Conservation Economics
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Module 2
What is Conservation?
Lecture 3
Unsustainable development

Namaste! We carry forward our discussion on Conservation, and in this lecture we will have a look at Unsustainable Development. Now, let us begin this lecture by remembering what Gandhi had said, "The world has enough for everyone's needs, but not everyone's greed.

Here Gandhi is emphasising that we have enough resources, but these resources are only sufficient to meet the needs of everybody, but not the greed of people. That is he is emphasising that the resources that we have are limited and while they can be used to fulfil everybody's needs; so, that everybody is well off they cannot be used to fulfil the greed's of people. So, if somebody wants to have more and more of all the resources, then that is not something that can be permitted, because that becomes unsustainable. So, here we are getting an idea of sustainability. If you use resources in such a manner that you are using them to fulfil your needs, it is a sustainable use. But, if you are using things to fulfil your greed, then it is probably an unsustainable use.

Now, technically we define sustainable development, as development that meets the needs of the present, without compromising the ability of the future generations to meet their own needs. So, when we talk about sustainable development we are saying, that we need to have a development and this development should be sufficient to meet the needs of the present. Again it's the same thing - everyone's needs. So, we want to have a development such that we are able to meet the needs of everybody, but without compromising the ability of future generations to meet their own needs. Now, why do we not want to compromise the ability of the future generations to meet their own needs? Because, again that if we are compromising the ability of our future generations, then probably we have shifted from the domain of needs to the domain of greed. And we are using so much of the resources that our children, and our grandchildren will no longer be able to meet their own needs. So, then we will call it an unsustainable development.

So, sustainable development is the development that meets the needs of the present without compromising the ability of the future generations to meet their own needs. And, we have seen before that if the world goes with an unsustainable development then, we have issues; we have

problems of conservation. Some examples of what an unsustainable development can lead to are over consumption - overuse of resources again. Overuse of resources because, we have shifted towards meeting the greed's of some people or greeds of majority of people. That leads to an over consumption. If you have an over consumption you will be clearing off a large portion of the forest to make space for agriculture, to get more and more amount of food, if you go for an over consumption you will deplete the resources, you will deplete the fish stocks, you will deplete the environment, you will deplete the ground water.

So, that is a result of unsustainable development: over consumption. Destruction of habitats which is bringing huge survival questions for a majority of species, desertification because the ground cover has been completely removed, because of the need for food, the need for water and also because of over grazing - that leads to desertification. Ocean acidification because, we are using so much amount of fossil fuels that we have increased the amount of carbon dioxide that is there in the atmosphere. And some of this carbon dioxide is now getting into our ocean waters - it is making the waters acidic. So, that is another consequence of an unsustainable development. Depletion of the ozone layer, changes in the biogeochemical cycles - we have shifted to an unnatural biogeochemical cycle - loss of biodiversity, extinction of species, changes in the distribution of organisms, changes in biodiversity, changes in climate, erosion of soil, changes in geomorphology all of these are some consequences of unsustainable development.

Changes in stratigraphy, changes in the element composition, changes in soil, introduction of invasive species, pollution, bleaching of corals, wars; so, a number of these things are arising, because of the greed of human beings. If everybody was targeting to fulfil their own needs, then the issues would not have arisen.

So, these are some consequences of unsustainable development. Now when we talk about the concept of sustainability - when we say that sustainable development is development that meets the needs of the present without compromising the ability of future generations to meet their own needs - then we are talking about two primary concepts. Here the first one is that of the needs of the present. What we are trying to say here is that there is a difference between needs and greed. So, the first concept is the concept of needs, in particular the essential needs of the world's poor to which overriding priority needs to be given.

When we talk about sustainable development we are not saying that we should refrain from development and we should put the world's poor in a position, where they no longer have control over their own lives. No, that is not sustainable development. Sustainable development says that needs of everybody and strictly the needs of the poor people need to be met. So, all the human needs - all the human requirements have to be met.

The second concept is the idea of limitations, or the idea of having a trade off. So, this definition is emphasising that there is always a tradeoff. We can go on meeting the needs, but if we

increase our needs to certain extent then the meeting of those needs will start to affect the ability of the future generations. Then probably that is not right.

So, there is always a trade off. You have to decide how much do you need today and how much needs to be left for the future generations. There is always this trade off that goes, there is always this idea of limitations, which is imposed by the current state of technology and social organisation.

On the environment's ability to meet the present and the future needs - the ability of the environment to meet the needs of the present as well as of the future generations is limited and so, this has to be kept in mind whenever we are trying to meet the needs of the present generation, or whenever we are trying to leave resources for the future generations.

We recognise three pillars of sustainability; we can talk about environmental sustainability, economic sustainability and social sustainability. So, these are the three pillars of sustainability: environmental, economic and social sustainability. What are these?

When we talk about environmental sustainability, we talk about things such as ecosystem services. Ecosystem services are the services that are provided to human beings by a well functioning ecosystem. So, these are things such as reduction of pollution, provisioning of services such as goods, things such as wood, fodder, fuel. We also have things like maintenance and regulation of the local climates and the microclimate. The benefits of biodiversity including things such as pollination or protection from certain diseases, availability of medicinal plants - these are all different ecosystem services which are provided by an ecosystem that is functioning well. And when we talk about environmental sustainability, we need to ensure that the ecosystem services are provided to the present generation and also to the future generations - which means that the ecosystems should be in a position where they are able to work properly. So, that is a part of environmental sustainability.

Then, we talk about things such as green engineering and chemistry. How can you manufacture goods or services in a manner that is less polluting to the environment? So, for instance, could you, say, replace a few chemicals that are inside a bottle - inside a plastic bottle, in such a way that when these chemicals leach out into the environment then they cause lesser degree of harm? When we start thinking about these things then we are talking about green chemistry. Can we replace plastics with biodegradable materials - bioplastics? So, this is also another concept in green engineering. In environmental sustainability we also talk about the quality of air and water, especially the levels of pollution that are there. We talk about reducing the effects of stresses such as pollution, greenhouse gas emissions and so on. So, if you want to maintain the sustainability of the environment you need to keep these stresses down to a certain level. We talk about resource integrity by minimising waste generation to prevent accidental release in the future.

So, when you talk about environmental sustainability there are two options, one to go with the business as usual, where you are generating a huge amount of waste. And, you are probably keeping this waste in a landfill or keeping them in containers, you are storing, say, chemical wastes or radioactive wastes in containers. And whenever you have such a situation, then it is possible that the future generations are going to pay for our misdeeds. Because, it is possible that in a near or a far off future, some of these chemicals may start to leach out. In that case we are putting a liability to the future generations.

So, when we talk about environmental sustainability, we say that no, we should go for such processes that the amount of waste generation is minimised, so that there is a lesser need to keep these wastes in a storage, which could cause an accidental release or issues for the future generation. So, we want to have the resources today, but we want to have them in such a manner that we are not creating a liability for the future generations. That is a part of environmental sustainability.

When we talk about social sustainability, we talk about things such as environmental justice, empowerment of communities that are burdened by pollution. In social sustainability, we have things such as the rights of the local communities. Suppose there is a big mining firm and it says that ok, I need these forests because below these forests we have a huge amount of minerals - we have a a a huge stock of ores. Now do you just permit this company to go cut the forest and start digging out the ores, or do you also ask the local communities?

Now, there could be certain communities who have been protecting these forests - because these forests are part of their culture. So, do they have a right or not? And if we say that these people also have a right, then we are talking about social sustainability. Similarly, in one of the later lectures we will have a look at things such as industrial pollution. If there is a company that is releasing chemical waste into the seas, and the fishermen who are catching the fish that are laced with these poisonous chemicals - they are losing out their jobs. The local community that is feeding on these fishes is falling ill. Do these people also have a right? And when we say that they also have a right to life, we are talking about things - which is social sustainability. In social sustainability, we talk about protection, sustenance and improvement of human health. Because again when we talk about the ability of the future generations to meet their own needs, then if the future generation is healthy then they will be in a much better position to meet their own needs.

And so, we need to ensure that we are not spreading pollution or industrial effluents to such an extent that it is impacting the health of any community. So, this is a component of social sustainability. Or things like increasing the participation of stakeholders - and here again the future generation will be in a much better position to fulfil their needs, if they have been involved in the decision making process - if they have been trained in the decision making process, if they know how to say bargain for things, if they know how to negotiate for things. So,

when we talk about social sustainability it is important to ensure that all the stakeholders get the right they have and they get a voice.

Whenever you need to make any decision - whether any industry should be set up, where should it be set up, what will be the modalities of collection of the effluents, or treatment of the effluents then the local people have to be involved. And when we talk about such stakeholder rights, we are talking about social sustainability.

Education about sustainability - the future generations will be in a much lesser position to meet their dreams, if they are uneducated. So, in social sustainability we also say that people need to be educated about sustainability. Sustainability is something that should be incorporated in the textbooks, sustainability is something that should be taught in the schools. Because, when people are educated about sustainability they will be in a much better position to assert their rights and they will have a much better control over their lives. Another thing that we talk about is the protection, maintenance and access to resources - protection of resources, maintenance of resources and access to the resources.

Let us take the example of a tiger reserve. Currently there are certain communities that are living alongside a tiger reserve. And their livelihoods are dependent on the tiger reserve because there are people who want to see tigers - they come to these tiger reserves and tourism industry is providing jobs to these local communities. Now, what will happen if all the tigers get forced out? If there are no tigers in a tiger reserve, there would be hardly any tourists who would want to visit the place. So, the protection and maintenance of tigers - here tigers are a resource - they are a natural resource and maintenance and protection of these tigers is critical to ensure that the future generations are also able to derive their livelihoods or employment through this resource. Similarly people need to have an access to the resources. Now, suppose the government comes up with a policy and says that ok, there is this tiger reserve, but all the facilities of tourism will be say set up and maintained by a third party. And we are not allowing the locals to have an access to this area or to the resources. In that case the ability of the future generations of these communities to derive their livelihoods and employment from these tigers or these tiger reserves will go down.

So, in social sustainability we need to ensure that the resources are protected, the resources are maintained in a good fashion and people also have access to these resources. We talk about promotion of sustainable living - that is also a component of social sustainability. Because, if people shift to living in a sustainable manner, then the next generations are in a much better position to meet their own needs. So, this is also another component of social sustainability.

Next, we talk about economic sustainability. In economic sustainability we talk about job security. If there is a resource - does it provide job security to people, or when we are talking about a tiger reserve is the condition such that people have a job one day and next day they can

be kicked out? If that is the situation - if the local people do not have a job security, then probably this is not a sustainable development. Because, the locals - or the people who are dependent on these tiger reserves - also need to be sure that they will be in a position to utilise these resources to meet their needs. So, in economic sustainability we talk about job security, we talk about incentivisation of sustainable practices. We have seen before that incentives are things that induce people to act in a certain manner. If you - if the society wants to promote sustainable living, then sustainable living needs to be incentivised. A good way out is through the provisioning of taxes and subsidies. If somebody is going towards an unsustainable living, then probably the government may tax that person more - which is why the government taxes polluting vehicles in a big way.

By these taxations the government is incentivising people to refrain from using these oil guzzling vehicles and pollution spewing vehicles. In a number of cases these incentives are also positive incentives such as subsidies. So, in a number of cases the government subsidises the purchase of electric vehicles, the government gives you a subsidy if you put up solar panels on top of your roof.

So, economic sustainability talks about the use of incentives to promote sustainability. It talks also about the market practices for sustainability: how do you tinker the market in such a manner that sustainability gets promoted. We will look at the functioning of markets in later lectures, but here it is important to emphasise that the demand for things depends on a number of factors, including whether people have been exposed to it and how culturally or socially acceptable is the using of a certain resource. Now, if through education or through awareness people get this idea that the use of solar panels is sustainable, or the use of SUVs is bad for the environment - that would impact the demand of these resources. And demand would also have an impact on the supply of these resources, on the prices of these resources.

Economic sustainability also talks about the market practices for sustainability, it talks about natural resource accounting. When we do an accounting for any industry is it only the profit and loss statements that we are interested in, or are we also interested in accounting for how sustainable was the manufacturing process?

Natural resource accounting incorporates things such as the sustainability accounting for industries; it also incorporates accounting for how much amount of resources do you have. Does the country say for instance perform an audit every few years about how much is the stock of forest that is available in the country, how much is the amount of groundwater that we have in the country, how much is the level of fish stocks in the country? When we incorporate accounting for all of these different natural resources, we are talking about economic sustainability.

Life cycle cost assessment: a very good example in the case of life cycle cost assessment is

plastics. Plastics are so ubiquitous because they are cheap to manufacture. So, it is very easy and it is very cheap to manufacture, say, a plastic bag or a plastic bottle. But once they have been used and once they have been thrown out, then it is difficult to collect them: especially because they are light in weight and they litter easily. It is difficult to carry them to say a sorting facility because again because of their light weight they use a very large volume - and so, transportation becomes difficult. It is difficult to sort them out into different categories because there are so many different kinds of plastics. There are so many different kinds of additives that we are adding to plastics - there are so many different kinds of plasticizers that are added. We have thermoplastics, we have thermosetting plastics - both of these cannot be mixed together, if you are aiming to recycle plastics. Then, when if these plastics are recycled, then there is a cost to recycling, if these plastics are put into a landfill, then there is a cost of land and water. Now, the person who is manufacturing the plastic or the industrialist who is manufacturing these plastics or these plastic bags is not paying for all of these - it is the society that is paying for these.

So, the municipal corporation of your city will be paying for say collection of garbage or processing of garbage or disposal of garbage. When we say that the municipal corporation is paying, it is the taxpayers who are paying, it is you and me who are paying for the disposal of these plastics - it's not the industrialist. So, if we emphasise that plastics are cheap - because they are cheap to manufacture, then it would be one story and if we emphasise that throughout their life cycle from their cradle to their grave, the plastics have such and such cost involved - the cost of collection, the cost of transportation, the cost of processing and the cost of keeping them stored for say 1000 of years - because they just do not degrade. When we incorporate all of these costs into the accounting we are talking about the life cycle assessment of plastics. And once we incorporate life cycle assessment, we will see that a number of biodegradable products are much cheaper than plastics. It is only because we do not consider the life cycle assessment that we say that plastics are cheap. If we incorporate life cycle assessment, we realise how expensive they are. Now, incorporation of life cycle assessments is important for conservation, but it needs to be done. And when we talk about life cycle assessments, we are talking about economic sustainability.

Then, in economic sustainability we talk about cost structures to reduce the risk and to promote new technologies. So, for instance if there is an industry which is a polluting industry, and this industry has an option to say install an equipment that would process these pollutants - but the installation of these equipment will entail certain cost. There could also be a requirement for putting money into research, for development of such technologies which will be able to control this pollution. Now, these sorts of things need to be incentivised. So, you need to incentivise industries to install such equipment, you need to incentivise the research institutions to perform research into developing these technologies. And, when we say that all of these are important and they need to be funded, say, by the government, we are talking about economic sustainability.

And when we incorporate all these three - the social accounting, environmental accounting and the financial accounting, then we are talking about the triple bottom line. Now, bottom line generally refers to the last line in the profit and loss statement. And it tells what is the level of profit or loss that a company has had in a particular year - that is the bottom line. But, then the triple bottom line says that not just the profit and loss, but you also need to see, if the social accounting and environmental accounting have also been a part of the functioning of this industry or company.

When we talk about sustainability, there are two different schools of thought. There is one school of thought that says that ok, we need to have sustainable development. But, we can say do a trade over or a trade off for meeting the needs of the present in a much greater way than meeting the needs of the future generations. That is weak sustainability. And there is another school of thought that says that no matter what happens the development has to be sustainable. You cannot trade the needs of the future generations with the needs of the present generation - that is the strong sustainability. So, weak sustainability assumes that natural capital and manufactured capital are essentially substitutable - natural capital such as forest and the manufactured capital such as say iron ore - weak sustainability says that both of these are essentially substitutable, which means that if you are destroying your forest, but, by destroying the forest you are having more and more industries or you are having more and more roads, or you are having more and more production of iron, then it is ok if the forest get destroyed. That is weak sustainability - it assumes that natural capital and manufactured capital are essentially substitutable. And it considers that there are no essential differences between the kinds of wellbeing that they generated. So, they are one and the same - the only thing that matters is the total value of the aggregate stock of capital, which includes the natural capital and the manufactured capital, which should be at least maintained or ideally increased for the sake of the future generations. It says that if we get rid of our forest, but we have developed an industry in its place, so through this industry the future generation will be able to meet its own needs - so there is no need to conserve the forest. That is weak sustainability - that natural capital and manufactured capital are essentially substituting. In such a perspective it does not matter whether the current generation uses up non renewable resources or dumps carbon dioxide in the atmosphere, as long as enough machines, roads and ports are built in compensation. This is weak sustainability.

The strong sustainability school assumes that natural capital and manufactured capital are essentially non substituting. It says that you need to maintain natural capital and you also need to maintain the manufactured capital. And you need to maintain both of these; you cannot just say that we will be maintaining the manufactured capital at the cost of the natural capital. That is the strong sustainability. It considers that there are essential differences between the kinds of well being that they generate. So, essentially you cannot substitute the joy of seeing a tiger by say providing a longer road. So, this is what the strong sustainability argument says - that the benefits that we receive out of the natural capital are very different from the benefit that you receive out of the manufactured capital. And so, when we talk about sustainability, we need to

maintain both of these capitals separately. Both natural capital and manufactured capital need to be at least maintained or ideally increased for the sake of the future generations. So, it says that the natural capital and the manufactured capital both need to be maintained and both need to be ideally increased for the sake of the future generations. That is if you look at the differences between strong and weak sustainability, the key idea in strong sustainability is that the substitutability of natural capital by other types of capital is severely limited, they are not substitutable. The weak sustainability on the other hand says that natural capital and other types of capital such as manufactured capital are perfectly substitutable and you can trade off one for the other. Strong sustainability says that certain human actions can entail irreversible consequences. A good example is climate change. It says that if you go and releasing large amounts of carbon dioxide into the atmosphere that would lead to global warming because of the greenhouse effect - and that could lead to climate change. Now, climate change essentially is an irreversible phenomenon and so, it will lead to consequences that are also irreversible. Weak sustainability says the technological innovation and monetary compensation can be done for environmental degradation. That is, on the one hand the strong sustainability argument would say that you should not release so much amounts of carbon dioxide because that will lead to climate changes and that would lead to negative consequences for a large number of people, on the other hand weak sustainability says that ok, even if there is climate change, we can provide monetary compensation to the people who are affected by climate change. So, weak sustainability would say that ok it is fine that there is climate change. You can always compensate people for it we can provide them with money. And, they should be happy with it and so, there is no need for the present generation to say stop climate change.

This is a major difference between ah the strong and the weak sustainability. The strong sustainability says that conserving the irreplaceable stocks of critical natural capital for the sake of future generation is essential because a number of stocks of natural capital are irreplaceable - you cannot replace them with anything else. The weak sustainability says that the total value of the aggregate stock of capital should be maintained or ideally increased - not natural capital. So, this is a difference between strong and weak sustainability. The key concept in strong sustainability is critical natural capital - it tries to emphasise again and again that the natural capital is critical. On the other hand the weak sustainability just says that optimal allocation of scarce resources is good enough.

The strong sustainability says that scientific knowledge is required as an input for public deliberation - it talks about procedural rationality. It says that scientific knowledge is crucial, and we need to develop these procedures. On the other hand the weak sustainability only talks about technical or scientific approach for determining the thresholds and norms - it is talking about instrumental rationality. So, on the one hand the strong sustainability is asking how are we going to conserve these natural capital, but weak sustainability is only saying that ok even if the national capital is going down we just need a method to measure this loss of natural capital, so that we are able to compensate for it by providing money. It only talks about a technical aspect, it only talks about an instrumental rationality not a procedural rationality.

Sustainability these days has come into our common currency, especially after the Earth summit of 1992. In the earth summit the countries came together and they agreed to agenda 21 - which is the sustainable development in the 21st century. This talks about sustainable development goals. These include things such as no poverty, or reduction of poverty - so, here we are talking about a social sustainability as well as as an economic sustainability. It talks about removing hunger - because, if you create conditions where people are no longer poor or hungry, then probably they - as well as their next generations - will be in a much better position, to ah fulfil their own needs and requirements. It talks about things such as good health and well being - which is crucial not just for the current generation, but also for the future generations. It talks about quality education to people. It talks about gender equality, clean water and sanitation, affordable and clean energy - not just clean energy - the energy needs to be affordable, so that more and more people have access to the energy.

But, then in the quest for making energy affordable, we just cannot go on with the non renewable sources of energy. We have to shift towards clean energy - and we need to to create such conditions that clean energy also becomes affordable. So, we need to invest into research into clean energy, we need to invest into those industries that are producing - say - the solar panels. We need to provide incentives to people - we need to provide subsidies, so that clean energy becomes affordable. So, affordable and clean energy is a sustainable goal. Decent work and economic growth - now we are starting to talk about economic sustainability: everybody should have an opportunity for a decent work, and should also have the opportunities of economic growth, industry innovation and infrastructure.

So, you need to have infrastructures, you need to have industries, which will make it possible for the future generations to meet their own needs. Reduced inequalities, sustainable cities and communities - so not just sustainability at the level of the industries; but also sustainability at the level of cities. Is your city in a position where it is doing rainwater harvesting? Is your city, for instance, having a sewage treatment plant, and even more preferably a sewage treatment plant that makes use of bio remediation - because that is one of the most sustainable ways in which we can process the waste. So, the sustainable development goals talk about sustainable cities and communities.

They, talk about responsible consumption and production - consumption needs to be responsible - which means that over consumption needs to be avoided. So, there is responsible consumption, but also responsible production. Responsible production is production in a manner where we are not overusing the natural resources - we are not generating a huge amount of waste. We are doing the production in some of the most efficient manners - we are doing production that uses clean energy. That is responsible production.

So, the sustainable development goals talk about responsible consumption and responsible

production. They talk about climate action: What are we doing to mitigate the climate change? It talks about life below water. It talks about water habitats - the aquatic habitats - are they functioning well? What about the fish stocks? Are we over consuming the fish stocks? That also needs to be kept in mind.

Also in one of the sustainable developing goals, it talks about life on land which includes biodiversity. Are we doing our development in a manner that conserves biodiversity, or are we doing our development in a way that is getting rid of biodiversity? It talks about peace, justice and strong institutions - because once we have peace, once we have justice, and once we have strong institutions, then it creates a society in which people have much more control over their own lives. It creates a society where everybody is able to develop himself or herself. And it creates a society in which not just the present generation, but also the future generations will be in a much better position, to say, do innovation or to have more control over their own lives.

The sustainable development goals talk about maintaining peace. If there is a war then probably the next generation will be in a much worse position to maintain their own needs. It talks about justice, it talks about institutions, and it also talks about partnerships for the goals - because of late we have realised that sustainability cannot be done at the level of just a single country. If for instance there is one country that is releasing a huge quantity of greenhouse gases, it is over using coal - then the consequences will not just be faced by that country, but also by the world in total - because climate change is a global phenomenon. If there is a a country that is burning a huge quantity of coal - then the acid rain that results will not just fall in that country, but will also fall in the neighbouring countries. If there is a radioactive substance release from one country, then this radioactive elements will move through wind and water to reach other countries, they will affect people in the other countries as well. So we require strong partnerships and we require common goals.

These are the sustainable development goals. Can you relate these to the 10 principles of economies? One: people in society face tradeoffs - and when we talk about sustainability, we are talking about the tradeoff between meeting the needs of the present generation and meeting the needs of the future generations. Sustainability says that we need to meet the needs of the present generation, in such a manner that the future generations are also able to meet their own needs. This is a tradeoff. Tradeoff of course, and you need to cost what you give up to get something.

If you want to do development in such a manner that your children and your grandchildren are also able to have control over their own lives, then you will have to forgo something. Cost as we have seen is what you give up to get something. And, if you want to perform development in a manner that your future generation is secure then probably you will have to reduce your own consumption.

So, tradeoffs lead to costs and sustainable development talks about these costs. Third: that people

respond to incentives. So, if you want to promote sustainable development you will have to incentivise sustainable development, and you will also have to disincentivized development that is not sustainable. And we have seen that taxes and subsidies are very good mechanisms. But we also have social incentives.

Is the society boycotting an industrialist who is polluting the surroundings? Is the society honouring an industrialist who is - say making an express effort to reduce pollution? When you go and buy an equipment - do you only look at the cost or do you also see, whether or not that industry is making the equipment in a sustainable manner?

We can also look at the energy audits of the industry - do you also look at the natural resource audit of the industry? If you do all of these then probably, you are incentivising sustainable development and disincentivizing unsustainable development.

So, people respond to incentives, industries respond to incentives - and it is not just the role of government, but also of each and every consumer. Then, we saw that markets are usually a good way to organise economic activity and so, if we want to promote sustainable development, we will also have to act at the level of the market. And markets can be influenced. Markets can be influenced by influencing the buyers and by influencing the selling.

Governments can sometimes improve the market outcomes, through interventions - and these interventions can be at the level of taxation, subsidies or direct command and control. So, we can make use of different principles of economics to ensure that we have a sustainable development. So, what kinds of things should be we promoting? And what sorts of things are being promoted?

One thing that is being promoted for sustainable development is clean technology. Clean technology refers to any process, product or service that reduces negative environmental impacts, through significant energy efficiency improvements, sustainable use of resources or environmental protection activities.

Clean technology is any process product or service - so, we can have it at the level of a process, we can have it at the level of product or we can have a clean technology even in the service industry. And, what does clean technology do? It reduces negative environmental impacts. And how does it reduce the negative environmental impact? By doing significant energy efficiency.

Here we are talking about such processes, or such products, or such services that keep in mind that the energy efficiency needs to be increased. Now, the best thing about increasing energy efficiency is that it also makes the industry or the process more profitable. So, for instance there are two methods of manufacturing a chemical. And the first one takes say 1 mega joule of energy. And the second one takes 10 mega joules of energy for the same quantity of product. Now, if the industry shifts towards the process that is taking just 1 mega joule of energy, then

probably the industry will also be doing significant cost cuttings, because of reduction in its energy usage - the bill for energy will go down. It is important that we incentivise such processes because, in the beginning it might be difficult for the industry to shift to a more energy efficient process or protocol. Because, it might require, say, installation of a different equipment. But, in the case of clean technology we try to increase the energy efficiency - or it promotes the sustainable use of resources, or it promotes environmental protection activities.

So, for instance if there is a product - or let us say that there are two packets of tea and one says that it has been sourced from those areas that are doing organic cultivation. And the second one does not do that. In that case if you purchase the one that has been sourced from organic farms, then you are promoting sustainability.

Or there could be say a chocolate that says that it has been taken from those farms, or those countries that do not permit child labour. Or if you purchase a mobile phone that says that when it was manufactured, we took care that the greenhouse emissions were net zero. If we are using these services or if we are using these processes or these products, what we are doing? We are promoting clean technology, which will lead to sustainability. Now, things in clean technology include renewable energy, water purification air purification, sewage treatment, environmental remediation, solid waste management, energy conservation and appropriate sustainable technologies.

Let us have a look at some clean technologies that have been incentivised. One is environmental friendly energy and energy storage, including things such as power generation with renewable energy, use of photovoltaics or solar panels, use of solar thermals - solar thermals are those power plants that make use of the heat that is given out by the Sun in the form of infrared radiation. It concentrates that heat and it uses that heat to run a turbine. So, it is different from a normal solar cell. Or energy generation using geothermal energy, which is the heat that is stored inside the Earth. Or power generation using wind energy, or power generation using bio energy or power generation using sewage gas. Another clean technology is the environmental friendly use of fossil fuels. In this case you are using the fossil fuels, but you are using them in a way that is more environmental friendly.

Remember that when we talk about clean technologies, we are only talking about increasing the energy efficiency, or shifting from a 100 percent fossil fuel to a less amount of fossil fuel. It is not necessary that it should be a a 100 percent shift. Because, clean technologies are to promote an incremental step - it is a gradual process. So, in the case of environmental friendly use of fossil fuels, we are still using fossil fuels. And it is important to remember that fossil fuels are non renewable energy resources.

They are limited and so, they need to be avoided, but then in cases where they cannot be avoided, we can at least shift to an environmental friendly use. Such as a combined cycle power

plant - in a combined cycle power plant, we use several heat engines together to increase the efficiency. So, in this power plant we are still using the fossil fuel, but by using a number of heat engines, we are increasing the efficiency.

Another is cogeneration plants where we have a simultaneous generation of electricity and useful heat. Now, this heat could be used to say heat up the buildings. So, cogeneration plants ensure that the heat that was released in the generation of electricity - that is also tapped - and that is also used, so that the heating cost somewhere else can go down.

Or shift to high performance power station. Or carbon dioxide reduced power generation. So, you can shift to a process that is still using fossil fuels -but you release less amount of carbon dioxide. Or we can shift to storage technologies such as mechanical storage of energy, electrochemical storage of energy, electrical storage of energy, thermal storage of energy. Storage technologies are clean technologies because they permit people to generate more and more amount of energy through renewable means, when they are available, store that energy and use them when the renewable energy is not available. A good example is solar cells - solar cells or solar panels will only work during the day time, when the Sun is there, but what about the night time? If you wanted to shift to solar panels, then you would have to devise a mechanism through which the energy or the electricity that is generated during the daytime can be stored. Now, this storage can be through means of a mechanical storage, for instance you can use the solar energy in the daytime, to run pumps and shift water to a higher level. And, in the night time this water can be made to run through turbines and get the energy back. So, in this way we will be able to store the electricity that was generated through sustainable means, or through renewable energy. Or we can go with electrochemical storage which is batteries - or we can go through electrical storage or thermal storage.

Another clean technology is efficient grids such as smart grid local - local and district heat grid. When electricity is moved from one place to another there is a huge loss that occurs, because this electricity is converted into heat energy. Through a smart grid, we can reduce the amount of energy losses during transport of electricity.

Another clean technology is in the circular economy section, such as waste collection and transportation. If you develop an infrastructure for increasing waste collection and transportation, you are working in clean technology. If you devise a method of base separation and sorting - so that the plastics can be recycled, then we are talking about a clean technology.

Or utilisation of waste through say recycling. If you devise a method through which plastics can be recycled into other product, then we are talking about clean technology. Or thermal waste treatment - we have waste disposal safeguarding and removal of contaminants and hazardous waste, that is also a clean technology. Reduction or utilisation of landfill gas - when we talk about a landfill the organic material that is put into the landfill is slowly converted into methane

and is released. Methane is a very potent greenhouse gas. It acts in a way that is very similar to carbon dioxide, but is much more effective than carbon dioxide in trapping the Sun's heat. If this gas can be reduced or it can be utilised in some way - because methane can always be burnt! So, if you devise a technology through which these landfill gases can be burnt to generate electricity, we are talking about clean technologies. Or, environmental remediation - bringing the environment back to the normal pristine state, such as land rehabilitation or ecological restoration. If we for instance devise a technology through which the holes that are left on the ground after a mining operation - they can be filled back again or they can be replanted. Then we are talking about a clean technology. Or sustainable water management such as water procurement and treatment including groundwater monitoring and water purification. If you devise a technology that can monitor the amounts of groundwater that you have - that is a clean technology, because that permits us to use water in a more sustainable manner. If you devise a technology that can purify water, especially the sea water, then we are talking about sustainable water management because, we will reduce our dependence on groundwater, which is a very crucial natural resource.

If we say tap out most of the groundwater, then it takes hundreds of years for the reservoirs to fill back again. And, if we did tap all the groundwater resources then probably we are leaving out less for the future generations. But, if you devise a technology through which ah sea water can be purified and used - in that case we will reduce our dependence on groundwater and that will be a sustainable use of groundwater.

Or things about water utilisation - that is if we could have ways of increasing the efficiency of the components of the water distribution system, reducing the losses there, working on a on a better water distribution grid - these are all different clean technologies. Or increasing the efficiency in water utilisation - can we talk about water efficient technologies in the residential sector, can we talk about say systems that use less amount of water? Can we talk about water efficient technologies in the commercial sector, or have clean technologies in the sustainable mobility sector, such as alternative fuels, biofuels, natural gas, hybrid drives, electric drives fuel cell drives? Now, many of these reduce our dependence on petroleum. Or alternative drive technologies - efficient combustion engines, environmentally friendly vehicle design or infrastructure and traffic control. If you have an inefficient traffic control, then probably a lot more people are spending their time, in the intersections with the traffic lights. And that is also leading to the usage of fossil fuels that could be avoided. Through an efficient traffic control, an intelligent traffic control, integrated traffic infrastructure, these can be avoided. Electricity charging stations, natural gas fuelling stations - if we are promoting these we are promoting clean technologies.

Or sustainable mobility management such as car-sharing. If you develop an app that that can promote people to go for a car-sharing arrangement or a car pooling arrangement, we are talking about a clean technology. Or vehicle fleet management.

Similarly, we also have clean technologies in resource and material efficiency. Cross sectional technologies such as biotechnology, nanotechnology, mechanical engineering and process technology, new materials such as compound materials and bioplastics. Compound materials in a number of cases are able to increase energy efficiency by reducing the weight of the equipment. Biomaterials such as bioplastics are very good alternatives to petroleum based plastics, and they are biodegradable. Or we can talk about material efficient processes, such as optimisation of existing processes or utilisation of new materials, or reduction of the operating supplies. So, in this case we are saying that we will be using the same process, but we will try to increase the efficiency so, that less amount of raw materials are required.

Or sustainable designing such as eco design, which is an approach to designing products with special consideration for the environmental impacts of the product during its whole life cycle, or life cycle assessment. As we have seen, if we did a proper life cycle assessment, then we will come to the conclusion that plastics are very expensive. So, life cycle assessment is also a component of clean technologies. Or increasing the energy efficiency, such as industry specific energy efficient production processes. Automation control technologies, efficient engines, recovery of feed that would otherwise have been lost to the environment, or making use of more efficient appliances electric appliances, information and communication technology appliances or illumination - if you are shifting from a a standard incandescent bulb to say an LED bulb - it is an efficient appliance. This is a clean technology. Or energy efficient buildings - if you look at the technical part or the equipments or build a building shell - which means insulation and windows so that you are able to reduce the amount of heating and cooling that is required in the building - that is a clean technology.

What we are seeing is that especially after the Earth Summit, and especially after agenda 21, a number of governments have been promoting sustainable technologies or clean technologies in a number of different sectors. So, sustainable development is not very difficult, but it does involve a tradeoff - it does involve a cost and if the society is ready it is easy to do.

That's all for today. Thank you for your attention. Jai Hind!