Strategy for Sustainability Design
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Lecture 6
Environmental Sustainability

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So, we will discuss about Environmental Sustainability. So, as we saw there are three major aspects to sustainability studies, those are environmental, social and economic. So, what is environmental sustainability? Well, we have this general idea the things in and around ecological balance the environmental balance they fall under majorly into environmental sustainability of the overall sustainability studies.

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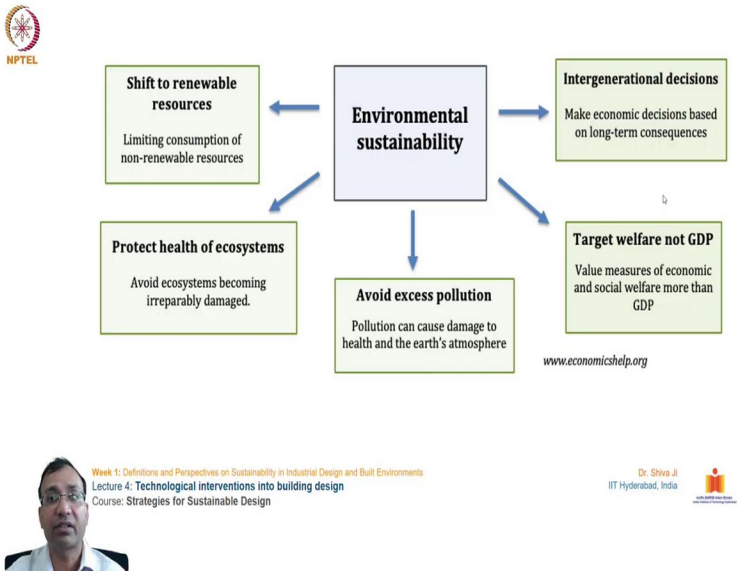

So, it has s per this organization it has five major point how to go about assessing environmental studies and what are environmental aspects of sustainability. So, intergenerational decision, the first one, so as we have seen in the overall broader definition of sustainability it talks about preserving resources, preserving natural balance for the generations to come out, so that means for the future.

So, the intergenerational decisions become very important part about taking decisions on the environmental, social or economic factors, so that the long term consequences and repercussions can be avoided. Because as the world is entering into a very different kind of scenario in the times to come where it may become very difficult to come back to the normal which was there in the pre industrialized world.

The second part, target welfare not the GDP, well it is very important as we were discussing how the humanity should be taken care of, how this society should function, how the equity, cohesion and the value system works. So, always development cannot be measured in terms of GDP only gross domestic product.

So, economic parameters wise countries have this system in place today to measure the development of that country in GDP terms, but GDP is not enough to assess a one person's well-being and happiness and how well he is able to live his life. So, GDP is not overall, cannot be overall indicator of the success of any country.

So, the value measures of economic and social welfare, I have they carry more value that the GDP only. The third one avoid excess population, well population can cause to the damage to the human body and the environment and the overall ecosystem the overall it can, it has the potential to disturb the ecological balance, so the pollution should be taken care of by each and every means.

Because whenever we are doing any industrial procedures or manufacturing or even we are trying to provide some services for example aviation. So, in turn of doing so there is a lot of pollution happening in all of the sectors like air, water, earth, soil, noises with there are several types of (())(03:25) even radiation, nuclear reactor or say one of the most considered to be one of the very environmentally disastrous ones because in case of any such eventuality or accident the catastrophic resultants will be very big, we are all aware of the world's first nuclear disaster took place in Chernobyl in Russia and the Chernobyl is a place where it is said that it cannot be habitable for next thousands of years.

So, that place is so contaminated with the high level of radiation that is it is not safe for the human. So, the second accident happened in the Fukushima Japan where the nuclear reactor got burst for some regions and then in the coming months there was this Tsunami and a lot of rain and that took away some of the parts of that, some of the radioactive material with it in the ocean and in the nearby areas and it was observed that radioactive material was found till very farther distances from the lake of Fukushima.

So, nuclear reactors have a this very hazardous very high hazardous quotient though they are the source of the very high volume of energy by putting a very little of material, but the toxicity and radioactive material and radioactive quotient and this overall pollution factor is very high with them.

So, we must take care of each and every type of materials or pollutions which are possible with the manufacturing on any of these (())(5:02). And the next one says about protect health of the eco system, when the health of the ecosystem is very important because if the balance is now is gone, then there will be (())(5:12) and that will become irreversible position, so from the point where the balance of the earth cannot be come back to its normal position and the last one shift to renewable resources.

Well, we have been discussing resources are finite finitely available, they are not infinite, so the supply and you know that this supply of these materials for our consumption is very very limited, so we must consume them in such a way, so that nature gets time to heal itself, gets time to restore itself, gets time to bring itself to the balanced position. So, these are the measure principles around environmental sustainability, we will move ahead from this and we will see some discussions.

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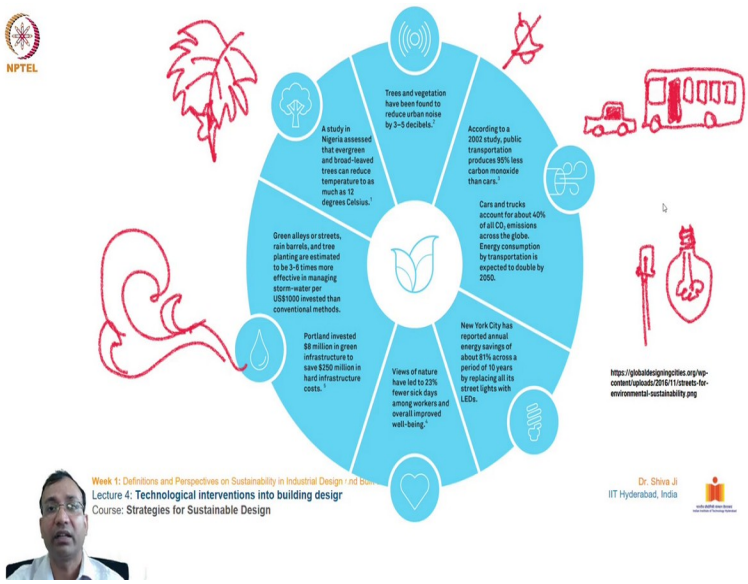

So, study in Nigeria assist that evergreen and broadly trees can reduce temperature to as much as (())(06:07). Well, I think it is very evident if we may have noticed whenever we enter to a forest area or maybe even cantonment areas of our major cities in India, or even bigger institutions who have big green campuses, for example some universities and some institutions, so we observe a significant drop in the temperature the moment we enter into those areas.

So, why is so? So, it is because of the dense vegetation, the dense plantation which is there in those areas. So, because of that the temperature of the ambient temperature of that area little lower, then the main the business parts of the business district part of the city. So, this observation is based out of recent observation based out of Nigeria.

The next one the green alleys or a streets rain barrels and tree planting are estimated to be 3 to 6 times more effective in managing storm water, per U.S dollar 1000 investor net commission

methods. Well, we have been knowing the traditional water sheds and these rain water management it happens through the roots of the trees.

So, wild forest are important not just for the vegetation and oxygen, they play a very important part in managing water, so whenever the forest or the green areas they receive rainwater they hold a large amount of that rainwater, in their roofs in the top soil and that water remains and gets filtered over the time and it starts coming down through smaller streams.

And in the form of the regulates and that is how reverse also get (())(07:54) because from the mountainous regions from the green areas this water starts seeping slowly slowly, if there is a berrant flat surface, all of that rain water is going to run off in one stream and then the next time there would not be any water left behind.

So, that is not good for the ecological balance, so this trees play a very important role, if we try absorbing or retaining this water through conventional means, other conventional means dams and all that, so that can retain the water but not in that quantity and plus the treating dams and such structures have their own ecological impacts on the place.

So, we should avoid as much as possible and so we should always increase the number of plantation, the density of plantation vegetation in the greener areas. And the next example says Portland invested 8 million dollars in green infrastructure to save 200 million dollars in hard infrastructure cost. Well, that is an example where these softer investments in the nature always be much yield in terms of the solid hard core infrastructure activities.

For example, if we want to establish greener areas, if we want to have fresh air to the supply, if we want the if we want to have continuous and perennial water supply for the cities and urban settlements, so we must go for the natural means of managing the sources. In place of managing them through constructed means or hard core infrastructure generation, because they can do that job, but they will take a lot of money plus their reproduction.

So, but natural means they do not have any such a reproductions, natural means help the nature to regenerate and grow it back. So, it helps even other species and other living beings to come back to their normal (())(9:56). The next example says view of nature have led to 23 percent fewer sick days among workers and overall improve well-being.

Well, this has a lot to do with the psychological feelings of the humans, we as a social-being we as a human-being, we always feel elated and we will feel good in and natural surrounding where at least we can see we can observe some scenic things, we can see other human beings doing their activities and normal chosen compared to or someone sitting inside a or the closed environment closed atmosphere where you cannot he or she cannot even see outside. So, there are always such psychological impacts of such mount places. So, it is always suggested to have to deliver to give as much view as possible for the workers from their offices or from work places, so that they can keep themselves psychologically connected to the outside world.

Then next example is, New York City has reported annual energy savings of about 81 percent across the period of 10 years by replacing all its streetlights with LEDs. Well, of course, it's a proven fact I think from every year recently I mean in the last few last one decade there has been a significant push from the government of India and the state governments also to replace those incandescent bulbs with the LCD or LED based bulbs. So, these are electrical advices have been highly subsidized also and they have been given to each and every household on through the medium of this rationing on the subsidized rate so that they can replace those power-hungry lamps with these power saving instruments.

So, it's not just New York I think it is true for every place, so in such efforts are commendable for the society. The next observation says cars and trucks account for about 40 percent of all CO2 emissions across the globe, energy consumption by transportation is expected to double by 2050, so here we can see these traffic based, these transportation based these exhaustion and then the emissions they have caused a significant contribution to the ghg emission miserly the CO2.

And well, so and if you compare the number of occupants who can travel in a car and number of occupants who can travel in a bus, so obviously there is a start difference. So, why not to save on these individual personal vehicles and go for mass vehicles or the public vehicles. According to 2002 study public transportation producers 95 percent less carbon monoxide then cars.

We know this is the fact I was stating just right now, the public transportation medium of course will save on the numbers, for a set of round 40 people, one bus would be enough, or a set of 40 people at least need 10 cars. So, if we go by that ratio the amount of emission which will be exhausted from the public vehicle will considerably be lower.

And the last one says, trees and vegetation have been found to reduce urban noise by 3 to 5 decimal. Well, it is true for the temperature drop as well as for the noise reduction also, because vegetation is one very good source of noise absorption, so it works for absorbing the noise whether it is for traffic from some manufacturing or some machining plant or any such a noise producing entity, so dense vegetation helps always for the sound as well as noise reduction.

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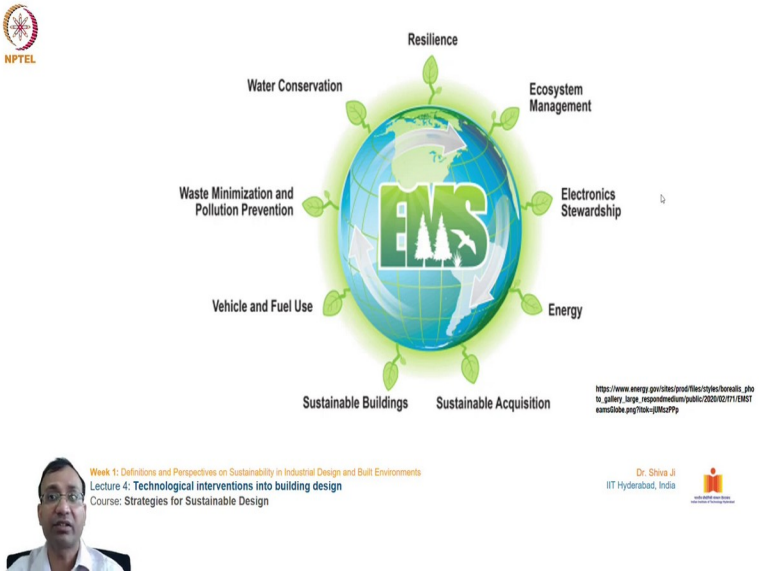

What are the measure features of this environmental sustainability? So, the capacity to have this resilience, what is resilience? Resilience is a capacity to come back to the normal position without much of external intervention. So, it is inherent quality, it is the inherent property between in the system which tries to uplift that system once it has gone through, once it has experience some catastrophic event or some kind of damage.

So, that capacity is known as resilience. So, resilience is there in the nature by default, for example rivers, so rivers have their own capacity to heal themselves, if there is some kind of pollution or some toxic material which is thrown in the river the river or that water body whether it is a lake or something, it takes some time and rejuvenates from that.

So, that is a resilient capacity of that thing, well the overall planet itself, if we see from the environmental perspective has some resilience to come back to normalcy to restore its normalcy. But of course, it has some threshold, it has a critical value after which it will become very

difficult and there is some value after which it will become kind of a irreversible to go back to the normal one.

So, we must take care of this the bio-capacity or that resilient capacity of the ecosystem, so that it enables itself to restore and then there is this eco management system, so we can manage ecosystem in such a way that it sustains for a longer time then there are electronic stewardship energy, sustainable acquisition, sustainable buildings, vehicle and fuel use waste minimization pollution prevention and water conservation, these are the one few of the major activities around environmental sustainability which play a vital role and they form the major component within the environmental sustainability.

Like energy we have been discussing, buildings are the majorly responsible for the consumption of around up to 40 percent of the total world energy produced that's a huge amount, it is even more than the industry sector, so if we see buildings are the single largest consumer of the total energy produced in this world, so even if there is a improvement of in the fractions, at scale of this whole world that the overall volume will be extremely high.

So, even if there is a saving of a very small fraction or small percentage the overall saving will be very high. So, we must put our efforts to improve this situation and sustainable acquisition talks about sourcing materials in a responsible way, sourcing for example a tree, so why cannot there be a crop cycle for harvesting of trees? Well, some countries Canada and New Zealand they have already have such systems and place, so they have some managed forest from where they do annual cycles of a forestation and they cut those trees for usage and consumption at the cycle of that those tree is specifically.

And every year if we plant X area of land with the trees so after that n number of years we will start getting those X area will start producing those number of trees and there is still no practically completely replaceable alternative material available for natural wood or timber. So, why not to have to start having such procedure to have forest as a cycle of crop and well of course there is a point of vehicle use and fuel use so as we saw vehicles and such things are the single largest emitters of the pollution, so we must work to prevent these things.

Waste minimization and pollution prevention, so of course waste with the as a bi-product of most of these industrial processes these day there is a huge amount of waste produced, so how this can

be minimized because nowadays landfills and these things are becoming very common and it is almost practical situation a practically compulsion that all of the waste which is being generated is not able to get recycle or treated properly and it is landing into the land fells.

And most of the Indian cities, most of the world's cities are plagued by this situation, though there are some countries who are doing fairly well like Sweden and some countries they have developed some mechanisms to go for power generation from the waist and they are running out of waste. So, this is really strange and I think is worth emulating in the elsewhere.

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So, let us move on to the next slide here I have taken it from Mitsubishi electric company, which has taken up this cause as a inspiration to drive their manufacturing and other things from their factory and they have given declaration where they have set up some guidelines for example the first guideline says apply diverse technologies in wide-ranging business areas to solve environmental issues.

So, that means so they are looking for some alternative technologies to deal with this situation. The second guidelines is, challenged to develop business innovations for future generations. So, that these innovative ideas, innovative business models can help to sustain themselves for the future generation also.

The third one publicize and share the values and lifestyles. So, the new value systems, well, though and these lifestyle should be propagated in such a way which can become a role model

for the other members of the society other members of the community. Those are which are worth mentioning worth emulating.

So, the key initiatives what this company has taken is the climate change measures, resource circulation, live in harmony with the nature, a long-term activities, innovation, nurturing human resources, understanding needs, co-create and disseminate new values, live in harmony with the region. So, these are key initiatives taken by this company.

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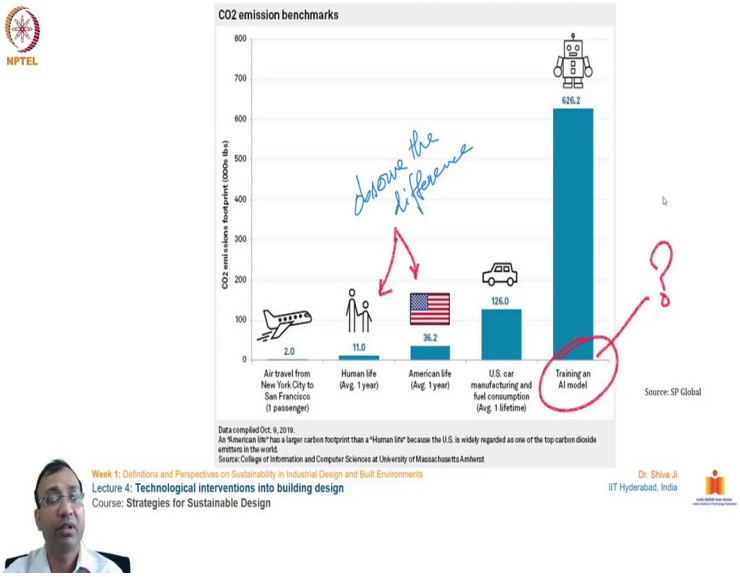

Let us, look at the CO2 emission benchmarks of different familiar things which we generally come across. So, you can see on the X axis there are some examples given air travel one-year of normal human life and one year of American's human life and the fourth one says about the car emissions cars from one car in the U.S and the last one sees about an AI model.

So, let us see on this Y axis you can see CO2 emission footprint. So, here travel from New York city to San Francisco for passenger required, it takes around, it emits around two units for example of the CO2 emission. So, CO2 emission of two units if you compare one person's the one year of CO2 emissions, so that is around 11 years and compared to one general human being from an average world citizen, so the one single American citizen himself or herself emits around 36.2 units, which is more than three times higher than a normal human being of world citizen.

So, that means the per capita CO2 emission of an American is three times the world average. Let us, see one-year, one lifetime emission of one U.S car is around 126 units, which is very high and the strange entry into this table is this last one training on AI model. So, training an AI model consumes 626.2 units of this CO2, compared to all other this is very high extremely high.

So, how this, even this kind of new technologies and these systems are power-hungry are going to have some kind of a pack, in fact is eye-opener, so we must go for analysis based observations only where we can conclude with the help of that numbers, otherwise sometimes most of our assumptions they sometime prove wrong. So, we must rely on the calculations and the data.

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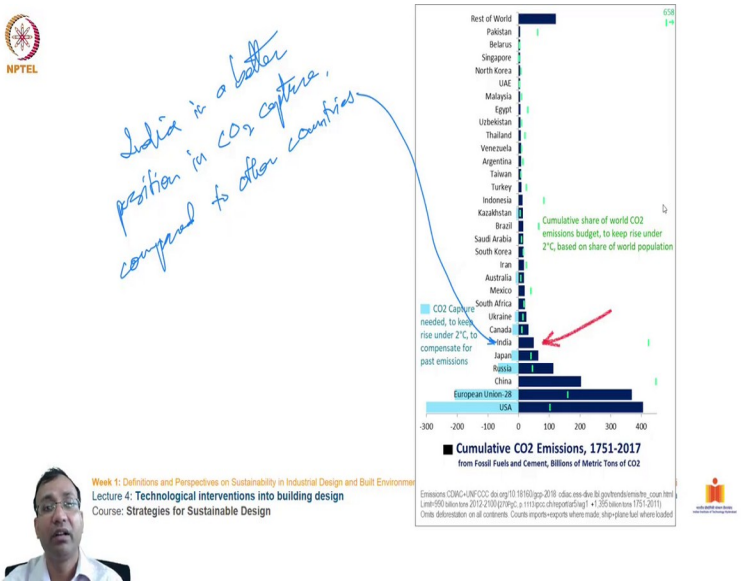

In the next part of this slide, so the data suggests over here the cumulative CO2 emissions between the year of 1751 to 2017, so from fossil fuels and cement billions of metric tons of CO2, that is the unit what they have taken over here, so if you see the rest of the world emits around 140, 150 metric tons of CO2 and U.S.A emits alone over 400 metric tons of CO2 has a has kind of excreted during this period, during this time line.

And the second comes the European Union with the 28 countries and the third one is the China. So, China in the recent times has developed very fast and is developing very fast and is the one of the largest producers of the lasted largest emitters of CO2 also in the world. If you see the next country Russia then Japan and then comes the India.

Those of the one amazing thing about India over here is even if India is one of the big emitters, it emits a roughly around 50 metric tons of CO2 it has emitted between this year 1751 to 2017, but CO2 capture which is needed to compensate this emission which has happened in these many years, to bring it back to the normal where we can at least go under the two degrees global warning temperature rise, so India for that it does not requires any CO2 capturing this thing, that means we are not in a very deficit kind of situations, we are in a positive side. So, India is a single country is not doing that, but I think it is doing fairly but of course in terms of emissions we should, we also need to control.

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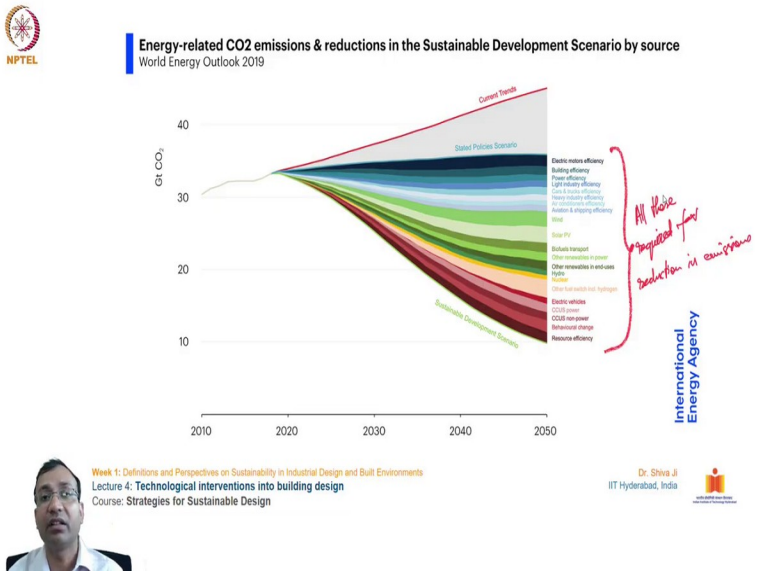

And here on this slide you can see what if that current trend of rise in the CO2, rise in the emission of the CO2 especially is purses, so the first line the top line in the red it suggests the current trends, with the rate of this present emission if it continues so it's going to go way above but there are some corrective measures which have been proposed by agencies, if we take them, so there are chances that this emission may come down and there is one desired sustainable development scenario also which can be called if this emission can be controlled, can be brought back to its normal revels where it can, where the nature finds himself able to restore.

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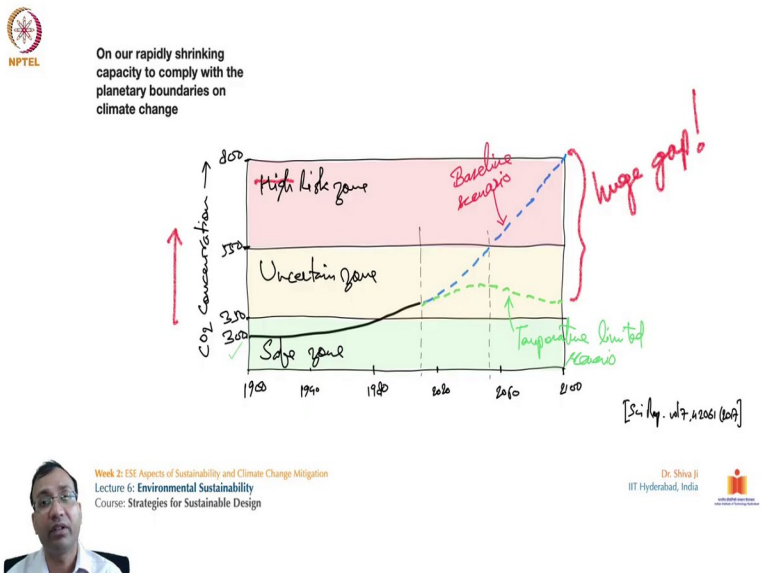

And here in this slide you can understand what are the threshold from where if there is way through which we can bring back that CO2 emission levels to the normal, so it can still be considered at safe zone and where nature can restore and restore itself. The second one is the uncertain zone where if the emission continues with the same pace, so it can have some catastrophic effect.

And the third one is the very high risk zone in, if it the CO2 emissions enter into that zone then the resultant catastrophes is could be very high, very extremely bad and that is very difficult to predict what could go wrong. So, this phenomenon can occur at the global level and there may be repercussions to be fit in the most of the countries, most of the places.

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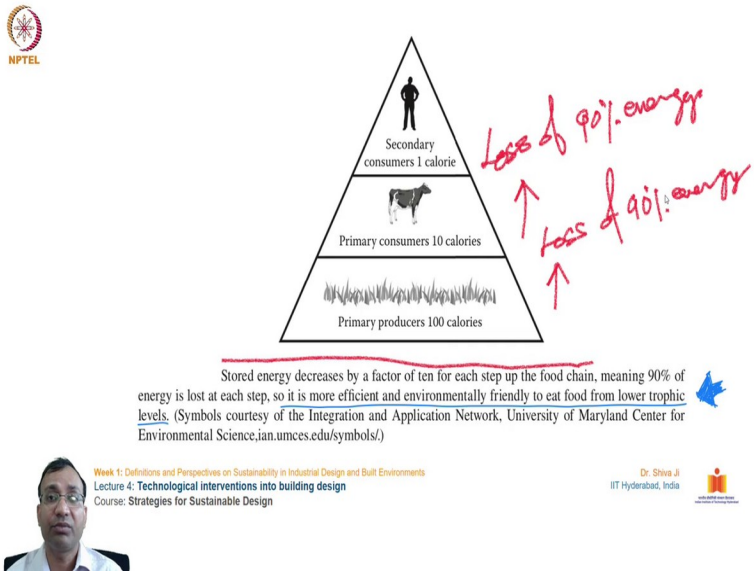

So, what to do to minimize the energy consumption, minimize the consumption of resources minimize this overall carbon footprint is to understand what are our consumption habits are, so our consumption habits in the recent times have changed and a per person consumption of resources has increased many fault.

So, as you can see in this pyramid, so the vegetables and vegetation based plant-based fruit and trees based these produce gives us 100 calories if and then the, at the next level once the animals eat and all the cattle consume, so there it reaches only 10 percent of that and the 90 percent of that gets last midway.

And at the top level if you see it reaches by just one calorie that means the further 90 percent from the level 2 to 3 decreases. So, we see there is trend off the loss of energy at the rate of 90 percent from one level to the next one. So, in order to save this overall energy we need to come bring our habits down to the lower base of the pyramid, so that we can minimize the losses. So, with this figure I would to highlight over here it is more efficient environment friendly to eat fruit and consume resources from the lower trophic, the lower strata of this pyramid.

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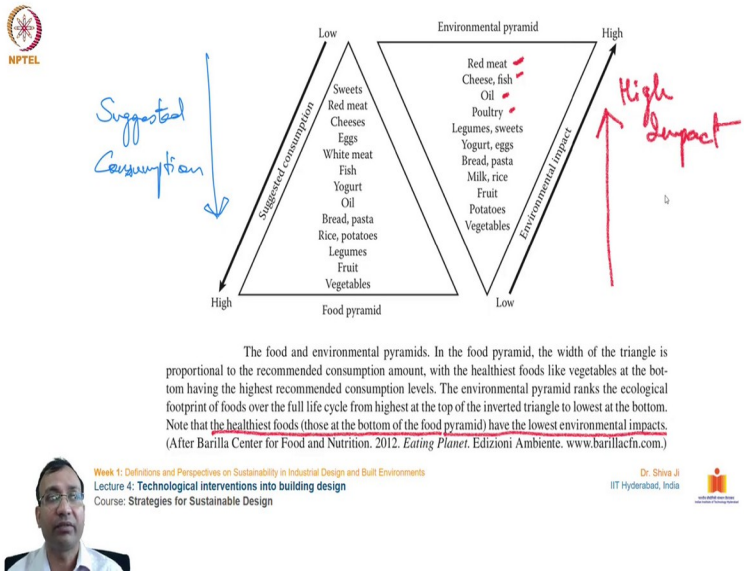

The food and environmental pyramids. In the food pyramid, the width of the triangle is proportional to the recommended consumption amount, with the healthiest foods like vegetables at the bottom having the highest recommended consumption levels. The environmental pyramid ranks the ecological footprint of foods over the full life cycle from highest at the top of the inverted triangle to lowest at the bottom. Note that the healthiest foods (those at the bottom of the food pyramid) have the lowest environmental impacts. (After Barilla Center for Food and Nutrition. 2012. *Eating Planet*. Edizioni Ambiente. www.barillacfn.com.)

Week 1: Definitions and Perspectives on Sustainability in Industrial Design and Built Environments
Lecture 4: **Technological interventions into building design**
Course: **Strategies for Sustainable Design**

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It is the quite evident over here with this slide you can see the common food items are listed down over here and they are arranged in two different orders, the first pyramid on the left side suggests the suggested consumption from low to high in the terms of in this pyramid, so the vegetables fruit legumes they come at the bottom of this and the sweets, red meat, cheese, eggs, white meat, etcetera they come at the top of this pyramid.

And in terms of environmental impact of them, so the first one talks about the energy, the second one talks about the impact. So, this we can see this pyramid gets inverted, the impact of the topmost item which is there in the food chain has the most of the impact, so red meat and cheese, fish, oil based foods have the highest impact on the global level. So, this suggests directly that we should go for a diet which is vegetable-based and a fruit-based and this kind of our nature directly which is produced from the nature.

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And it is I think very clear from this slide over here, what are the food items which are considered very bad on the environmental impact scenario and which are the food items which are considered a good on the environmental impact scenario. So, you can see on the left side all these fruit-based vegetables and vegetable based diet are good for this consumption.

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So, overall if you see how this consumption, how the sourcing of material happens from the nature, so we take raw materials from the nature, we process them we design, we then go for

production or manufacturing or remanufacturing, we go for the distribution, then consumption, then collection, again recycling. So, if this cycle continues then the cycle is closed.

But we discussed in the earlier lecture, so they if the cycle closed then the there are, there would not be or the very very minimal impact on the environment, but if there is a residual waste coming out of this cycle, then there is a big problem. So, how to take care of that waste? So, this is a one of the challenges and there are several ways, you may have read about a 3 hours, 5 hours, 7 hours. So, there are several reuse, recycle and replenish in such efforts such strategies, which we employ to deal with residual waste which comes out of any cycle. So, we will study more about these hours in the coming lectures. With this I would to close this session. Thank you.