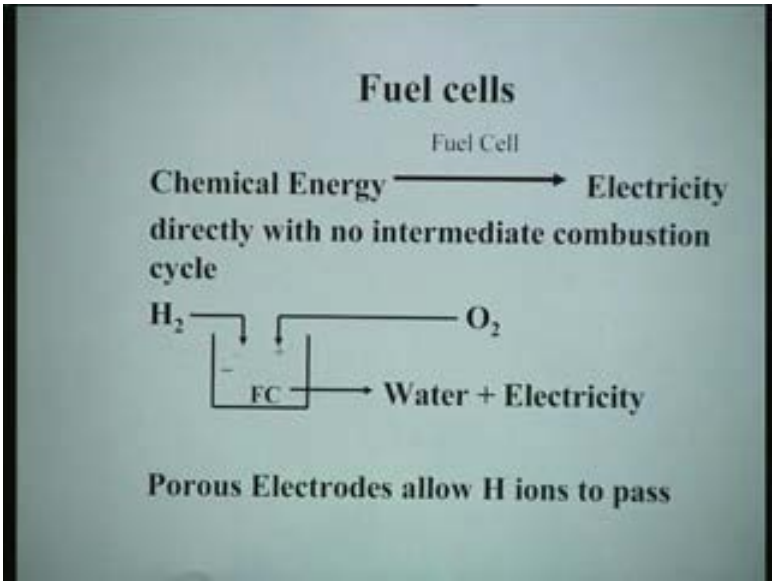

Now, fuel cells are another way of storing energy. Lot of work is going on in fuel cells thought the world. We must have read somewhere or have seen, there is the car in Japan which is developed very recently using fuel cells. Now, of course, the cost at the moment is two crores and nobody will buy it in India, but tomorrow, who knows it may be 2 lakhs. By this tomorrow, I mean in some number of years, which is not known.

In fact, what is done in fuel cells is the chemical energy is the input and it is converted into electricity, directly and with no intermediate combustion cycle and that is the beauty. There is no intermediate conversion and it is something like MSD. There is also no intermediate change of cycle, which is there in a conventional convergent process like chemical to mechanical, mechanical to electrical. What you do here? We bring in

hydrogen and oxygen. This is the simple chemistry. All of you done this chemistry in your eight classes, ninth class and tenth class. This gets combined and naturally H 2 O that is water plus electricity. This electricity is used. These are porus electrodes, the electrode I have not shown here. They allow hydrogen ions to pass.

Of course, they are costly, I just now mentioned you that. Anything, which is in his initial years, in the beginning years are always costly, but as the time passes it, becomes cheaper. Same things happen to color TV; same thing happened to pc, same thing is now happened to mobile. Even for color prints also, remember when color photography came it use to seven rupees per copy. now it is been very cheap.

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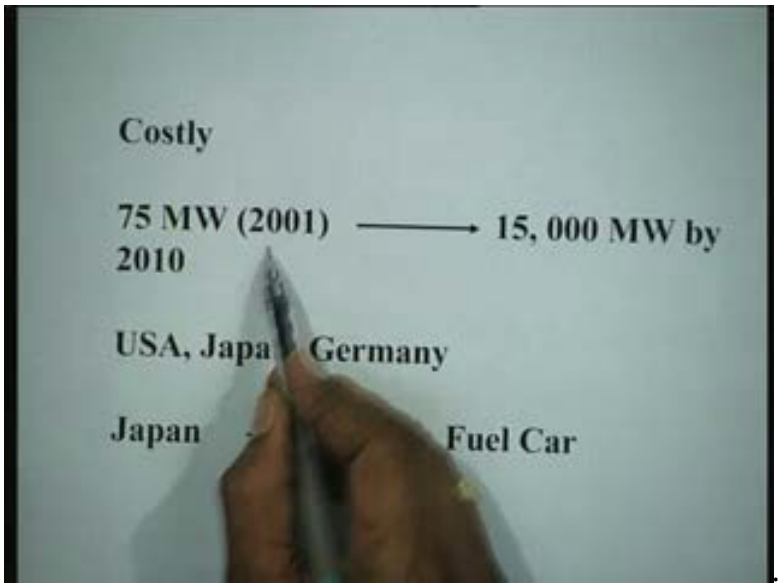

Now, till 2001, the total power generated, and I am talking about the whole world, it is just 75 mega watt. Whereas, it has been envisaged that it may become 15000 mega watts by 2010, which is not far off. Even I am hoping that I will be around. So, I hope to see this 75 becoming 15000 mega watts. These are three countries in the world where the fuels research is in forefront and in hydrogen research also. I mean any Germany, Japan USA are in a barring. In Japan there is no wind, but in US, Germany there is wind also, as I have been telling you earlier on. Japan of course, is a first to bring a fuel cell car, which I just now told you. We come back to hydrogen again; because hydrogen was used in fuel cells as well as we have just seen.

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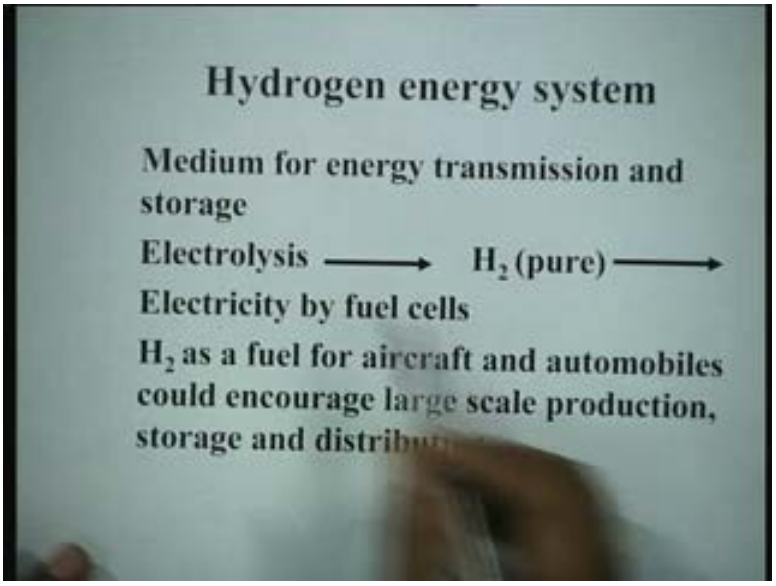

This is a medium for energy transmission in storage. I was just mentioning about scooter. There are books on hydrogen in our central library. If you are getting interested in hydrogen and if you can read at least a book, which contain a chapter on hydrogen energy that you can always use. Well electrolysis will give you pure hydrogen and of course, the fuel cell can be used. Hydrogen is a fuel is also used in aircraft, automobiles. I already told you about cars, scoters and once it get used; naturally it will prompt large scale production.

See there is catch 22 situation. Unless and until there is a use, nobody will produce, because it is a commercial venture. If we are producing something then it must get sold. Otherwise, why produce it and there are problems of storage and distribution. You must be seeing about LPG gas. If you do not handle it carefully, there have been explosions in various kitchens in the world due to leaking or if it is not properly closed. So, you have to be careful whether it is a nuclear power, whether it is even hydro power, thermal power. There are precautions to be taken.

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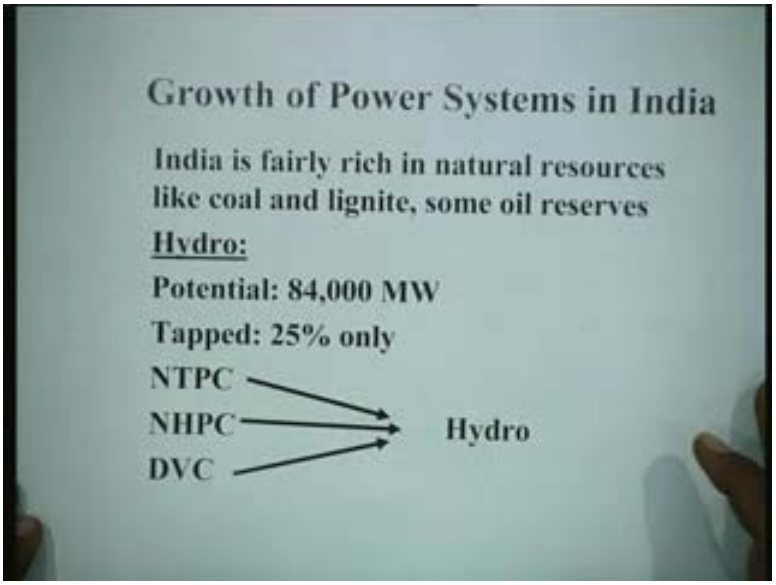

Now, let us further study on how the power system grew in India; growth of power system in India. Of course, we are fairly rich in resources. You name a resources and that is available. But the main problem is how to use them meaningfully, judiciously and optimally. You have talent. Where do you lack? You do not know how to channelize it, how to plan your things or how much you should study a particular subject or when you should study? Should we get up in the morning or you should get up or work late in night time and so on. You have to plan your life. Every one of us plans our life.

We have coal as I told you for next 200 years, so no problem. We have lignite and even now we have lot of oil. We got lot of oil. There is a Bombay high; there is Assam and so on. At least we can have 40 percent of our requirement we can have all. That is a different matter you do not want use it and keep it for future use. That is what USA does. USA is a self sufficient in oil; still it gets oil from middle-east and uses that and not using of their own oil. This I have already told you that hydro potential in India is 84000 mega watts. You could only tap for only 25 percent and there are reasons for that.

Now government of India brought this so called Navarathna, you know the public sector. NTPC came in 1975, which is National Thermal Power Corporation. They use to employee at least 300 engineers in a year. I remember the interview is to be on per month in all over place. Suddenly, the requirement has come down and again which is

looking up. Why because we have to add hundred thousand of mega watt more as I have said and how do you add it if NTPC does open the new plans for power generation.

Luckily, they have also entered in hydro now in big way. So, how long this name they can justify I do not know. It is no longer only thermal, now they are going in a big way for hydro. Note that for getting this there is a separate corporation for hydro, NHPC, National Hydro Power Corporation. Then there is a DVC, Dhamodar Valley Corporation, of course Bhakra authority is separate. All these are generated or generating hydro power in our country. I have already told you that with freedom we got only 1300 mega watt as total installed capacity in 1947, which was nothing much. Prior to that it was only few pockets during British time, just not much electricity was available.

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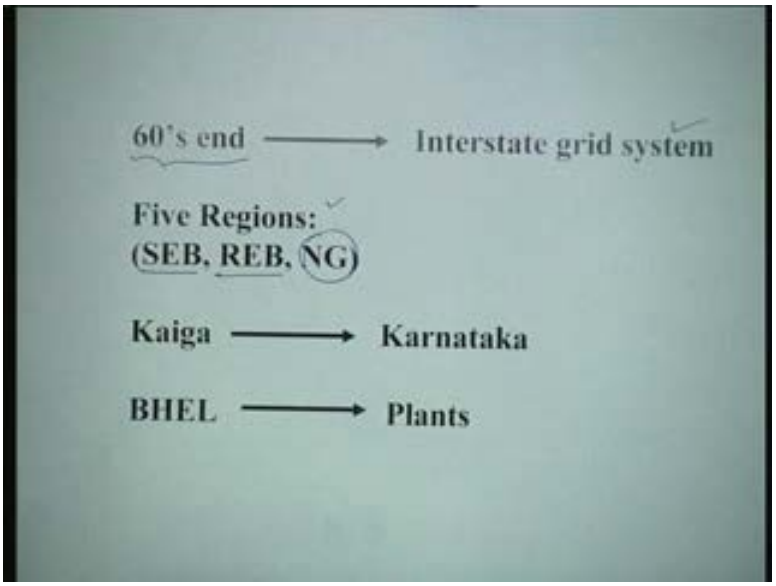

With five year plan, the first five year plan in 1951, we started planning for generation, transmission and distribution. By this 60s end, in 1960s, say by 1970 interstate grid system started. Till that time it was only state electricity boards like the UP state electricity board, MP state electricity board. So, power could not be given to a neighboring state even if you have surplus. For long years Kerala use to be having surplus power, because Kerala is a very small state, very rich in hydro power. If you traveled in Kerala you hardly find any space there and all water everywhere.

So, it is good irrigation, good water and their economy is also good because from every house someone is in middle-east and someone is nurse in medical, Para-medical. They

are all educated; 100 percent education. So, interstate grid means what? They can connect the states and they produce five regions and which where those five region, I will just show to you in the map. NREB, SREB, WREB, eastern region electricity board and north-east, north east always have a special treatment, because they are not developed. These SEB, state electricity board got converted into REB, regional electricity board. Now, next step is why not inter connect these regions and that is natural.

If you have become four figure salary earner and the next aim is to become five figures and so on, if you can make further progress. The national grid, so far, we have been talking from 1980s that we should have a national grid soon. Already 25 years are over and yet we no national grid in place; however, these five regions are now loosely interconnected.

So, in a way, there is possibility or power transfer among this various regions. BHEL is manufacturing power plants; Kaiga is a name of a nuclear power plant in Karnataka. BHEL is exporting power plants. There was a time when we imported power plants from Germany Siemens in 70s. Now, BHEL among strife international competition is able to get contracts or turnkey projects to start power generation in several countries, in the world including developed countries. Do not thing it is doing only developing one, because it works are to be cheaper. In globalization that is the competition is the name of the game.

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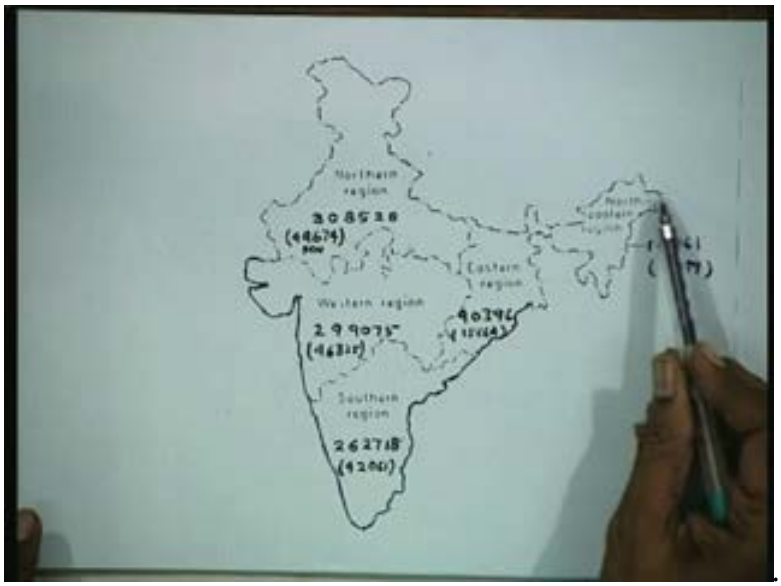

Now as promised this is the map of our country India and these are the five regions. NREB consist of nine states Jammu Kashmir, Rajasthan, Himanchal Pradesh, Haryana, Punjab, Delhi, Uttaranchal, and Uttar Pradesh. Eastern region has Orissa, Bengal, Bihar, and north east is that of Assam, Arunanchal Pradesh, Naga land etc. Western region is Maharashtra, Gujarat and MP, of course, now Chhattisgarh. The eastern regions also contain Jharkhand, which I forget to mention. Southern region is same for southern state like Andhra, Karnataka, Kerala and Tamilnadu.

I have given the mega watts install capacity in these brackets and this is the energy generated as on today; today, means 2002. These figures may change with time because more and more power is getting added and produced. Now, as I have said there are western region is connected to NREB, western region is also connected to SREB. So, there is a tie line through which power can flow in either way, depending on which region is having excess at given point of time.

Of course, if there is a contract obligation then whether it is enough or not, you have to subtract, because you have already entered into a contract. So, once it is a contractual obligation then it is not a question of whether you have or not then you have to. You may have a power cut in your region and that much power you have to satisfy or supply to neighboring region, because you have already entered into a contract; perhaps you have

already taken money for that. What is energy conservation? It is even a course in your M.Tech semester. Are you undergoing this course? It may be next semester.

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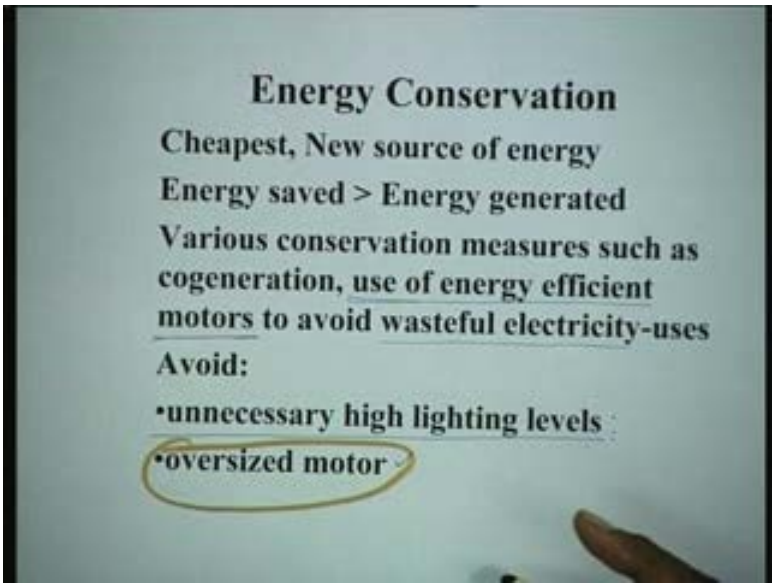

It is very important. There are books written on energy conservation. Why this important? It is cheapest new source of energy. If somebody asks you what is the best way of earning money, do not spend. If you do not spend that money is with you. Same thing, same logic is in with conservation. You conserve the energy that is produced. So, it is with you. It is cheapest is the sense is there is no money. In fact, a dollar saved is more than a dollar earned, or a rupee whichever currency.

Why because if you earn you to pay income tax, if you save, I do not think there is any income tax in most countries in the world. I cannot vouch for all countries. There may be some countries saying why are saving, pay some tax. I am not aware of any such country. That is what it is written here that energy saved is more than energy generated. Why because if you generate and if you take it to the load center there will be a loss on the way, whatever be the amount, let us not go into that. All of you know how much TMD losses are there in our country, but if you save energy, where is the question of any loss. So, 1.25 per unit is equal to, if you save one unit is equivalent to 1.25 unit because if you generate 1.25 to get that per unit, because that 25 percent will get loss on the way.

Various conservation methods, this is a big project in fact each utility now is forced to go for energy conservation and energy audit. That is why I told you to obtain the energy

audit course as and when in the evening. It is worth going and attending that one hour per week if it not include in your MTech syllabus. Co generation, as you have already learnt, I told you about topping cycle, bottom cycle why waste that heat, conserve that heat, collect that heat and use it again to generate power. Use of energy efficient motors, all of you must have done machines course in your third year, second year depending on your university or your college.

We must have seen that motors are used from fractional hour's power to several hundred mega watt. Throughout the world, you do anything, you need a motor. if it is a vacuum cleaner there is a motor there, universal motor, even a shaver, whatever, the fridge, ac, mixture, lathe machine, any machine, workshop, industry, you need thousands of motors being run in the country. Imagine in all these motors, if we replace, they are normal motor, if we replaced by energy efficient motor, how much energy you will save? Instead of having 70 percent, 70 to 80 percent efficiency in a normal motor, the energy efficient motor has efficiency of 90 percent. So, 10 percent higher efficiency means 10 percent less loss, and sigma of that. It is not one motor working, if you take the whole world, my goodness, how many motors are running throughout the world and all of them if you ...do not replace now.

Ask and when the existing motor is outdated, out lived its utility, they are going to throw it, declare it; we are going to write it off, as they called it in management terms. Then at that time while purchasing a new one, at least for god sake, do not repeat the same mistake of purchasing a normal efficient motors, but purchase energy efficient motors. There is full chapter written on energy efficient motors in latest machine books or drives, courses. To avoid wasteful electricity, even simple housekeeping message can improve save energy. A 60 watt bulb in a house, why people have to wait for Diwali to clean it or when it gets fused then you throw it. Why cannot you when do dusting of other things, sofa set, center table, why not you also have a hand on the bulb.

If you clean it, naturally you get more luminescence. Your eyesight won't get spoilt. You will be able to reach much more clearly, but, we do not do this. even if you going for bathroom, you can always switch it off, because it may just possible while coming you may get busy with conversation with someone in the familiar and that fan lights are still on. So, these are the important conservation measures. they should be a switch outside every room, whether in a campus, anywhere, whether institute or hostel or houses, so

that even if you locked and gone out, another man come like, what else, you can switch it off, otherwise it is on or everybody has to pay.

Any wasteful electricity you should be avoided. unnecessarily high lighting levels, if you go to any big building, any five star hotel, if it is necessary yes, by all means you have a high lighting level like a shooting is on, or it is may be Diwali or may be some important function, but why in a normal daily life, why should you have a high lighting levels, what for, and especially you are not reading or writing anything, just chatting.

You please understand that in each five star hotel a 40 percent bill of that hotel is for electricity bill. So, high is a lighting level. Oversized motor, selection of motor must have been a very important topic in a utilization of electrical energy course, whether you have Taylors book or Vadvas book or Prataps book or any book, stars book. every book has to talk how to select a motor for a given purpose. Normally you tend to select oversize motor in thinking that in future there may be expansion. Who knows when there will be an expansion, it may be other than around, you may not get business, you may have to cut down your production, then it is happening in the reverse, rather than expansion you are going for other direction.

So, this oversized motor, which you designed for a given purposes, further gives you loses. And you all understand sometime working at full load is more efficient. your have drawn efficiency curves and if you were getting half load, you are working, just we have talked about energy efficient motors, and now yourself are not using it correctly.

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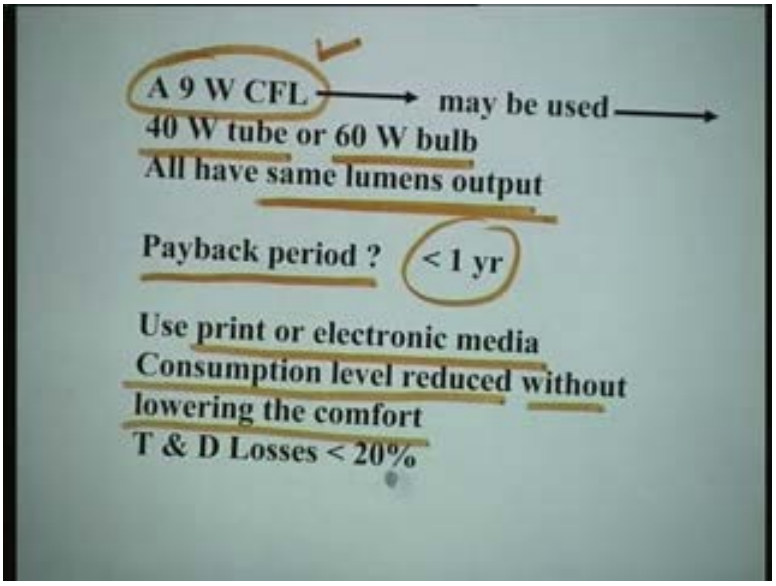

I think all of you know that a 60 watt bulb, 40 watt tube and 9 watt CFL; what is CFL? It is compact fluorescent lamp. Even in train now days you go, you have a fluorescent lamp, even in houses, where 9 watt is, where 40 watt is and where is 60 watt. In fact, this 40 watt is 54 watt, if you considered the chokes and other things for wattages. So, the energy consumption gets drastically reduced. If you replace bulbs, tubes by CFLs. Now, there is a problem of course, all of them have a same lumen output.

I am sure you have done illumination course in your graduate; luminous intensity, intensity of lamination and so on. The problem is cost, a poor person may not be get, then now it is cost coming down constantly, when it started with a 400 rupees and with Chinese goods coming in, CFL of the Chinese brand is 40 rupees. What is payback period even if the cost is more? Hardly less than a year, few months you are able to recover the extra cost, which you might have spend. But there is a harsh reality here.

The socio economic conditions of Indians, who are BPL, below powered line, are several. The fact is most of the houses by 25 th of every month, hardly any money is left. If you are a single army, of course, now a days there is nobody single army, I am talking about our generation and then when the house ladies says, “Look, the bulb is fused”, you have no money even to bring bulb, forget about CFL or tube. The bulb cost 10 rupees. It is a separate issue of socio economic reality of Indian house wives.

But, otherwise it make perfect sense, if you going to purchase the CFL rather than a bulb or even today bulbs get sold, tubes get sold. I am not sure whether you are aware of the Philips, which came out with thin tube light. There is a normal tube light and thin tube light was priced higher initially. People use to bang the shopkeeper saying that do not thing that we are fools, you are giving me a thinner. I want that. Sir, this is energy efficient. Alright, I do not want that. Then they started making same price for both. Still you know that much of awareness is not there among people. That thin was better than thick, because nobody advertises on that such issues.

We have to use print or electronic media to spread awareness. On just celebrity, the energy conservation day is not enough. Of putting a poster, which normally we do in India, speak in Hindi I will be happy, but nobody speaks. So, those posters are of no use if you are not going to implement it. Consumption level must be reduced. I have been talking about this, but, without lowering the comfort. Do not become blind; do not have such a small bulb, which you are not able to read. That is not the intension. The intension is you should be comfortable and you are not wasting energy.

So, there has to be an optimum mix, the judicious choice. T and D losses in our country are too high and they should be brought within range of 20 percent less or than 20 percent. Imagine, how much energy we can save, how much power we can save, if you can reduce the thefts, the metering is faulty, even if you meter, there is no recovering. There is no billing.

Even if you bill, bills do not reach the consumer. Even if it reaches consumer do not pay, even if they pay, they payless. So, these are all the problems we are facing in our country. Use technology, the technology is normally misused. Yesterday in a TV program they were showing on how just making an ISD call, you can have a bomb blast anywhere in the world. A circuit gates connected, just while making a call, so why technologies is being used for bad purpose? Why not for good purpose?

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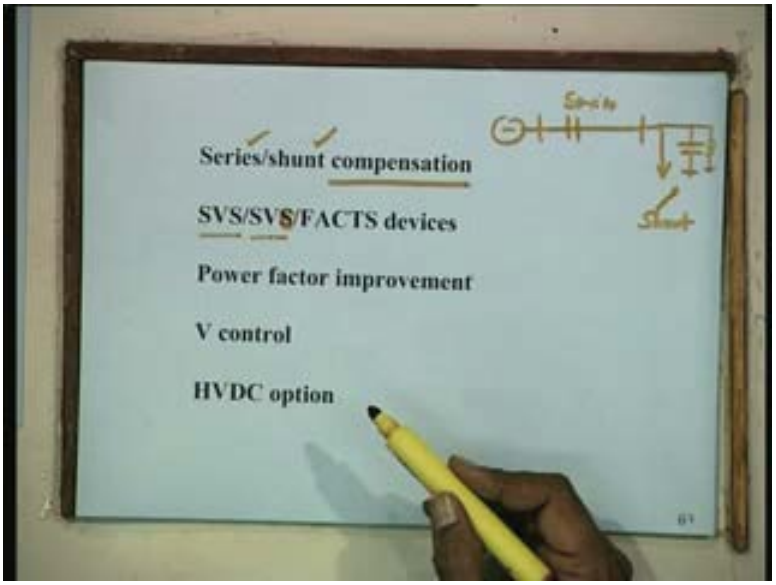

There is a compensation; series and shunt, you might have read already. Just by investing few rupees, if you can save several hundred; several thousand then why not, and the compensation is series and shunt; this is a transmission line, this is a load. Others have shunt capacitor or shunt inductor or you can have capacitor here, this is series and this is shunt. What is the cost? Just cost of a capacitor and it will improve three in one. As I said on the other day, the power factor gets improved, the efficiency goes up and of course, voltage control gets better, regulation better. So, this svs, static watts system svc static watts control, and svc it should be.

Static watt compensator, facts devices, power factor improvement, voltage control, HVDC option, wherever is possible you should go for a HVDC. In our country, now as I told you from north to east to south, there is a 2000 mega watt corridor, they have created for HVDC. HVDC, another use is of course that asynchronous back to back dimension, which is there in subguda or in so many other places.

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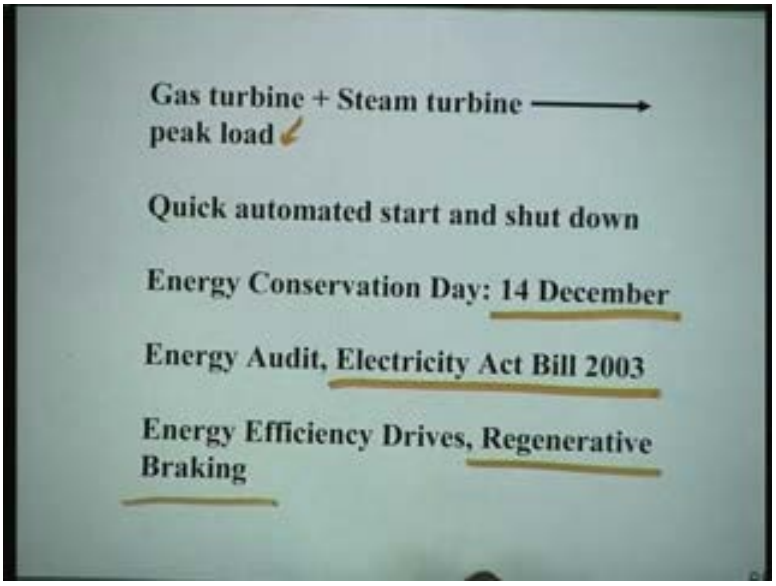

We have a combination of gas turbine and stream turbine, combines cycle. The gas turbine used for peak load and steam turbine for normal load. Quick, automated start and shut down is possible with gas turbines. we do celebrated several days in our country like children's day 14 November, Sadh Bhavana divas for anti-terrorism day. So, we also celebrate energy conservation day on 14th December every year, but this day should be celebrated in such a way that we make people more and more aware what is this all energy conservation about.

Energy audit; electricity act bill of 2003; how many people talk on this bill? They talk about women reservation or SC, ST or OBC, but why is the media not interested in talking on electricity act bill, which was passed, but hardly any panel of discussion or anything on this particular bill. Energy efficiency drives regenerative braking, and I am sure that you must have learnt braking in undergraduate, plug-in, rheostatic braking, and regenerative braking. In traction, the electric trains, we have perhaps the biggest railway network in the world and our terrain is not so smooth throughout India. We have ups and down, whenever we are going down the hill we should regenerative braking, like coming down from Shimla to Kalka and can save lot of power.

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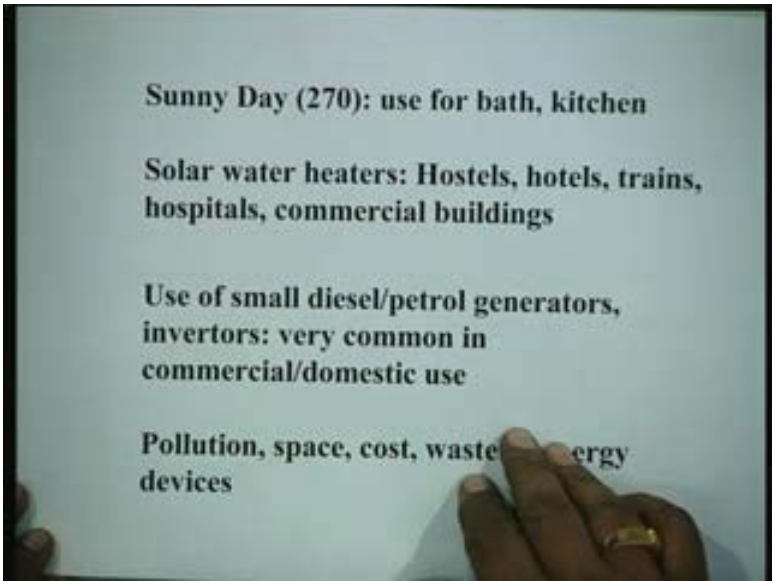

Talking about sun, the solar, I told you that we have 270 sunny days used for bath and kitchen or whatever. Did I tell you what our forefather is to do by keeping bucket of water in the outside and take bath? Whereas we use geezer, you forget geezer is on, you go on watch TV, read newspapers, even take breakfast and the geezer is still on. This I think, I had told you already that solar water heater, hostels, hotels. Are you aware that at (( )) hostel, the energy center has put in solar water heater there. You should be going in seeing that.

You may ask me question what we do solar water heater in summer, but, wash our utensils in a mess, rather than cleaning them with cold water. Hygiene is always a question mark. So, it will be better if you wash your vessels with hot water which is available in free of cost in summer days. Similarly, I told you about hospitals and commercial buildings and so on. Now, we use inverters, inverters users are gone up. Do we realize that most of us have only two rooms at houses; (( )). The majority of us and even you are facing the music now having three students in one room, where is the space to move even. You may not be facing, but the undergraduate students do have to stay like that or I.T hostel or somewhere. I was told that even in wardens' house, some 16 girls are staying.

So, space is the problem and then if you have an inverter, I am sure you cannot sleep in that place in the room available. If you put outside the house, tomorrow you may not find

it. So, you have to put it inside the house and whichever the room you put it, since the fumes come, the gases come, there is the acid, and I do not think that you should sleep. Even some research has been done on those mosquitos' mats and all those things, there are some fumes coming out and you inhale them. I am sure it is not room freshener, it is not deodorant, which is now a day's every person using in different quantities different frequencies.

So, inverter is must and yet it is again a health hazard. Do not think that only bottle water or Coke or Pepsi having parasites. So, pollution space caused wasteful energy devices. So, use solar energy inverter which is available in 1600 rupees, again available in that Adhitya shop. For two bulbs, two fans it can be used with that and it gets automatically charged inside. I also want to tell you the photovoltaic type is being used in night time in Rajasthan on camel back. Why because you get a light, because it is a dark, the electricity has not reached villages, as I told you and in dark you cannot go. It is safe and you are secured also. In fact in a Kargil war the Pakistani soldiers use PV jackets, whereas our soldiers were not having proper shoes, where is the question of PV jackets and that keeps you warm.

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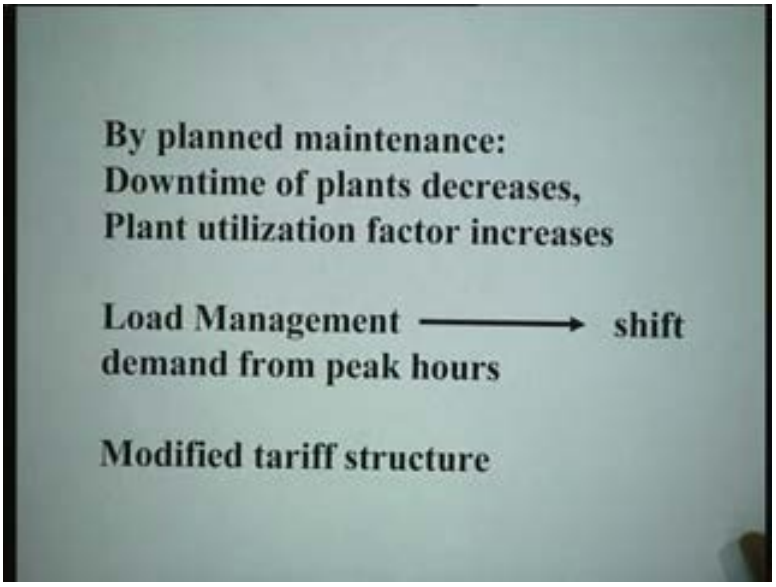

So, the photovoltaic has applications in every walk up life. Maintenance, as I have already talked about it some time back. The down time of plants will decrease; I told you about the bath the curve also. The plant utilization factor will grew up. If the plant is

down, naturally you are not able to use it. If your car is not available, it is staying in garage for more number of days than in your garage, naturally what is the use of spending 2 lakhs. So, that should be available to you for most number of days, rather it should find parking in workshop. Load management is a very important topic. There is a paper of 60 pages by the Talukdhar on load management.

Anybody wants to know more about it, the reference I have given in my book, in first chapter, and read that paper, in case you want to do more work on energy management, load management, the management has become very important along with IT. Everybody wants to have the BTech degree from computer science in IIT and then MBA from Harvard, if not from IIM, Ahmadabad or Lucknow. So, these load management, energy management, you can shift demand from peak hours. You have already talked about those five golden rules and then modified tariff structure.

The tariff has to be modified and we will take more about it on Friday about modified tariff structure. How we have to restructure it? With privatization it will be possible. Now, I will ask, I will request you to have few questions clarifications or suggestion whatever we are covered today. Does down time of the plant means the repairing time? No, down time in plant means is not available for generation. Of course, that includes time of repair also, because while repairing also the plant is not available. It depends on you how much of time you take time to call the repair team, if you do not have anyone. Sometimes, you do not have in house, but now it is the era of outsourcing that is what US started doing. It started giving their problems to India rather calling Indians there. They found it cheaper and that is why our security is also outsourced. Everything will be outsourced nowadays because then you do not have to spend, there are not you employees. Is there any other question?

Well energy efficient motors will have a better cooling, better insulation, so more costly. That is why they are costlier, because you are putting more in and due to that the losses get minimized. There is no other magic, just by calling them energy efficient motors, they will have more efficiency. That means we have to change the design and itself is a very important fascinating topic. Please read any modern machine book of PC Sen or Fizrads sixth edition. Even our book, machines book, I do not know very well it also talks more about energy efficient motors. So, well the ladies and gentleman I must thank you for today and I will see you on Friday.