Selection of Nanomaterials for Energy Harvesting and Storage Applications

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Lecture - 15
Other Energy Resources

Hello my friends, in this particular lecture, we are going to discuss about the Other Energy Sources. So, in our last couple of slides or maybe the lectures we have discussed about some type of conventional energy sources like the thermal energy or maybe some kind heat energy. So, in this particular section, we are going to discuss about some kind of unconventional energy resources or maybe the conventional, because we will talk about the conventional and non-conventional both in this particular lecture.

So, you can see that except the heat or maybe the thermal or maybe some other means or maybe the electric rather we are going to discuss some kind of natural resources, basically, that wind energy or maybe that tidal energy or maybe some other means.

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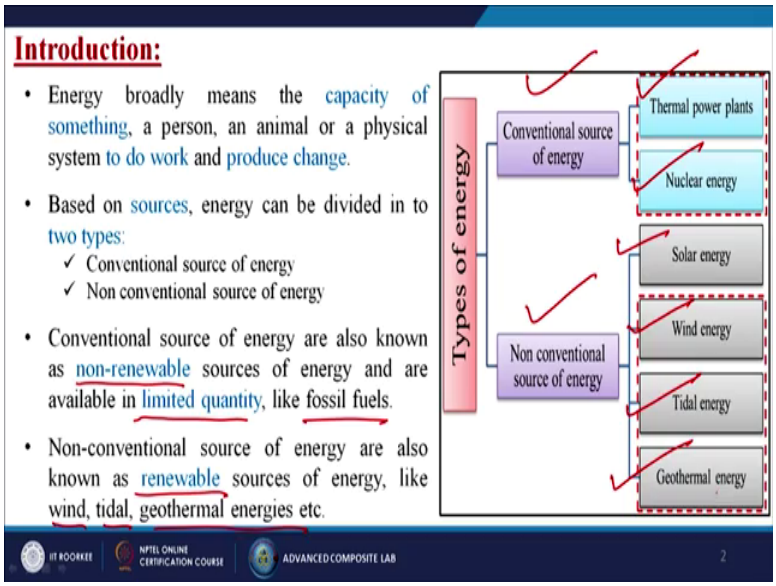

So, basically in this particular case we are going to discuss about the non-conventional source of energy and some conventional source of energy also. So, basically if we divide the energy sources, there are two methods; one is called the conventional source of energy, another one is called the non-conventional source of energy.

So, by this, we can divide the total energy spectrum in the universe into two broad spectrum. How, because the conventional source of energy are also known as non-renewable source of energy and are available in limited quantity like the fossil fuels means I am talking about some petroleum products like petrol, diesel kerosene. So, these kind of fossil fuels. Non-conventional source of energy are also known as renewable sources of energy like wind, tidal, geothermal energies. So, these all are the non-conventional energy sources.

So, if we talk about two types, so conventional source of energy like thermal power plants and the nuclear energy, that means, by using the nuclear materials basically. Then if we talk about the non-conventional source of energy, so that is basically depends on the solar energy, wind energy, tide energy and the geothermal energy. Now, if you remember that we have briefly discussed about solar energy and about the thermal energy, basically the pyroelectric or may the piezoelectric materials in our previous lectures. So, in this particular lecture, basically we are going to discuss about the thermal power plant, nuclear energy, wind energy, tidal energy and the geo thermal energy.

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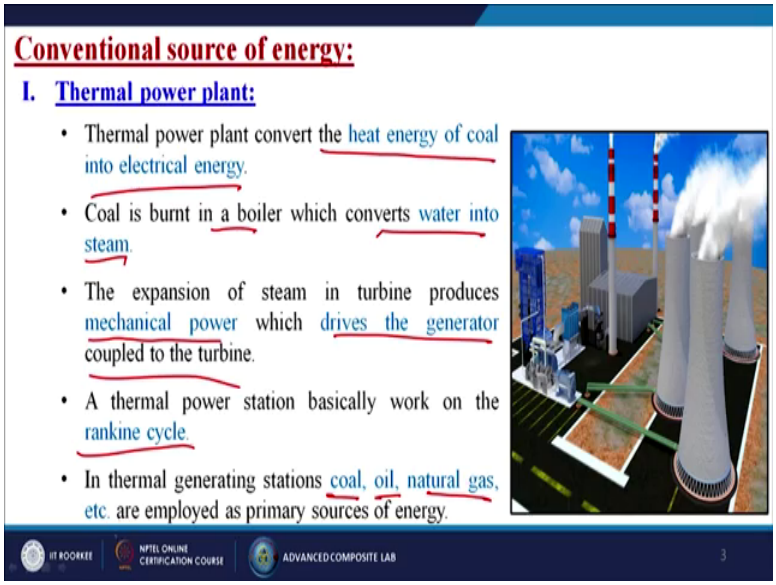

So, now what is conventional source of energy? So, first as I told already if you remember when I am talking about the conventional source of energy, there are two types; one is the thermal one and other one is the nuclear one. So, if we talk about the thermal power plant, so what actually it is doing or maybe what mechanism basically it

is working. Thermal power plant convert the heat energy of coal into the electrical energy that is the simple layman word.

So, coal is burnt in a boiler which converts water into the steam, and then due to that high pressurized steam it is rotating the turbine, and then generator is coupled with the turbine, and we are generating the electricity. So, basically in this particular case, one source of I can say heat energy also it is one kind of thermal energy, because the coal is we are burning, then it is making the water into the steam. So, thermal energy is converting into electrical energy.

The expansion of steam in turbine produce the mechanical power which drives the generator coupled to the turbine. Thermal power station basically work on the Rankine cycle. So, basically there are so many types of heat cycles are available. Like one is that Rankine cycle, one is that called the simple Diesel cycle on which generally the cars, or maybe that bus, trucks they are working. So, these all are calling basically the heat cycle and the scientist who has invented this one based on their name, basically we are calling it as a Rankine cycle or maybe Otto and Diesel that is why I am calling it is a Diesel cycle, so that nomenclature is something like this. So, in thermal generating stations, coal, oil, natural gas, etcetera are employed as primary source of energy.

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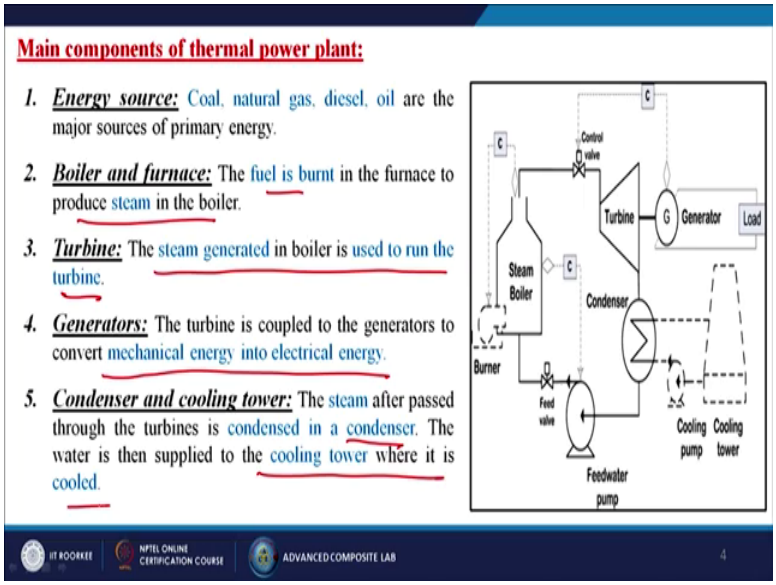

Now, what are the components of the thermal power plant? As I told already first is that energy source, coal, natural gas, diesel, oil are the major source of primary energy, that

means we are burning those fossil fuels either coal or maybe that some natural gases or may be the diesel, or maybe some petroleum products, or maybe some kind of oil.

Boiler and furnace the fuel is burnt in the furnace to produce the steam in the boiler itself. Turbine the steam generated in boiler is used to run the turbine blades. Generator the turbine is coupled to the generators to convert the mechanical energy into electrical energy.

Condenser and the cooling tower the steam after passed through the turbines is condensed in a condenser, the water is then supplied to the cooling tower where it is cooled, so that means, it is a one kind of recycling process. So, when the excess steam or may be unused steam, simply it is going to the cooling tower; and then from steam, again it is becoming into the water; and then that water, again it is coming into the chamber or maybe that furnace; and then again it is heated up, steam is generated. So, it is a one kind of you can say that is a circular things or maybe closed loop.

So, what are the materials basically we are using in thermal power plants like MOF. It is nothing, the full form of the MOF is known as the metal organic framework. So, basically MOF materials because this is a some kind of complex kind of materials. I have told many times in my lectures that everyday our demand is increasing. So, it is not possible to achieve all the desired properties by using a single or maybe the virgin metal or maybe the material. So, that is why people trying to add different types of materials to enhance the overall properties as per their choice.

So, if I use a single material, may be one property will increase, but some other property will decrease, but my requirement is that both the property should increase. So, how I can I achieve then only I will apply two materials in which both the material will increase both the properties. So, I can make some kind of complex kind of materials and that is the best example is that MOF materials, that metal organic framework. People are working on it.

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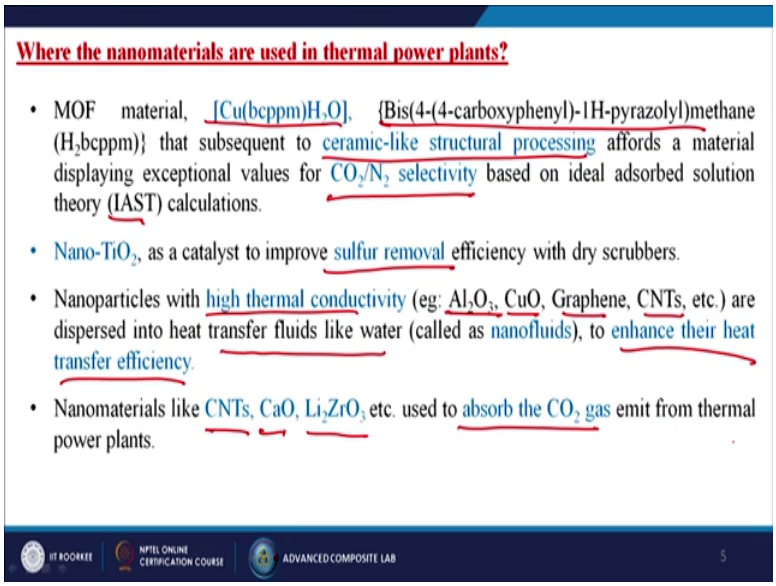

It is some kind of this kind of structures basically people are using that subsequent to ceramic-like structural processing affords a material displaying exceptional values for carbon dioxide and nitrogen selectivity, so basically for the sensor purpose based on ideal absorb solution theory which is nothing, but the IAST calculations. Nano-TiO2, nano titanium dioxide as a catalyst to improve the sulphur removal efficiency with dry scrubbers.

Nano particles with high thermal conductivity like alumina - Al 2 O 3, copper oxide – CuO, graphene, carbon nano tubes are dispersed into heat transform fluids like water, basically this process is known as the nano fluids, because we are adding certain kind of nanoparticles into the water, so that it can absorb more heat. And not only that it can withstand that particular heat for a longer time, so that the material or maybe the water will not cool so quickly, to enhance their heat transfer efficiency.

Nano materials like carbon nano tubes, calcium oxide, lithium - Li 2 Zr O 3, lithium, basically it is lithium zirconate used to absorb the carbon dioxide gas emits from the thermal power plants.

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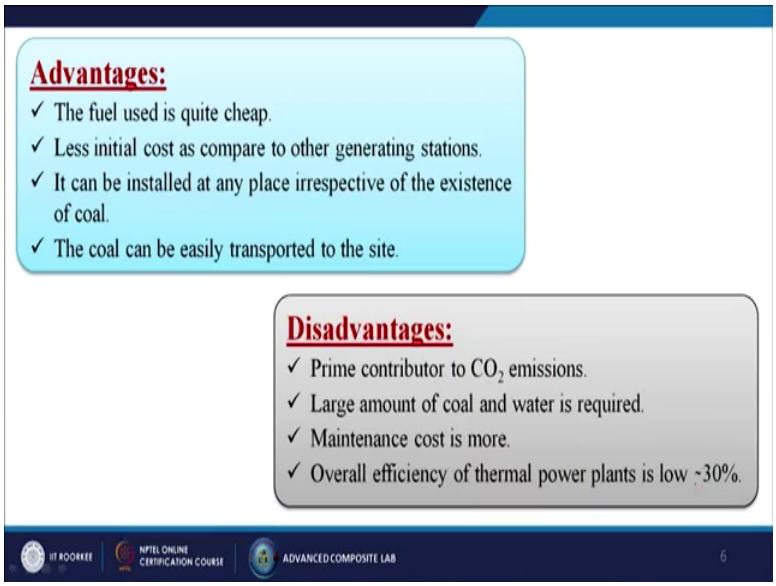

What are the advantages? The fuel used is quite cheap; less initial cost as compared to other generating stations; it can be installed at any place irrespective of the existence of coal. The coal can be easily transported to the site itself. Of course, there are certain disadvantages. What are those? Prime contributor to the carbon dioxide emissions, yes, of course, because when you are burning the coal, so it generates certain kind of toxic gas which is directly going into the environment, so that is a hazardous materials for our body. Large amount of coal and water is required. Maintenance cost is more, because you are transforming the high amount of heat from one place to another place, having a boiler which is running in a very high temperature and pressure, so of course, that is why the maintenance cost is higher. Overall efficiency of the thermal power plant is low as much as 30 percent.

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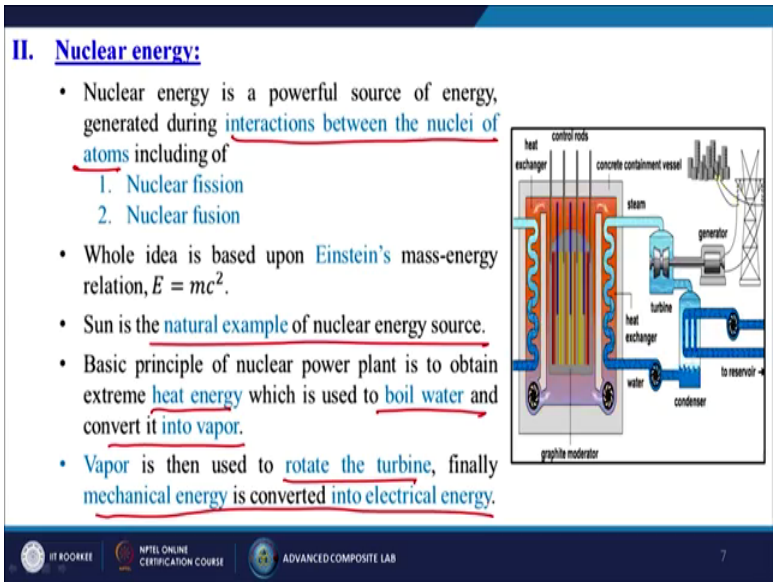

Now, we are going to talk about another conventional energy sources that is called the nuclear energy. So, basically the nuclear energy is a powerful source of energy generated during interactions between the nuclei of atoms. So, basically this works into two theory; one is called the nuclear fission, another one is called the nuclear fusion. So, little bit difference in between that fission and fusion which I will come into the next slide. So, basically this works based on the Einstein theory that is nothing but the E is equal to mc square. So, based on this theory this power plants basically works.

In this particular, case sun is the natural example of nuclear energy source, because everybody knows that every day we are getting whatever the temperature in the daylight directly from the sunlight itself. So, basic principle of nuclear power plant is to obtain extreme heat energy which is used to boil water and convert it into vapor. Vapor is then used to rotate the turbine; finally mechanical energy is converted into electrical energy. So, this is the simplest method.

So, I am boiling, steam is generating, that steam is rotating your turbine, then turbine coupled with generator, the generator is rotating, and it is generating the electricity. So, it is the simple principle.

Now, let me discuss about the nuclear fusion and nuclear fission. So, basically the nuclear fission, fission is nothing, when I am talking about the fission means break. So,

basically a larger particle will break into the smaller, smaller particles, so that is the concept of the fission.

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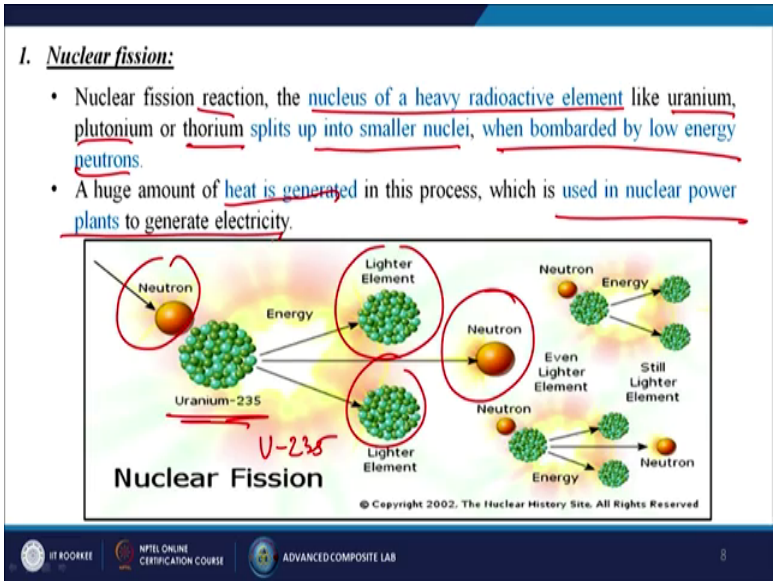

Nuclear fusion reaction the nucleus of a heavy radioactive element like uranium, plutonium or may be the thorium splits up into smaller nuclei, when bombarded by low energy neutron. So, in this particular, we are using the uranium 235 that is means maximum cases we are using this uranium 235 or sometimes you are calling it as a U 235. So, basically this is the well available materials, and maximum cases all over the world the people are using the U 235 source.

So, when that U 235, I am hitting by the neutron itself. Now, you can see that lighter element as I told you already, so it is breaking into the small, small particles, and it is same neutron it is following. A huge amount of heat is generated when it is breaking into the two parts which is used in nuclear power plants to generate the electricity. So, like this way we are breaking the U 35, and then we are generating the energy, and that energy we are converting into the generations of the electrical energy.

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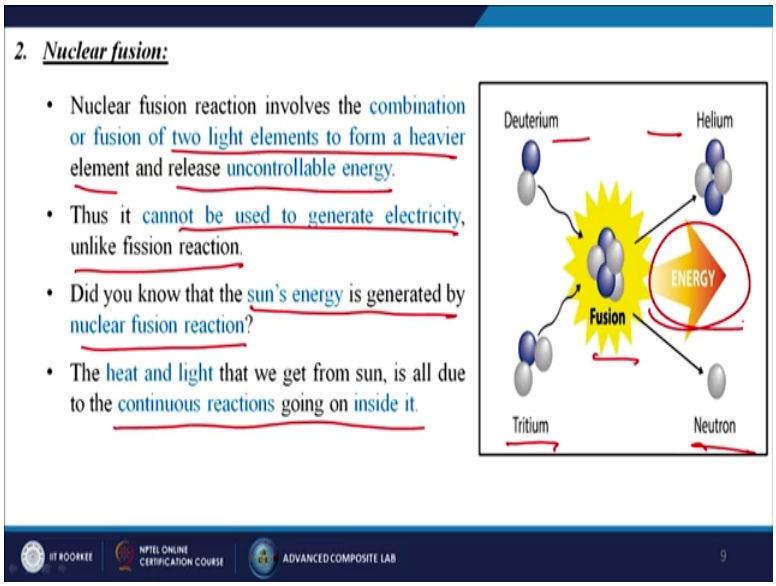

Next come to the nuclear fusion. Nuclear fusion reactions involves the combination of fusion of two elements to form a heavier elements, and release the uncontrollable energy. It is just the opposite one. In the earlier case, one material, we are hitting that materials, breaking into small, small parts, we are collecting the energy. In this particular case, we are having two or three materials, we are combining each other; due to that combinations high heat generation is taking place. Thus it cannot be used to generate electricity, unlike fission reactions. Did you know that sun's energy is generated by nuclear fusion reactions?

The heat and light that we got from the sun, is all due to the continuous reactions going on inside it. That means in the sun there are certain materials all time they are doing the reactions due to that reactions high heat energy and the light energy it is generating which we are basically are getting from the earth's surface.

In this particular case, what happen if I add deuterium and the tritium, so if I do the fusion, so automatically it will produce the helium and the neutron and high source of heat energy it will produce. So, that means, these two materials will come and they will generate heat and the light along with helium and the neutron.

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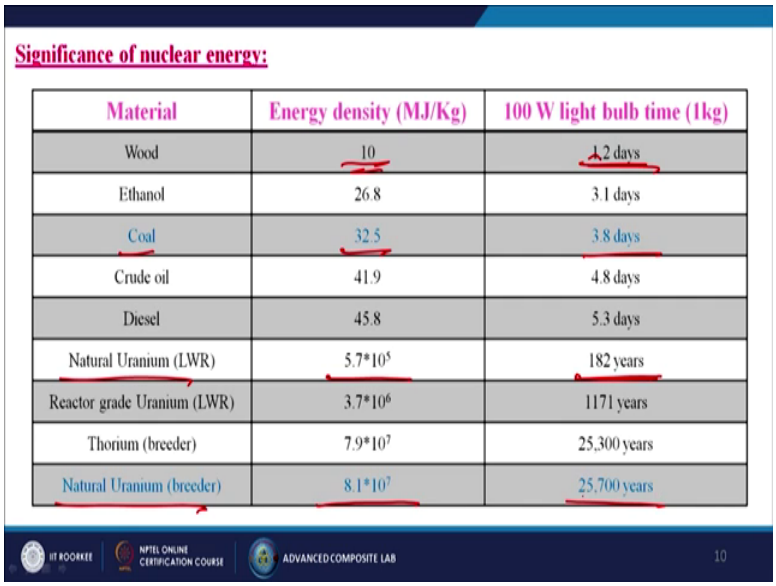

Now, what are the significance of nuclear energy. So, basically in this particular table you can see that if we use the wood as a nucleus source, so what is the energy density that is Mega Joule per kg that is only the 10; 100 watt light bulb time, it is only 1.2 days it can glow. But if we talk about the coal, it is 32.5 Mega Joule per kg. And what is 100 watt light bulb time, so it the bulb can glow for 3.8 days. But if I talk about the natural uranium, now we can see that how drastically values are changing, it is coming 5.7 into 10 to the power 5 Mega Joule per kg. And it can glow that bulb for 182 years. And nowadays people are using the natural uranium which is nothing but known as also the breeder material. So, its energy density is 8.1 into 10 to the power 7, and it can glow that particular bulb for 25,700 years. Now, you can see that if we are able to get these materials that at least for how many years we are in the safe region.

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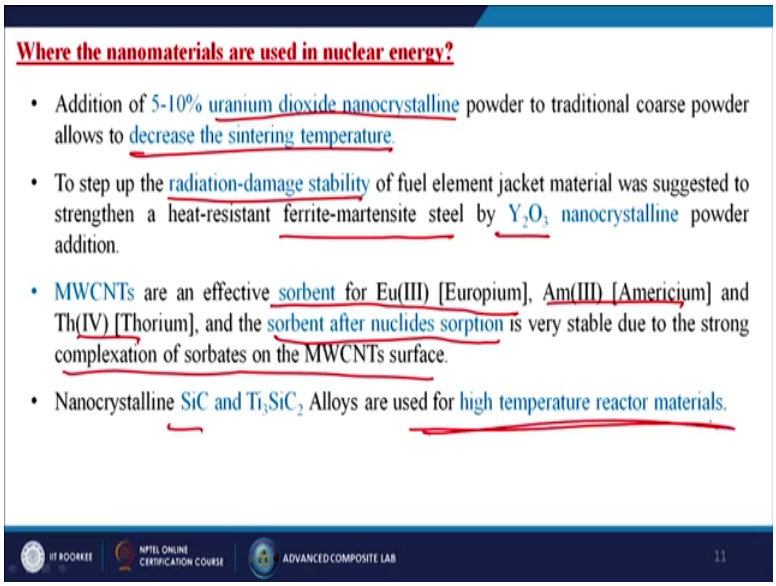

Now, what kind of nano materials basically we are using for this nuclear energy generations? Addition of 5 to 10 percent uranium dioxide and nano crystalline powder to traditional course powder allows to decrease the sintering temperature. The radiation-damage stability of fuel element jacket material was suggested to strengthen a heat-resistance ferrite-martensite steel by yttrium oxide nano crystalline powder additions.

MWCNTs – Multi Wall Carbon Nano Tubes are an effective sorbent for Europium 3, Americium and Thorium, and the sorbent after nuclides sorption, and the sorbent after nuclides sorption is very stable due to the strong complexation of sorbents on the multiwall carbon nano tubes surface. Nanocrystalline like silicon carbide or may be Ti 3 Si C 2 alloys are used for high temperature reactor materials.

So, basically these kind of materials we are using for generation these kind of nuclear energy. Yes, of course, because now you can understand that how much energy it is producing. So, of course, we are doing it into inside some vessels or maybe some materials, so that material should have that capability or maybe that capacity that it can withstand that much of energy without any distortions or maybe without any physical or chemical properties change. So, that is why people are using these kind of materials which can withstand that much of energy.

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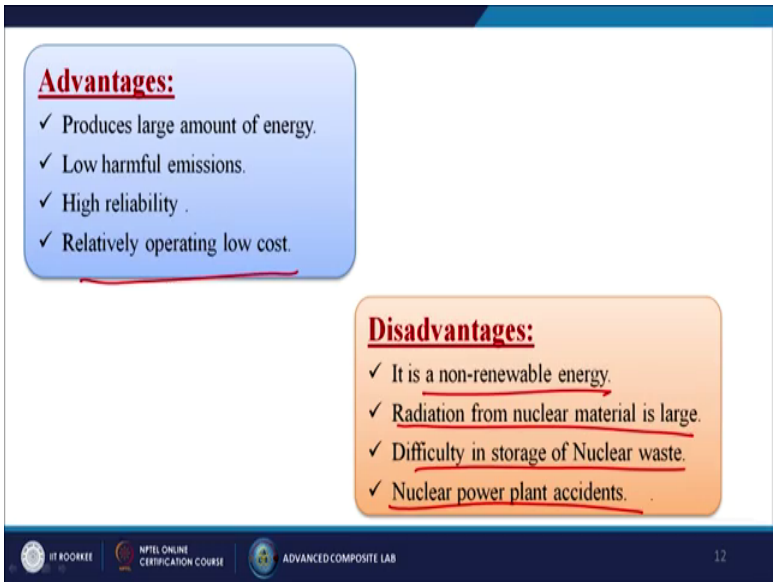

Now, what are the advantages? Produce large amount of energy; low harmful emissions; high reliability, and the relative operative low cost. Of course, there are certain disadvantages. What are those? It is a non-renewable energy. As I told it is the simply the conventional energy system. Radiation from nuclear material is too large, and sometimes it is not good so that is why few years back you can heard about that some kind of nuclear leakage has been taken place in Japan or maybe sometimes it happened once in India also in the (Refer Time: 17:10).

So, these all are the problems. So, basically we have to use that materials very carefully because he is very harmful for the environment as well as for the human being. So, radiations is one kind of a big concern for using this kind of material. Difficulty in storage of nuclear waste is also very, very difficult, because it should not come into the contact to the soil or maybe the environment; otherwise the people or maybe the human being will face lots of problems in terms of some disease or maybe some kind of other problems. Nuclear power plant accidents is also a dangerous things to the society.

Now, let us discuss about some non-conventional source of energy. So, as I told already the first and foremost is called the wind energy. So, simple, in this particular case, wind is there we are using that particular wind to rotate some kind of turbine, and then the same thing the generator is coupled with that particular turbine, and then we are generating the electricity.

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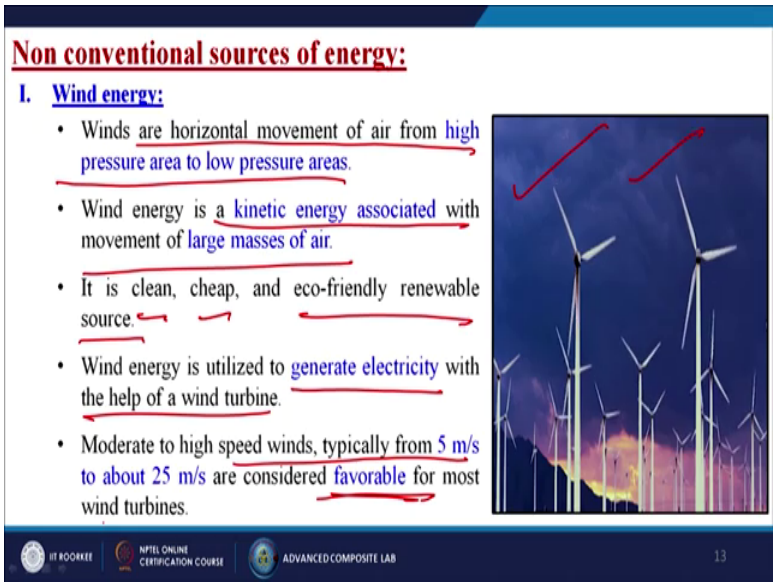

So, basically these all are the systems. And I can tell you probably everybody we have see it, that if we go any kind of seashore over there we can see these kind of turbines are placed at the seashore, because the high wind flow is coming from the seaside level due to the temperature difference, and then that wind it is coming it is rotating the turbine and we are getting the electricity from that particular turbine itself. So, in this particular case, winds are horizontal movement of air from high pressure area to the low pressure areas. As I told already because one side is into the normal and another side we are having that water. So, automatically there will be a temperature difference in between these two.

Wind energy is a kinetic associated with movement of large masses of air. It is clean, cheap and eco-friendly renewable source. Wind energy is utilized to generate the electricity with the help of a wind turbine. Moderate to high speed winds, typically from 5 metre per second to about 25 metre per seconds are considered favorable for most wind turbines.

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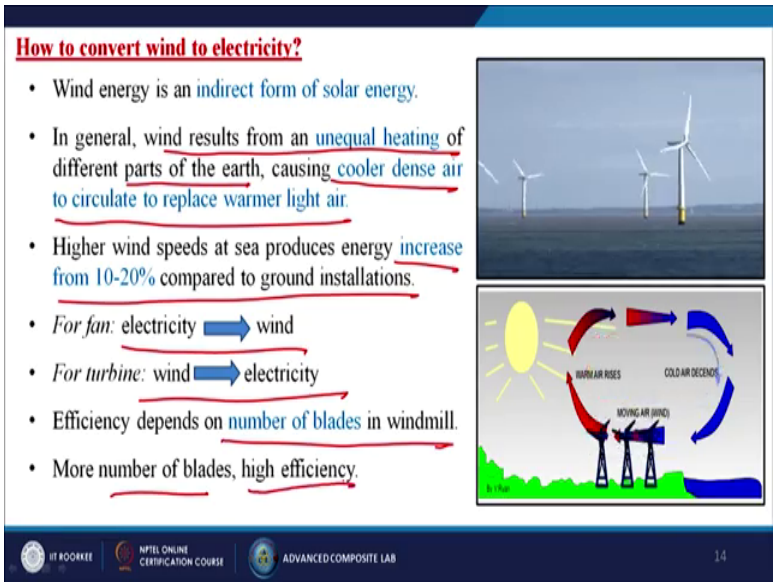

Now, how to convert the wind to electricity that is a good thing. So, wind energy is an indirect form of solar energy. In general, wind results from an unequal heating of different parts of the earth, causing cooler dense air to circulate to replace the warmer light air. Yes, of course, because in the seashore one side is the sand and other side is the water. So, automatically the sand will be more heated up. So, what will happen, here the air became lighter; and here in the sea or maybe on the waterside the water is more heavier. So, automatically the heavy water will come from the higher lower temperature to the higher temperature to occupy that particular place; so, density wise. Automatically the wind will come from the seaside to the seashore side, and you are putting the turbines over there. So, due to that automatically you are generating electricity.

Higher wind speed at sea produces energy increased from 10 to 20 percent compared to the ground installations. For fan, electricity to wind; for turbine, wind to electricity. Efficiency depends on number of blades in the windmill; more number of blades high efficiency. Of course, because if I increase the more number of blades, automatically the air resistance will be more, so automatically it will its rpm will be increasing. And due to that your energy generation will be more.

How to select the material for the wind energy blade material? Yes, of course, because you are putting it into the sea shore. So, sea the water is some kind of salty water or maybe some kind of brine water. So, automatically there is a chance that the win blade

will be corrode very quickly, and maybe some kind of oxide or sulphur formations can be taken place. So, you have to choose the material in such a manner that first of all it can with stand that high pressure of that wind and also this kind of corrosion protection property should have. So, basically first is that low weight to reduce gravitational forces because otherwise if the blade itself is too weighty or may be too bulky, then it will be very difficult to rotate.

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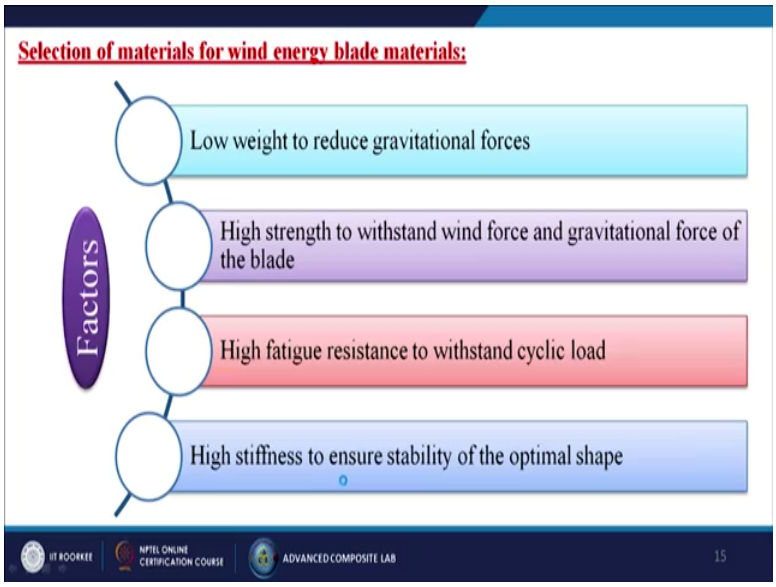

Next, high strength to with stand wind force and gravitational force of the blade. Third fatigue resistance withstand the cyclic load; fourth high stiffness to ensure the stability of the optimal shape. Another important parameter is that as I told already it should be corrosion protective materials otherwise oxide formation or sulphate formations or maybe the abrasion will be taking place. Because in the wind, dust particles are there, so automatically the dust particle will rub your blade and the material will get corroded or maybe the abraded, so that is also the another prime considerations.

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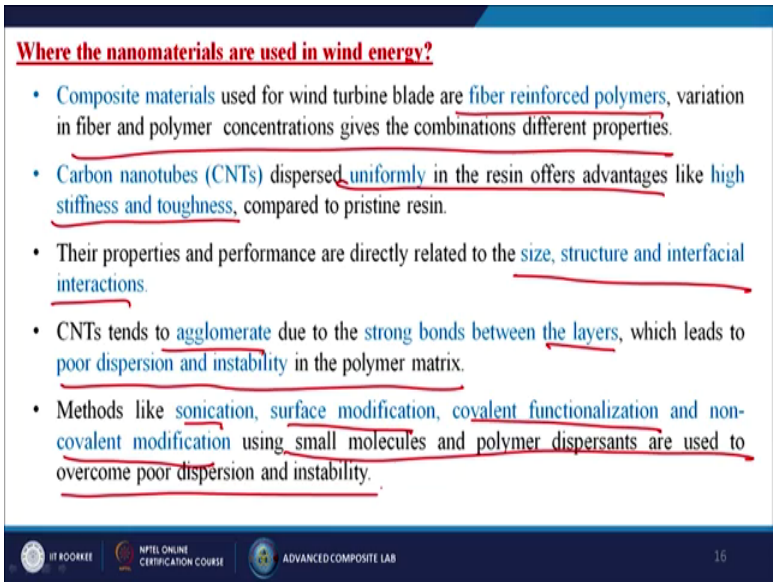

So, what kind of materials basically we are using for generations of the wind energy? Composite materials used for wind turbine blade are fiber reinforced polymers, because their mechanical strength is almost equivalent to the metals, but very lightweight. So, that is why nowadays people are using the fiber reinforced polymers, variation in fiber and polymer concentrations give the combinations of the different properties.

Carbon nano tubes dispersed uniformly in the resin offer advantages like high stiffness and toughness, compared to pristine resin. Their properties and performance are directly related to the size, structure and interfacial interactions. Carbon nanotube tends to agglomerate due to the strong bonds between the layers which leads to poor dispersion and instability in the polymer matrix. Yes, of course, so that is why in the polymer matrix or maybe the polymer fiber, people are adding different types of carbon nanotubes, simultaneously they are using certain kind of linkage materials, so that the carbon nanotubes first of all it will be homogenously dispersed among the matrix. So, that the material can give the overall satisfied performance.

Methods like sonication, surface modifications, covalent fictionalizations and non-covalent modification using small molecules and polymer dispersions are used to overcome the poor dispersion and instability. Yes, sometimes we are doing the wrapping of those fillers. Generally, in the material scientist point of view, we are calling it as a fillers or maybe the additive materials, or maybe we are doing the doping on we are

doing certain kind of surface mortifications, so that it can create a good bonding in between the fillers and the matrices, and not only that it should not agglomerate. So, sometimes we are adding some kind of hydrophobic or maybe the hydrophilic nature of coating, so that the nanoparticles will not stick together, so that it can be dispersed throughout the matrix and we can achieve the better properties.

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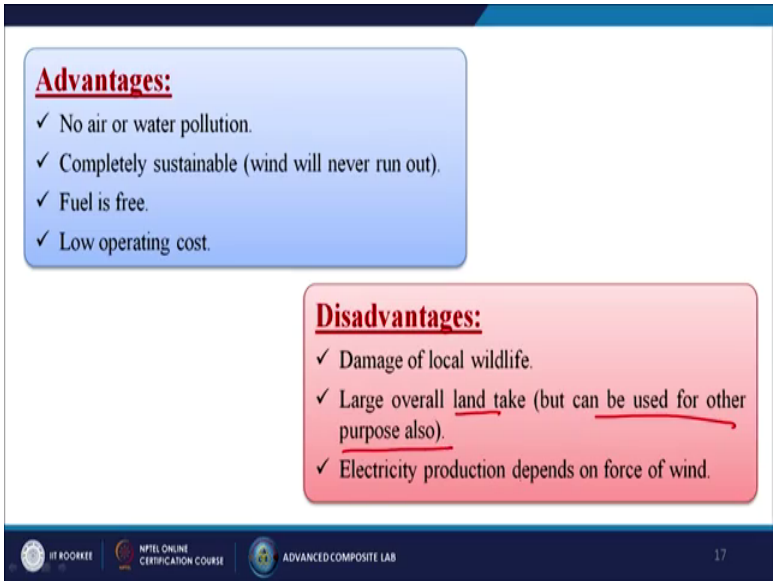

Now, what are the advantages? No air or maybe the water pollutions. Completely sustainable, wind will never run out, because any day time on night time, it will work. Fuel is free. Low operating cost. Of course, there are certain disadvantages damage of local wildlife, because for putting those turbines or maybe the wind mills, you need a larger area. And basically you have to put it either maybe into some forest area or maybe some seashore area where you can find that so many trees and all these things. Large overall land take, but can be used for other purpose also. Electricity production depends on force of wind, because throughout the day the force of the wind is not same, sometimes maybe it can stop, sometimes maybe it can run. So, it is not the continuous one, or maybe we cannot expect a huge energy generation by using this particular technology.

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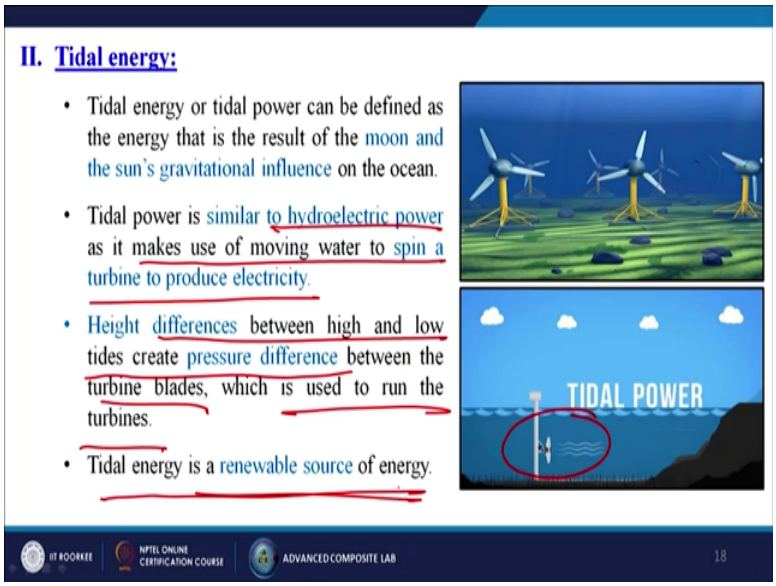

Tidal energy,. So, tidal energy or tidal power can be defined as the energy that is the result of the moon and the suns gravitational influence on the ocean. The biggest example is that maybe in the time of full moon or maybe the half-moon or maybe the no moon time, you can see. In the full moon, what is happening the water level on the pond or maybe the sea or maybe that lake, it is going up; but in the no moon region, so it is going down. So, basically it totally depends upon the moon positions on the earth itself.

So, tidal power is similar to hydroelectric power and it makes use of moving water to spin a turbine to produce electricity. So, when the water is going up, so if I am putting certain kind of dam kind of things. So, one side the water is going up one side is going down. So, automatically there is a height difference in between the water level. So, now if I allow this high volume of water to going to the low volumes, automatically there will be huge force or maybe the speed will be generated. Now I am going to put my turbine blades in between that. So, what will happen, due to that high water flow, this turbine blade will rotate, and then the generator is coupled with that particular turbine blade. So, automatically the electricity can be generated.

So, in this particular case you can see that we are putting sometimes under the water also. So, basically what is happening, when due to this moons positions when the any kind of wave formations is creating into the water itself due to that your turbine is rotating. Height differences between high and low tides creates pressure difference

between the turbine blades, which is used to run the turbines. Tidal energy is a renewable source of energy.

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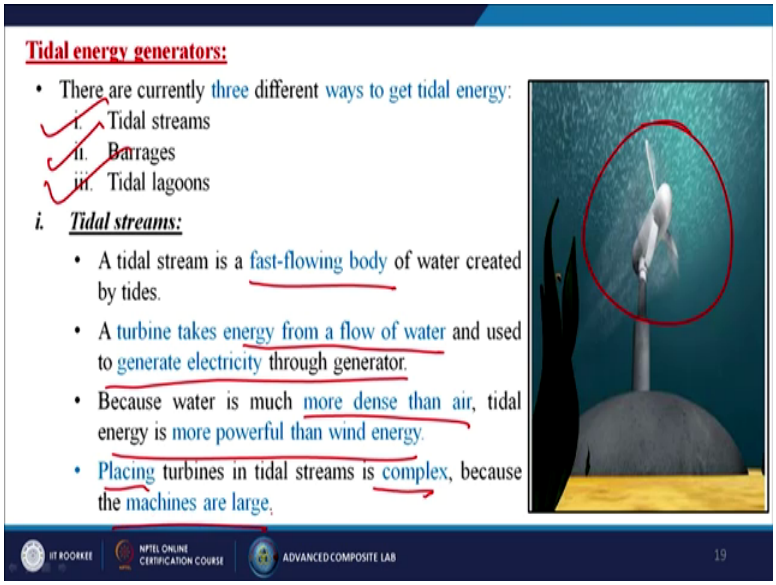

Tidal energy generators, there are basically three different ways to get the tidal energy; one is called the tidal streams, barrages and the title lagoons. So, what is tidal streams? So, basically a tidal stream is the fast-flowing body of what are created by the tides itself. A turbine takes energy from a flow of water and used to generate electricity through the generator itself.

So, you see this is the example over there which we are putting under the sea itself; because water is much more dense than air, tidal energy is more powerful than the wind energy. Placing turbines in tidal stream is complex because the machines are too large.

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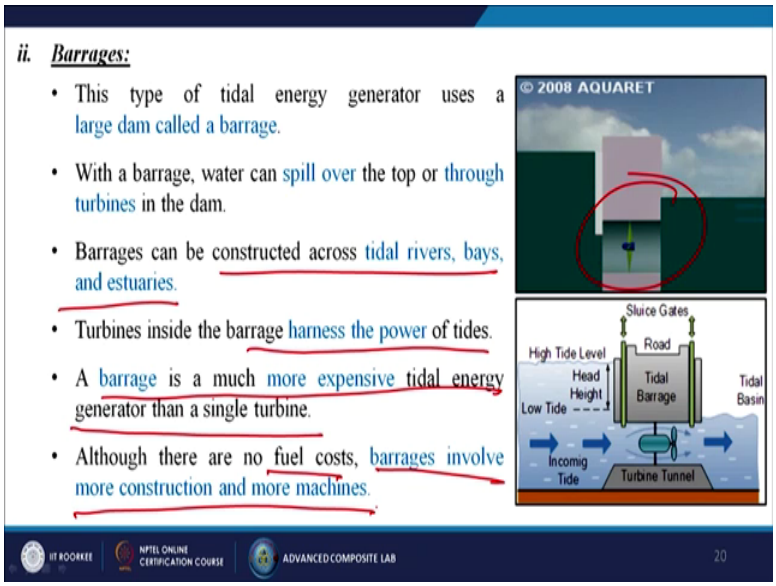

Next is the barrages, simple the barrage or maybe the dam. So, automatically what is that nothing just we are closing the water flow. So, automatically the one side the storage of the water will be become more, one side it will be less. Now, slowly I am allowing the water coming from the higher to the lower end. So, automatically the speed generation will be taking place, and now I am putting my turbine blades over there. So, in this case two things either when I am stopping it. So, automatically this side, the water generation will be more if it can became opposite also. So, this side will become more this side will be less, so that time the turbine wheel rotate into the opposite directions.

But any way if it is clockwise or maybe anticlockwise directions, both the case your turbine blade will rotate, generator has been coupled with your turbine blades and you can generate electricity. So, barrage can be constructed across tidal rivers, bays and the estuaries. Turbines inside the barrage harness the power of tides. A barrage is a much more expensive tidal energy generator than a single turbine. Although there are no fuel cost, barrages involve more construction and the more machines.

So, here the high tide level here is the height difference because this is the level of the low tide. So, this is basically the height difference. And now that is the incoming tide and that is the going. So, I am putting my turbine tunnel in that particular zone. So, automatically the water is going like this in high speed, and then due to which your turbine blade is basically rotating.

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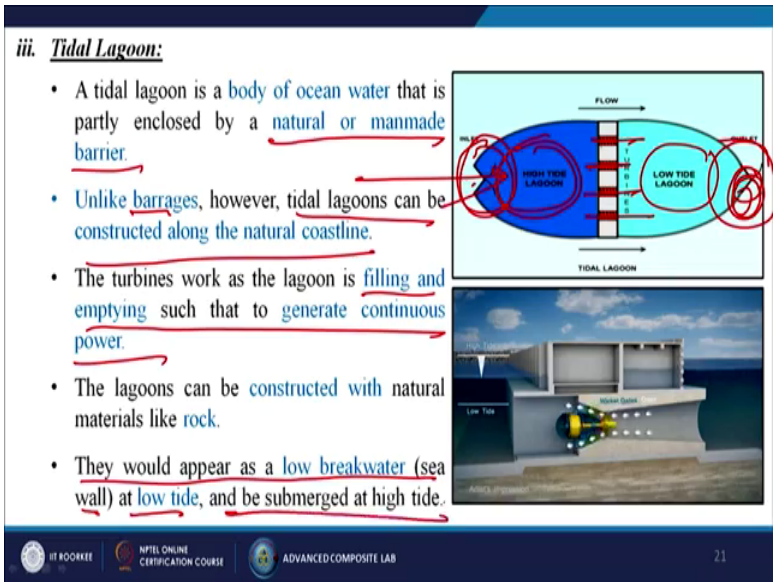

Next one is called the tidal lagoon. A tidal lagoon is a body of ocean water that is partly closed by a natural or maybe the man made barrier itself. Unlike barrages, however, the tidal lagoons can be constructed along the natural coastline. The turbines works as the lagoon is filling and emptying such that to generate the continuous power.

So, in this particular case what happen, so when I am talking about the lagoon, so, one side you can see that high tide lagoon, one side is low tide lagoon, and we are putting the turbine blades over there. So, inlet, that means, the water is going through this particular channel, it is passing through the turbines and it is coming to the other sides. Now, the outlet first initial stage, it is almost into the closed position.

So, what is happening a flow of water is coming from the high pressure to low pressure region. And now again you can close this one, and then the opposite thing also you can do it, so that is why it is the continuous process basically. So, in this particular case, what happened, first initial stage it is the closed position. Now, when have done opening, so flow of water is going from this side to this side, so basically the high tide and low tide, so you can itself create the height difference over there and so that these lagoon can work continuously. They would appear as a low break water or maybe the sea wall at low tide, and can be submerged at high tide.

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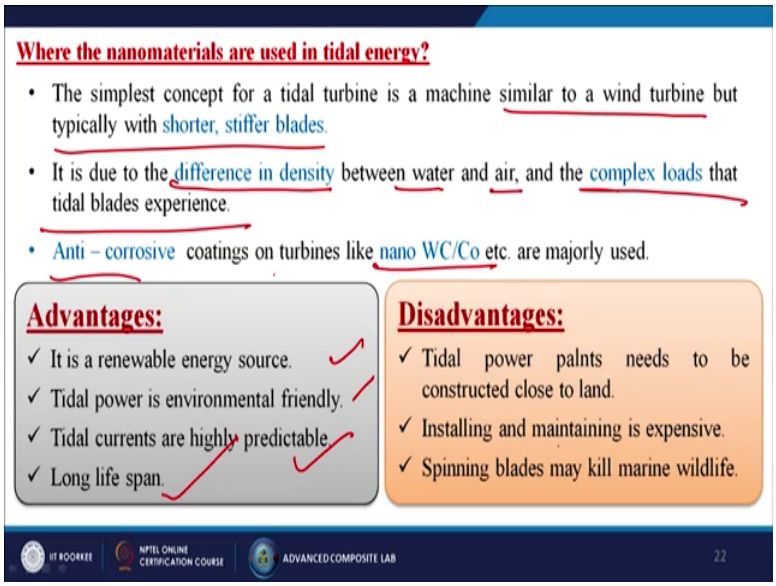

Where the nano materials are used in the tidal energy, the simplest concept for a tidal turbine is a machine similar to a wind turbine, but typically with shorter and the stiffer blades. It is due to the difference in density between water and air, the complex loads that tidal blades experience. Anti-corrosive coatings on turbines like nano tungsten carbide or maybe the tungs nano cobalt are the majorly used.

What are the advantages? It is a renewable energy source. Tidal power is environmental friendly. Tidal currents are highly predictable; long life span. Of course, there are certain disadvantages. Tidal power plant needs to be constructed close to lands; installing and maintaining is expensive; and spinning blades may kill marine wildlife. So, these all are the drawbacks.

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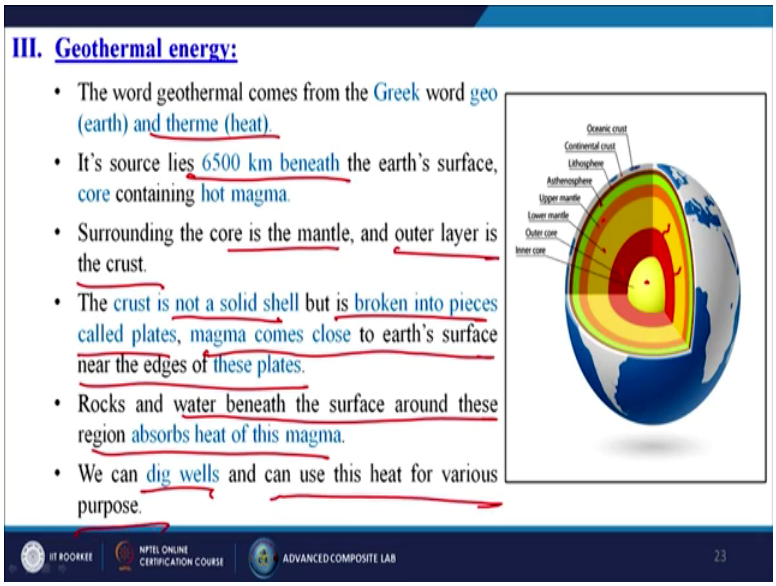

Now, come to the third one that is called the geothermal energy. So, the word geothermal comes from the Greek word geo that means earth and the therme that means heat. So, basically under the our soil, so if we go towards the centre of the earth, so heat is there. And when you are going into the deeper into the deeper, we will get that heat will increase towards the centre or maybe the epicenter of the earth itself. So, its source lies 6500 kilometer beneath, the earth's surface core containing the hot magma. Magma is nothing but the viscous kind of materials.

So, generally sometimes we see that through volcano that kind of materials is coming out that is known as basically the magma materials. So, it is the inner core, then outer core, then lower mantle, then upper mantle, then we are having that asthenosphere, then lithosphere, and then continental crust and oceanic crust we are having. So, basically it is a layer by layer structure. Surrounding the core is the mantle and outer layer is the crust. The crust is not a solid cell but is broken into pieces called plates, magma comes close to earth's surface near the edges of this particular plates.

So, that means, it is having some kind of cracks kind of thing, so that the magma material is coming closer to the earth surface. Rocks and water beneath the surface around these regions absorb heats from this particular magma. We can dig wells and can use the heat for various purposes simply.

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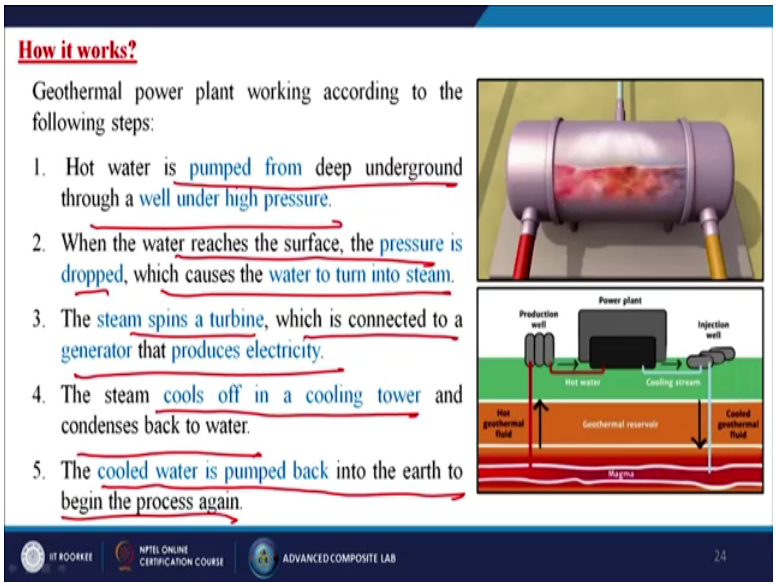

How it works? Geothermal power plant working according to the following steps. Hot water is pumped from deep underground through a well under high pressure. When the water reaches the surface, the pressure is dropped, which causes the water to turn into the steam. The steams spins a turbine, which is connected to a generator that produces the electricity.

The steam cools off in a cooling tower and condenses back to water itself. The cold water is pumped back into the earth to begin the process again. So, simple you are injecting the cool water into the under the earth systems, align that water to make getting absorb the heat from the magma itself, and it should produce the steam. And then that steam you are taking it out and putting on to the turbine and then the rest steam again we are having that cooling tower. So, basically you are you cool it down. So, again it is come back into the water and then again that water you are injecting into the system. So, basically that is a closed loop systems like this. So, recycling is also taking place.

So, you are having that cooling steam; you are having that injection well. You are putting the water near the magma, it is getting heated up, it is generating the steam, it is coming to the turbine. And then the excess one or may be the wastage one hot water, it is going to the power plant through that chiller, it is cooling it down, and then again that water you are injected into the system.

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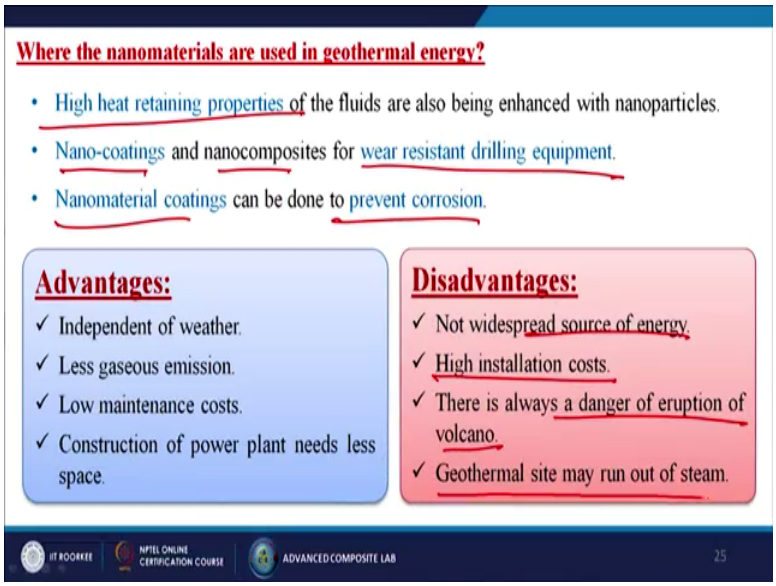

Where the nano materials are used in the geothermal energy? High heat retaining properties of the fluids are also being enhanced with nanoparticles. Nano-coatings and nanocomposites for wear resistant drilling equipment. Nanomaterial coatings can be done to prevent the corrosion. Advantages - independent of weather, less gaseous emission, low maintenance costs, construction of power plant needs less space, these all are the advantage. Of course, there are certain disadvantages also; not widespread source of energy, high installation costs, there is always a danger of eruption of the volcano as I told already. If the magma will get a chance it certainly that hot magma will come out to the earth surface. Geothermal site may run out of steam. So, these all are the disadvantages.

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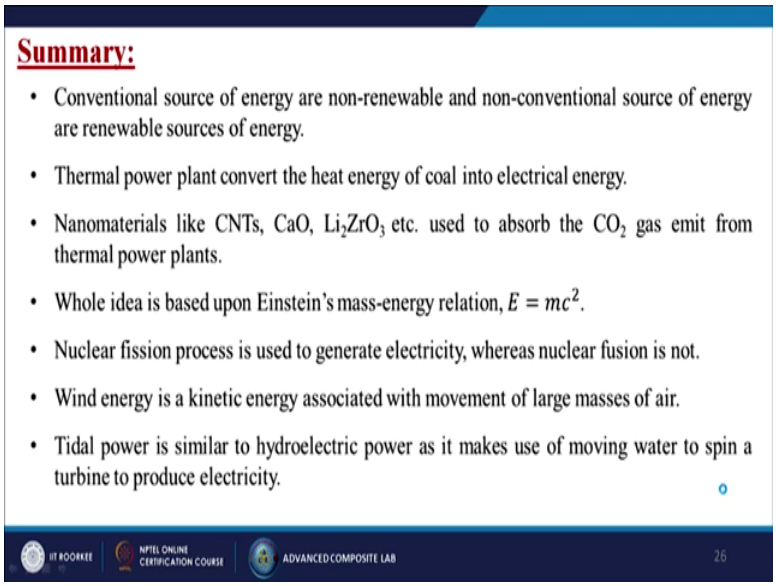

Now, we have come to the last slide of this particular lecture. So, in summary, we can conclude like that, that you have talked about the conventional source of energy, which are the non renewable and the non-conventional source of energy and are renewable source of energy too. Thermal power plant convert the heat energy of coal into electrical energy. Nanomaterials like carbon nanotubes, calcium oxide, Li 2 Zr O 3 etcetera used to absorb the carbon dioxide gas emit from thermal power plants.

Whole idea is based upon Einstein's mass-energy relation, E is equal to mc square. Nuclear fission process is used to generate electricity, whereas nuclear fusion is not. Wind energy is a kinetic energy associated with movement of large masses of air. Tidal power is similar to hydroelectric power as it makes use of moving water to spin a turbine to produce electricity.

Hope you have understand what I actually want to talk about. So, basically this all are the conventional or maybe the and conventional source of energy. These all are the waste energy that waste energy basically we are gathering, storing and then we are using it to convert into the electric energy. So, in this particular lecture, we have discussed about all these things.

Thank you.