United Nations Sustainable Development Goals (UN SDGs)
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Circular Economy

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Hello everyone. So, in this module we will cover circular economy designed for sustainability and thinking alternatives and innovation this is module 6 under the course of UN SDGs.

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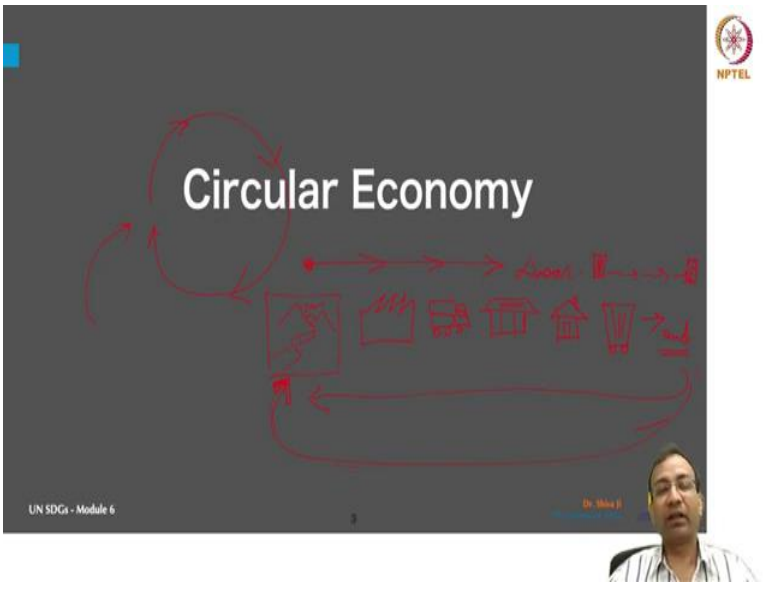

So, first we will see circular economy. Well, what is circular economy? I think before getting on to that we need to know what is linear economy. So linear economy is that conventional economy in which there was a resource exploitation from the nature, resources coming from the natural sources and then it goes to the factory, then it gets manufactured, then it goes on

to the transportation, then it reaches to the markets and then it goes to the shops and then from the shops it goes to the household for consumption to the individual users to the consumers.

And then from here it gets discarded and thrown to the garbage dustbins, landfills etc and it comes to an end, this is a typical linear economy in which the resource which was taken from this place is not coming back here. But when it does it becomes circular economy because it is reaching at the end of a slight step it is going back to the place where it has come, so you are connecting this last leg, this last segment also and you are making this go back to its place of origin, that completes the circle that is why we call it as a circular economy and this one conventional as a linear requirement, because it begins at one place and ends at another place not at the same place. So, this is a typical a difference we will see this in detail.

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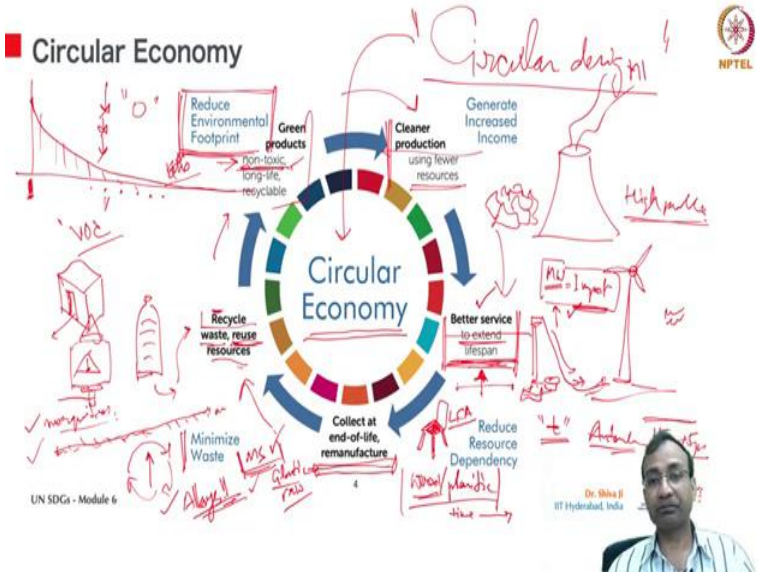

So, this graphic talks about circular economy, you can see from here, collect at end of life, so this becomes the raw material or the resource, then reusing, recycling, etc making a green products, making cleaner products, using cleaner production, cleaner energies, better services and then again so circular economy actually helps in multiple ways.

So, in any of these nodes if you see this has a form of responsibility and accountability towards the environment, it is not trying to pollute as the conventional things used to be. So, here also if you see there is a recycle again making use in some other ways, recycle waste reusing as it is if you want to reuse, for example these bottled water so this bottle if you want to reuse it in some ways or you can definitely recycle it you bring it to the recycling facility and then you kind of, you make it another some plastic item or something that.

And then here we have non-toxic long life recyclable things so non-toxic as we know some products mainly factory manufactured products since they are composed of several chemical compounds in different proportions, so chemical compounds usually they have some kind of impact, they are not friendly or perhaps or they are hazardous to human health or other biological and things and etc etc so those kind of things go into the toxic category.

To give some example VOCs volatile organic compounds if you enter into a freshly painted room, how do you feel, it feels very pressured the air is very pressured and it is going across your nostrils and it is putting some pressure very strong that pungent smell kind of anything not pungent but very peculiar kind of a smell these paints and varnishes and all the stuff they actually produce, that is because of this volatile organic compounds.

So, since in a freshly painted room the concentration is very high, it is a new room, so new occupant they are going to have it a more. And over the time actually it kind of goes down but it takes a long time for it to come to almost nil, so over a long period of time it takes it to come down but initially it is very high then gradually gradually gradually it comes down.

Well, if the percentage is more of course on the day zero, day one it will be in a very high quantity and it is not good for the human health it can cause several respiratory conditions and things, skin irritation, eye irritation and some more things. But even if it is few months old or over the time they still I keep on emitting a sum.

Well, the ratio here is very small so we do not perhaps notices so much or we do not feel bothered so much. For example, another example of mosquito repellents you may have seen those warnings written on though with these mosquitoes repellents, it contains a poison it is not safe for touching and direct smelling and things.

Well definitely we know it kills a mosquitoes, so of course it is a kind of a poison which is which potency is very high for killing a mosquito but perhaps that potency is not sufficient to kill a human being but it does not mean it is not harmful, it is harmful in perhaps in a lower ratio a smaller ratio but it is harmful.

But the thing is if it is getting accumulated over a long period of time a tiny tiny tiny tiny tiny lots of tiny bits it may give you some condition, it may kind of put you into some health complications respiratory conditions and things. So, these are all actually product categories where it is not that much toxic and direct usage and that is why it is kind of permitted for human uses.

But still there is a factor of toxicity you have to remember, so it is a kind of a negotiation how much is permissible and how long you want its exposure and all that so you can decide based on your own considerations what do you prefer for your own well-being or your family's well-being.

So, if these kind of substances they go into the atmosphere in the ecology definitely they have some kind of impact on the other living forms also other natural elements also, some of the compounds they are good enough to spoil water resources, air resources, soil and all of these. So, those you consider as non-toxic.

So, as economy where such compounds are responsibly taken care of that becomes, that is, that becomes a part of a circular economy. So, these collectively let us call them green products where consideration is there. So, reducing environmental footprint you see this term mentioned over here because overall they carry some impact. So, if you cannot bring this impact to zero but at least you can minimize it, minimize it and minimize it more and more.

Then cleaner production, so cleaner production means even while producing there should not be much of impact, so lesser and lesser the impact better and cleaner it is. So, the same thing, for example, conventionally we know these coal power plants, thermal plants where electricity generation takes place, so they used to be very high polluting units and that is how why actually they were kind of less preferred as the time actually progresses.

Now, there are other much cleaner forms of energy generation. Well no energy generation now has any kind of impact even windmills and all also if you see they rely on batteries and stuff and all that. So, some impact even they have if you go for a hydropower structures and all where there is huge retention of water and then the water forcefully flows at the down and then there are turbines here which are running and electricity getting produced, so this has its own kind of impact and of course nuclear power has its own kind of impact.

So, it is kind of negotiation again it is a negotiation where how much of megawatt you are able to produce in how much of impact, so you need to kind of establish this relation and go for that negotiated threshold where you are minimizing the impact in the maximum of power generation.

So, and again the form of power generation that is also important air pollution, noise pollution, water pollution, nuclear radiation pollution and all of those kind of things. So, it is

again a kind of a big a negotiation kind of thing so that qualifies as a cleaner production now you know.

Better service to extend lifespan so here it means extending lifespan for example if I am using certain product for example this pen, so this pen is kind of an object which for, whatever X long duration of time I am able to use it the more efficient you can call it perhaps, each and every product almost is designed it is life span also in mind.

For example, automobile industry if you see so it is said that typically designed for 15 years plus 5 more years and once this period is over 20 years, so RTO is going to kind of put a ban on that particular vehicle that means it is time to scrap and send it back for recycling, reusing, etc etc.

That means in this 20 years that product comes to its end but what if there are other type of consumer appliances for example washing machines, TVs and refrigerators etc they do not go I know so bad so easily, so if you keep on using them for a longer period of time. For example, even furniture like chair, so a simple chair from our grandparents time if you see those wooden chairs whether it is definitely not good to use wood but if you make an LCA analysis and compare a chair made up of wood and a chair made up of plastic or other composite materials which one is good.

So, definitely you will be able to find kind of impact what these different materials exert and the time span how long they will be in use you can use them their durability so that thing. So, the more and more time grandfather's chair perhaps it is still there in your home so you can understand one piece of chair has served for so many decades.

So, but today's furniture typically do not last for so many decades, forget about several leakage they just go back in few years and they are very difficult to kind of repair also, there different types of material for example glass and steel and steel to plastic, plastic to aluminium, aluminum to something else, etc etc. So, different types of materials and their joinery brings complication, so you want to simplify it.

So, this is where this strategy comes into the picture, these strategies I have discussed in my another course strategies for such design, maybe you can refer that separately. So, utilizing those strategies you can extend the lifespan and in turn you are saving a new product, so that is as good as a making or saving that product from manufacturing. So, that is the concern where we use this kind of strategies.

Now, next collect at end of life like remanufacturing so if it has finally come to its end of life stage then still you can go for salvaging it, recovering some things from it, metal components if you see if it is a pure metal a MS mild steel definitely you can take it out and kind of recover almost 100 percent out of this except into some rust and wastage and cutting, etc mostly you can recover up to the highest percentage even glasses, if they are not kind of laminated or maybe retreated or something else you can further recover a glasses also by 100 percent.

But some other things, for example, nylon other upholstery material which actually degrade over time, leather, pus, etc those are the materials which actually degrade over time, so it is difficult to kind of salvage them and make use of them. So, and yeah another point alloys for example now automobile industry is kind of fanciful sector where alloys, now almost every vehicle is having alloy wheels those rims.

So, alloys use they come with a very high melting point, very high stress and strain taking capacity and all of that very nice shiny non rusting and all of those kind of things. Well, it has all the good properties but it makes it equally hard and difficult to recycle because since alloys have a very high melting point it takes more and more energy.

So, the thing is the recycling also is an economic process you have to keep this in mind, nobody does any of these works just for charity or for the well-being of environment, there should be some economic motivation otherwise nobody is going to take up these things for sake of doing good things.

So, it becomes essential that the recovered amount what you are going to get out of salvaging these components is greater than the energy and amount invested in salvaging it. Then there is only, there is a value in doing and taking up this exercise otherwise nobody will be financial economically motivated to do such kind of things.

So, as a designer, as a manufacturer, as a engineer, as a production manager whatever capacity you are or as a student also you need to keep this in mind while you are designing it. Like what happens when it comes to its end of life cycle stage. So, this is how we actually go from circular design to circular economy.

So, this actually ability, this quality which you are weaving, which you are encoding in your design that your design is going to take care of so and so points what we discussed leads to circular economy and economy means the whole all of the manufacturing units, all of the

suppliers, all of the users, consumers, buyers etc etc. So, combining all of them if they all follow that economy becomes a circular economy. So, I hope now you have understood.

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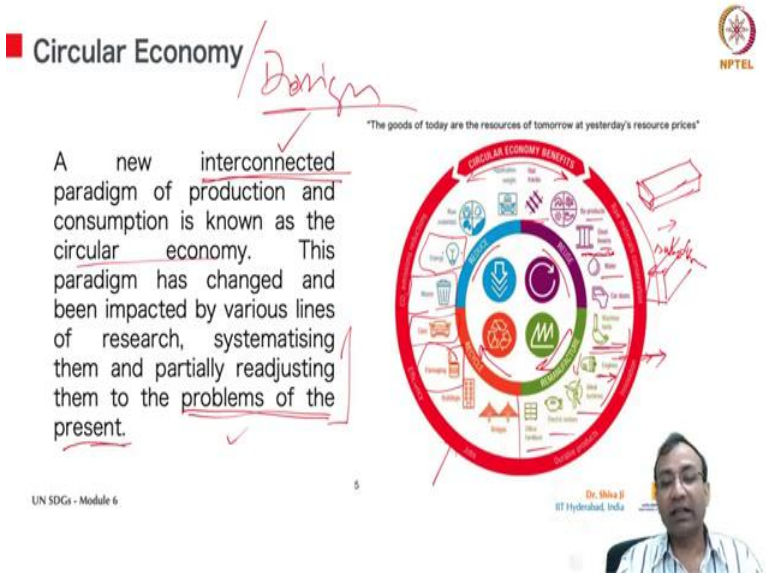

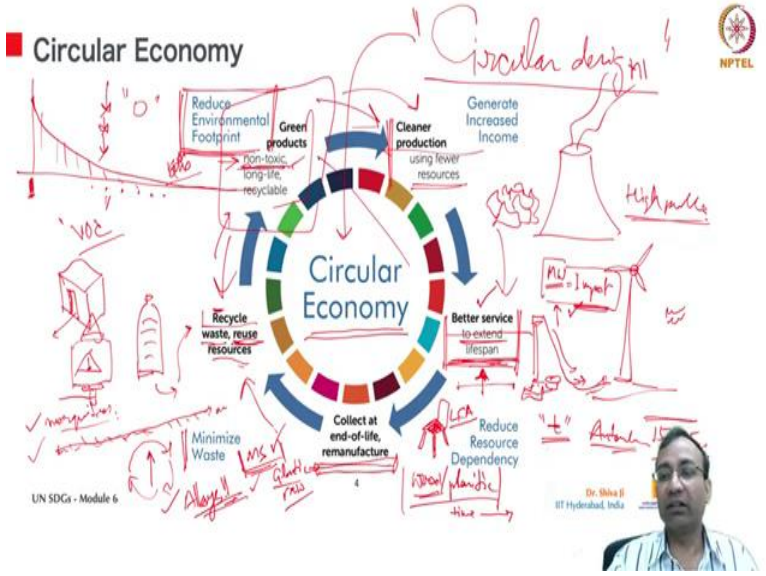

Yeah so a very amazing example of the circular economy that it is an interconnected economy, we saw here this cannot stand in isolation, this is definitely related to the manufacturing plant or resources and the usage and all of that, so it cannot be a stand in isolation it is always interconnected and that is most amazing beauty of circular economy and circular design.

So, you see this illustration over here it talks about some strategies reducing, reducing the consumption you yourself can take a call whether you really need to buy something. So, the moment you decided I do not need it perhaps that much immediately at that moment you

have saved one product from being unnecessarily manufactured, so this is the way all of us can contribute.

Then reusing it for example if you have already bought it and then if there is no choice, so in multiple ways, in multiple ways how you can reuse these and all of those then remanufacturing and then recycling all of that and now more details you can see here over here the benefits given on the both side.

So, raw material conservation conventionally real tracks you used to carry these wooden members those slippers and just imagine how many millions and billions of pieces often this wood earlier were used on the railway tracks. So, if there is any substitute definitely nowadays we use concrete based these blocks these bars these slippers, so those are used.

Byproducts steel beams, yes mostly almost 100 recoverable, water, car doors, then in innovation there are machine tools if you see how much they have optimized work so that efficiency. Engines if you can remanufacture or reuse if you see aeroplanes engines they are very sturdy and long lasting amazing piece of equipment machine which is manufactured with extreme amount of research and innovation and technology and very high precision equipment if you refer them separately it will be amazing to look at how do they manufacture airplane engines.

Wind turbines, electric motors, office furniture and then in the jobs how do they create, so these all if you see are somewhere related, the efficiency, reuse, saving on the packaging materials, saving on the efficiency of the car, managing the waste, managing the embodied energy and other indirect energy consumptions, etc etc, so they are all inter connected let me read this.

A new interconnected paradigm of production and consumption is known as the circular economy. This paradigm has changed and been impacted by various lines of research, systemizing them and partially readjusting them to the problems of the present. So, what were the problems of the present?

We all know, all of those emissions, pollutions, over consumption, over usage, too much of electricity consumption or electric energy consumption, too much of machine resource consumption, all of them and if you optimize all of them together with an interesting interconnection that leads you to circular economy.

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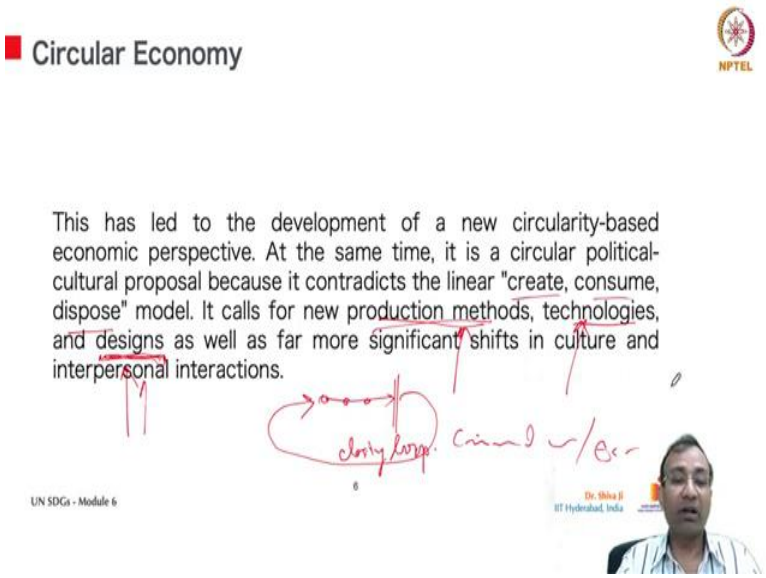

This has led to the development of a new circularity based economic perspective at the same time it is a circular political cultural proposal because it contradicts the linear, create, consume, dispose model. In the first slide, second slide we saw how typically things end, they come to a dead end. But if you bring back right here that is closing the loop so if you are able to close that loop this becomes a circular design, circular economy kind of a concept.

Calls for new production methods, of course new technologies and designs, most importantly design, because if design is responsible, design is kind of a conscious enough you are going to save on all of these things, even more things like emissions, end of life cycle stage and all of that.

So, more and more thinking is going to make your whole system very very optimized, that is why more brains should go into the designing whatever assignment or infrastructure project or design project you are doing more and more investment should go into the design.

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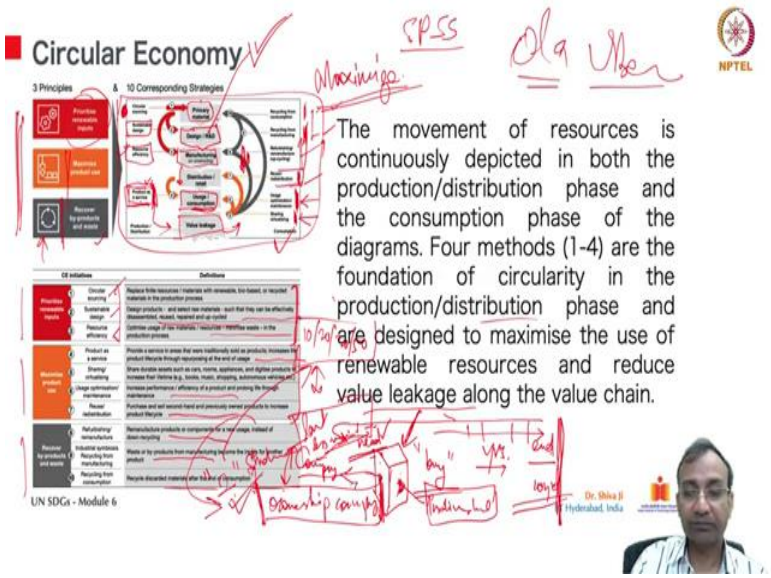

The movement of resources is continuously depicted in both the production distribution phase and the consumption phase of the diagrams. Four methods, one to four are the foundation of circularity in the production distribution phase we will see on the left side and designed to maximize the user renewable resources and reduce value leakage along the value chain.

So, you can see over here three principles here on the left side, prioritize, renewable, inputs which one do you want to prioritize there are several solutions I said thermal, hydel, tidal, nuclear, gas based, many others so or wind ones or solar farms, so which one is most suitable you need to take up and all of that exercise separately there is no universal answer to this question.

So, always remember based on the context and application you need to take this claw and availability of things what is closer what is easily applicable or achievable so all of these factors actually matter that is why this decision is essential to take up project by project. Then maximize product use, recover byproducts and waste, so that maximum usability even when it becomes a waste.

And those strategies you can see over here circular sourcing as primary material and then from here design and R&D very important stage the most important perhaps among all because here you carry the largest potential of saving on to all sorts of impacts going for sustainable design.

Resource efficiency on all sides in that the manufacturing stage from here you go to distribution retail, sending to the places from there it will go to the consumers, buyers,

product rises service, we will discuss briefly in few minutes. Uuses and consumption at this stage where you and me as a user get involved and then there is value leakage it says so that means it is kind of it slowly starts losing its value when it comes closer to the end of its life.

So, how again it can go back? So, from here if you see these arrows start going from this side this stage and up, so from here sharing, visualizing, usage optimization, maintenance and these stages the strategies what you can employee so at this stage rather uses consumption you can go for optimization, maintenance so that it lasts for longer if a machine is not maintained there is a chance that it may collapse or malfunction.

Then reusing this redistributing to the maybe other users and people for example books, if you have done reading so maybe you can put it in your library but if you do not want if you have access often a books if you want to dispose it or better you give it to somebody because that printed book is almost a worth nothing else but reading only, so maybe better you (())(26:56) to somebody or maybe sell it to somebody or just give it to somebody or give it to give it to maybe a library or maybe some public reading space where more and more people will come and read that.

So, that thing, then refurbishing, remanufacturing at this stage. So, if a component has malfunction maybe it can be refurbished or reused again in the next product. Recycling, recycling from consumption, recycling from manufacturing at each stages you can go for such strategies and this actually completes if you see here in this whole enclosed steps a kind of this has the potential to maximize the uses of any product, any manufactured good.

So, now we will come and discuss this one product as a service. So, what is this? Well product as a service is a concept coming from SPSS sustainable product service solutions. So, what is this so I will give you one example if you need washing machine so why do we need washing machine of course to clean our cloths, do our laundry.

So, these washing machines almost if not every but every second household perhaps I do not know the number so let me not comment on that but households typically have a washing machines. So, these washing machines we buy and we keep them in our home as our own personal product, personal usage product.

And over a certain period of time it develops some snacks and finally it comes to the end of his life and now it is perhaps at a time to discard or throw it down or buy another one, so

perhaps 10 years, 12 years, 15 years maximum perhaps as a domestic washing machine life stage, life age, life duration.

So, this comes to an end. What could be the another approach? So, for that you need to go back right here. What is the need? So, the need is to clean the clothes, for that you are buying this machine. So, the basic need is to clean the cloth and that can be satisfied by other beans also, conventionally they are used to be a washerman there was no washing machines earlier.

So, you used to give your cloths to them, they used to wash and give it back. So, if you go for similar kind of thing if there is some outsourcing kind of facility for example this washing machine itself, well there is no manual washing anymore. So, machine based washing only but if this machine is not owned by you but if it is owned by the company itself and you are just availing the uses of it for example 10 cloths 10x rupees or something that. So, pay per use kind of thing.

So, in that case the ownership of the machine lies with the company. So, what changes here? Now, these are two different scenarios in this case company is the owner and in this case individual is the owner. So, what changes you will be surprised to learn amazingly these are two completely different scenarios for the design of this same machine and it is not the same machine anymore, if it is an individual household based on a machine they make it little lesser sturdy not so industrial grade quality machine and all that.

So, that it comes to an end in this particular in years of time plus meanwhile also sometimes intermittently it requires some service, repairs etc etc. But in this case since the owner is company itself they are going to design it differently because now it is the headache of the company and they are not going to charge you additionally for its maintenance, repairs, spares, etc etc.

So, they will design this machine in a much sturdier way so that it lasts longer, it requires less maintenance and things that. So, this will definitely go into a industrialized form of manufacturing and perhaps not just one householder, perhaps in 10, 20, 30, 50, households can use it maybe at a common place.

For example, if you go to western countries you will see such laundry rooms in common places you go and use it for per consumption siphon. So, the design of the thing changes because how often we need the machine perhaps maybe once in two days that may be a typical washing cycle.

So, actually in individual ownership you do not need it every day, every hour but if it is designed for industrial use the same machine perhaps with the twice of consumption can serve to 20 families so at least you have sent saved on the 18 such machines so that becomes a concept of product as a service, so not the product itself but you are selling the service.

Very famous example of such things you may be already aware Ola, Uber and such Taxi Wala companies, where you need not own the vehicle whenever you want it is there, so that way. Now, we will see on this table at the bottom, priority, prioritize renewable inputs, the first at the top we saw maximize product uses recover.

So, initiatives, circular sourcing, circular design, resource efficiency what do they mean, so definitions are given over here, maybe you can note it down for your reference, replace finite resources materials with renewable bio based or recycled materials in the production process, design products, select raw materials that they can be effectively disassembled, reused repaired and this upcycled, optimize use of raw material, source minimize based.

And then the second we have provide a service in areas that were traditionally sold as products, increase the product life cycle through repurposing at the end of uses, share durable assets, increase performance, efficiency, purchase and sell second hand or previously owned products. New manufacture products or components, waste of byproducts, recycle discarded materials.

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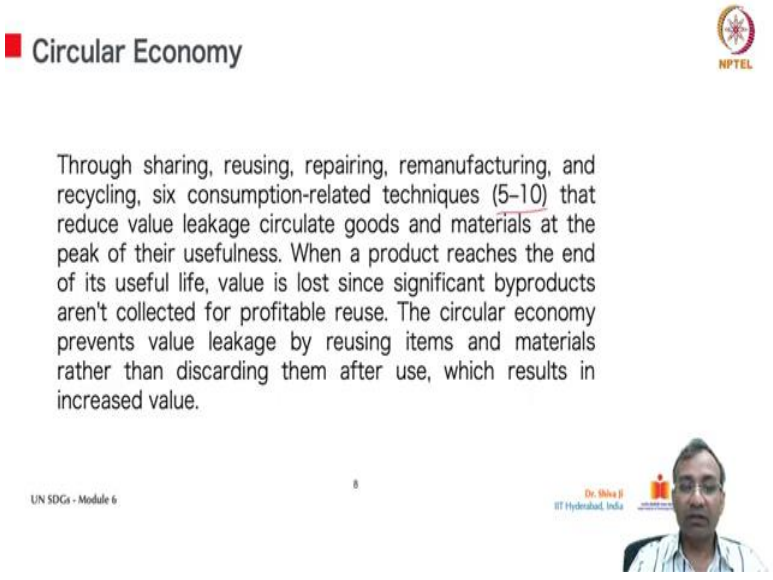

So, moving on through sharing, reusing, repairing, remanufacturing and recycling, six consumption related techniques five to ten we saw previously that reduce value leakage

circulate goods and materials at the peak of their usefulness. When a product reaches the end of its useful life value is lost since significant byproducts are not collected for a profitable use reuse. The circular economy prevents value leakage by reusing items and materials rather than discarding them after use which results in increased value.

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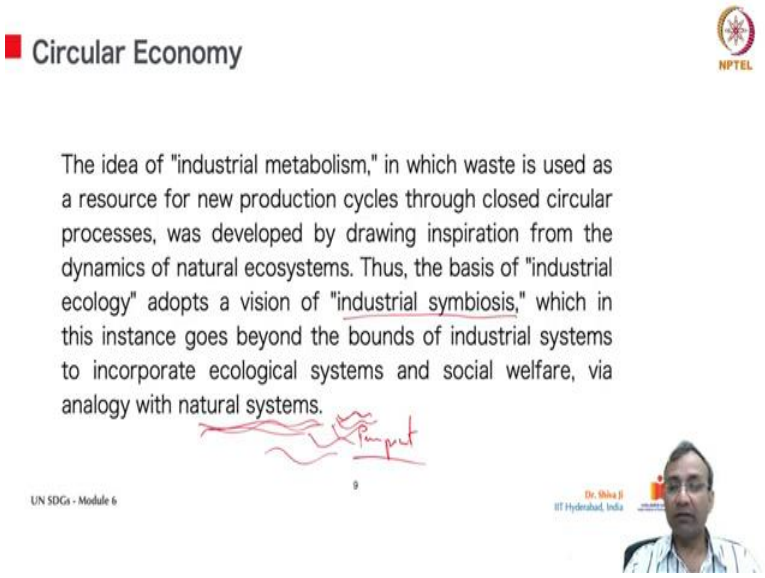

The idea of industrial metabolism in which waste is used as a resource for new production cycles through closed circular process was developed by drawing inspiration from the dynamics of natural ecosystems. Thus, the basis of industrial ecology adopts a vision of industrial symbiosis which is in this instance goes beyond the bounds of industrial systems to incorporate ecological systems and social welfare via analogy of natural systems.

Like how natural systems actually work, they are efficient, they do not have an impact. So, this symbiotic relationship between different elements in the nature if we emulate them in our kind of design and manufacturing sectors it will tremendous change.

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And for that itself these 17 goals were actually framed and now we are studying it so circular design if you see has potential to save on and many of these directly and perhaps all of them indirectly. Like sustainable cities and community, responsible consumption and production, industry innovation infrastructure, recent work, economy growth, so these are some direct related ones.

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How it is related that we will see with the respect to SDG 2 severe starvation, malnourishment are the focus of Sustainable Development Goal 2 because they continue to be the obstacles we previously we have covered this how SDGs in that too also a properly SDG2 is crucial for the human being.

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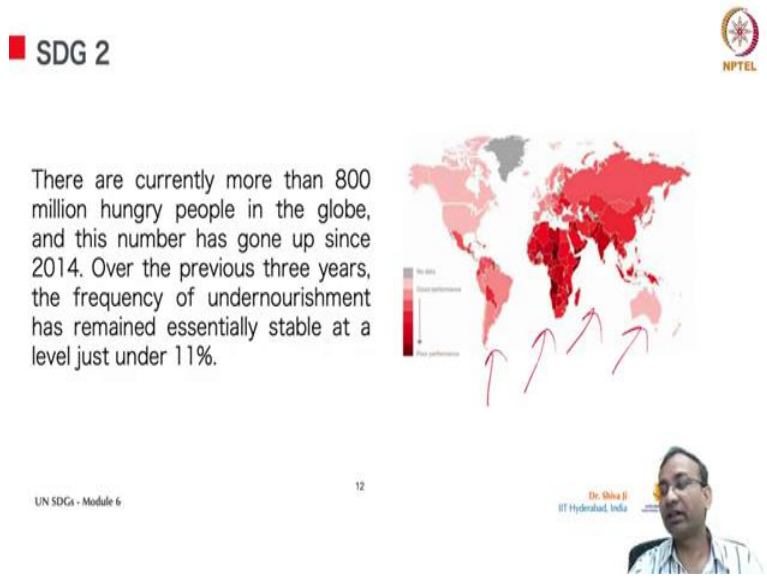

And currently what is the kind of status and different countries how good they are.

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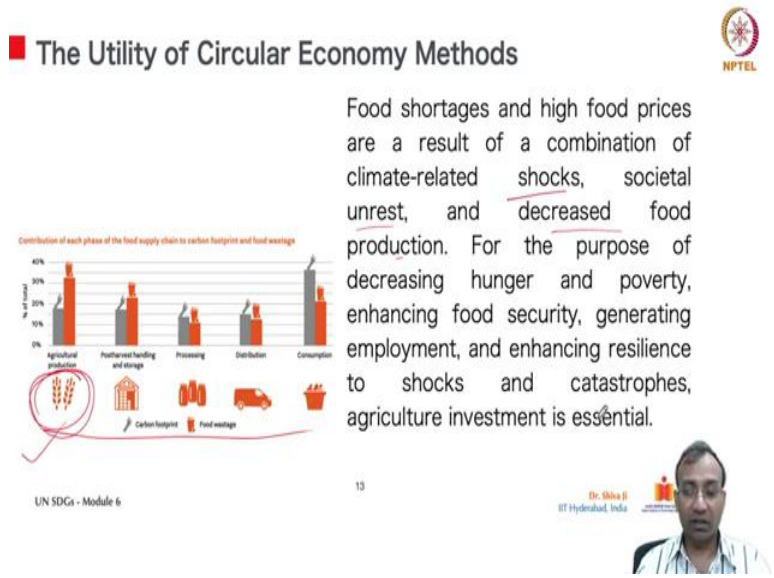

So, with the reference to that you can see food shortages and high food prices are result of a combination of climate related shocks, societal unrest and decreased food production. So, both happening simultaneously or concurrently could be the regions for how there may be shortage of food also previously we saw how much of percentage of food actually gets wasted.

So, all of those things actually further enhance the catastrophe even though they had food but we lost it somewhere, it got it wasted and now there are more and more hungry mouths to feed, so that is a kind of mismatch. For the purpose of decreasing hunger and poverty,

enhancing food security, generating employment and enhancing resilience to shocks and catastrophes, agricultural investment is essential. So, for meeting food demands that is not possible without agriculture, so agriculture production stage is the most crucial one from where this whole actually food comes from.

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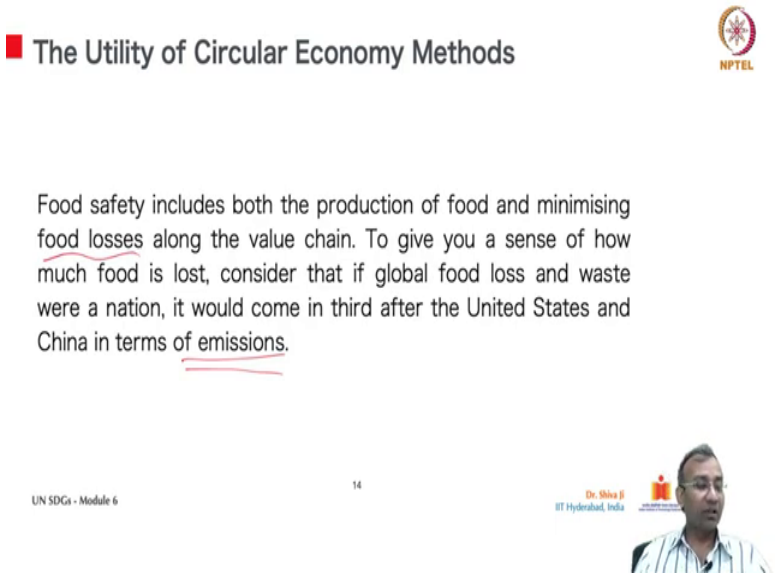

Food safety includes both the production of food and minimizing food losses along the value chain. To give you a sense of how much food is lost consider that if global food loss and waste were a nation it would come in third of the United States and China in terms of emissions. So, just imagine how much our food is getting lost and how much of impact even that lost food is having. So, it is a kind of a double impact.