Sustainable Transportation Systems
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Lecture 39
Circular Economy in Transport Sector

Hello friends. So, you may recall that this circular economy related conceptual understanding we have already gone through. Today we will discuss about the application of circular economy in transportation sector. So, on the basis of this content list like what is the need of circular economy in transportation sector and how can we apply this concept of circular economy so that in different kind of parts of the transportation sector or segments of the transportation sector like vehicular design or transportation infrastructure or mobility planning and transport related policies, vehicular manufacturing, all those things.

We will also discuss one case study of Kera which one district in Espoo city of Finland and little bit two or three other cases within this, apart from this case study that will give us feeling of the importance of application of circular economy and how it can help to boost the transportation sector with environment friendly approach. So, that way we will conclude at last.

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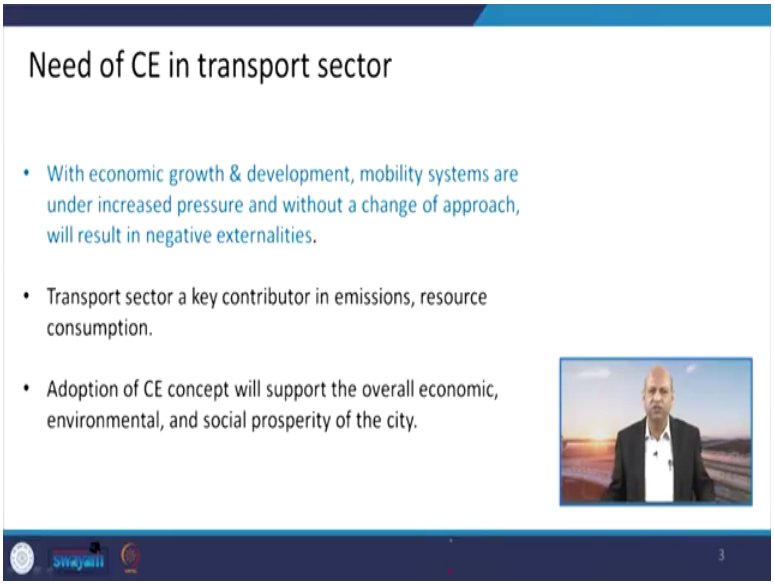

So, if you come to the need of circular economy in transportation sector, basically as you know that when economy is growing and development is occurring across different kind of economic sectors and in that growth the transportation sector plays very crucial role. So, so much pressure

increases when economy grows then mobility systems also grow. So, the pressure increases on all these resources which are part of the transportation infrastructure and transportation sector.

So, if we do not pay proper attention to the transportation sector then several negative externalities emerge out of that, like pollution and the land use related issues. Those kind of things, and then you know the transportation sector is key contributor in air pollution emissions, greenhouse gas emissions and resource consumption and energy consumption basically.

So, that way if we can address this through circular economy, we can do a lot of saving in terms of resources and energy and we can significantly reduce the emissions. Plus, the adoption of circular economy and this concept of circular economy that can support the overall economic growth and the environmental protection and the socioeconomic prosperity of the city or state wherever we want to apply this circular economy concept.

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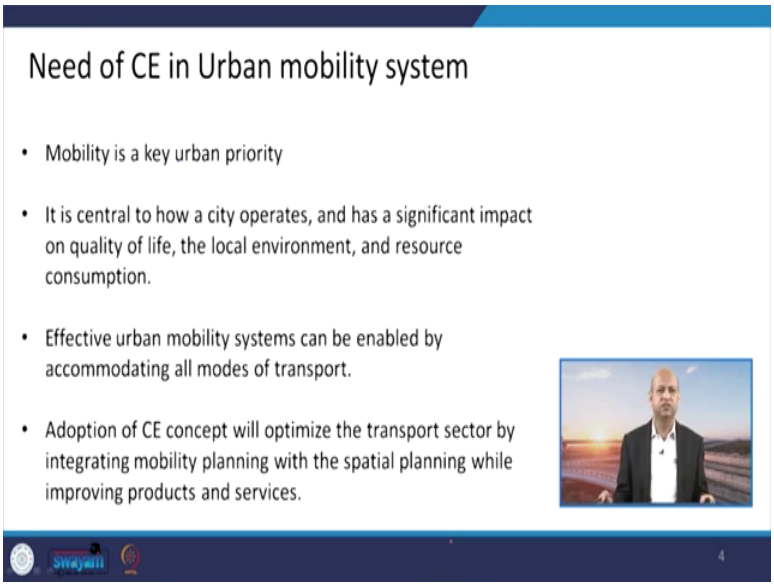

Plus, you know like in urban mobility if you want to focus the circular economy then as you know that in urban areas the mobility is the key factor, because whenever you want to interact with people or you want to serve the people through transporting goods or services, so the mobility is the part, without mobility you cannot give most of the services or transportation of the goods.

Then if we see like cities are planned or how do they operate then there is significant impact of the transportation type of infrastructure and what kind of transportation modes in the city we are using. So, the effective urban mobility systems, it is very importance for accommodating different kind of modes of the transport so that the integration happens in an optimum way.

Also, the adoption of this circular economy concept, it will optimize this usage of the transportation sector, integrating different kind of planning, roots of the transportation, plus as we see that modes and other services, whether like not only these economic activities but also the passenger related transportation and goods related transportation.

So, if we talk about the adoption of circular economy in vehicle's manufacturing, so design part, manufacturing part, all these things, so this can really help us to, like repairing related activities or reuse or re-manufacturing and recycling of the components of the material.

Because this concept is basically focused on minimization of the resource's consumption. So, that is why this reuse, recycle and repairing related, means design should be like that, so that the reuse and recycle of different parts of the vehicle are easy, and repair can be done properly so that the usage of the vehicle can be up to its lifespan properly.

Then if we consider like how vehicles are designed, so that we can easily not only the repair but also different kind of usage, they can be used, different parts can be removed and recovered, all those things, and the energy related issues, if we think about, then also energy kind of, these waste parts or the disposal, those kind of energy related issues we can easily address if we are not discarding those parts. Because then you can reuse them.

So, the energy consumption which was required for disposal of some material or for land use, that landfill related issues that will be kind of minus in that, so this is win-win situation. When we talk about further in this area of vehicle manufacturing so the designing of the vehicles have to be properly, in terms of adaptability with the availability of the resources from the old vehicles. So, those kind of design aspects we have to consider.

Plus, the usage of different processes like you want to re-manufacture something, so that way if simplistic design is there it will help, otherwise complicated designs will really make it difficult to draw certain materials, which can be reused or recycled. So, the design must be simplistic,

kind of a thing and modular related design is really helpful, because then you can easily swap and you can, some material, for example a battery, if it is not fixed then you can just remove the battery, you can put the new one and this old battery can be recharged or it can be used for extracting some material.

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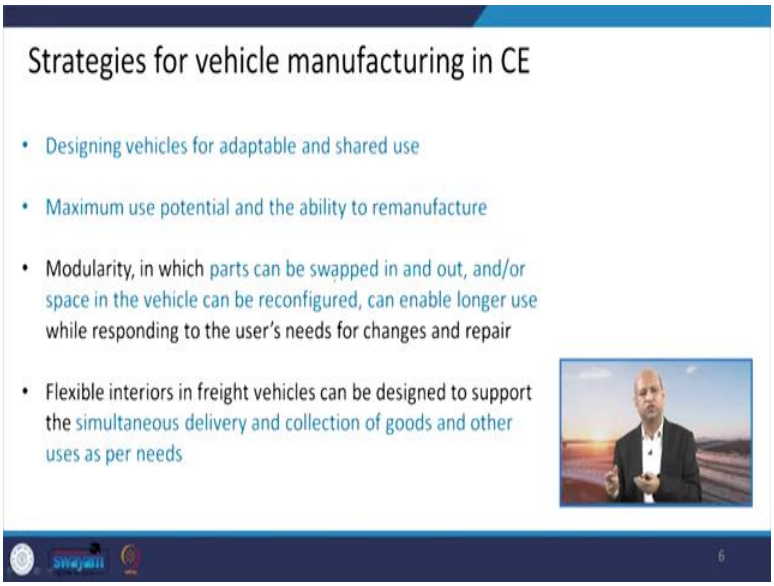

Similarly, like interiors must be also flexible in the sense of design sense and the usage and operational. So, that simultaneously you can use different kind of services as well as transportation of goods.

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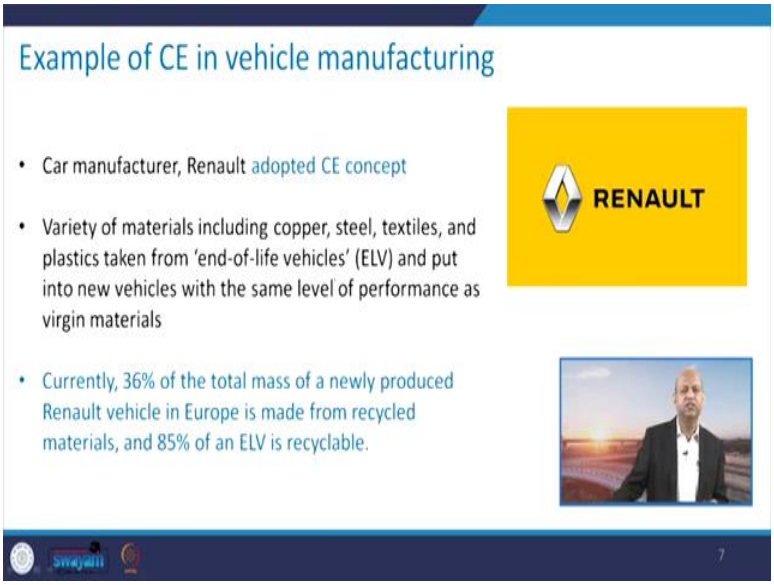

For example, there is this initiative in case of Renault company, where this car manufacturing company it is, so, for variety of material which can be taken back like copper steel, textiles or plastics, end of the life vehicles, it is the concept which have been used. So, around 30 percent of the total mass of newly produced Renault vehicle sin Europe is made from recycled material from the old one, and 85 percent of this end-of-life vehicles is recyclable.

So that design concept is really helpful. So, in that sense if we think and adopt innovative procedures and ideas then this circular economy concept can easily be implemented at the floor level as well as on the road also.

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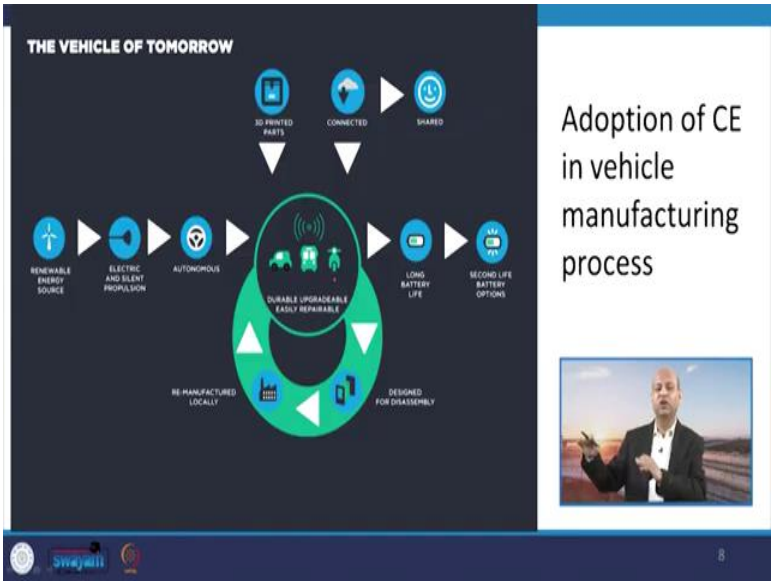

When we talk about adopting this circular economy and manufacturing, so this is the pictorial representation which can give a good idea like renewable energy sources should be used for energy and then electric and silent propulsion kind of technology we should go for. Autonomous, yes, it is possible and then you can see that all these activities are designed in such a way that optimization happens in terms of material utilization in minimum and energy utilization minimum plus recycle of maximum of the vehicle parts.

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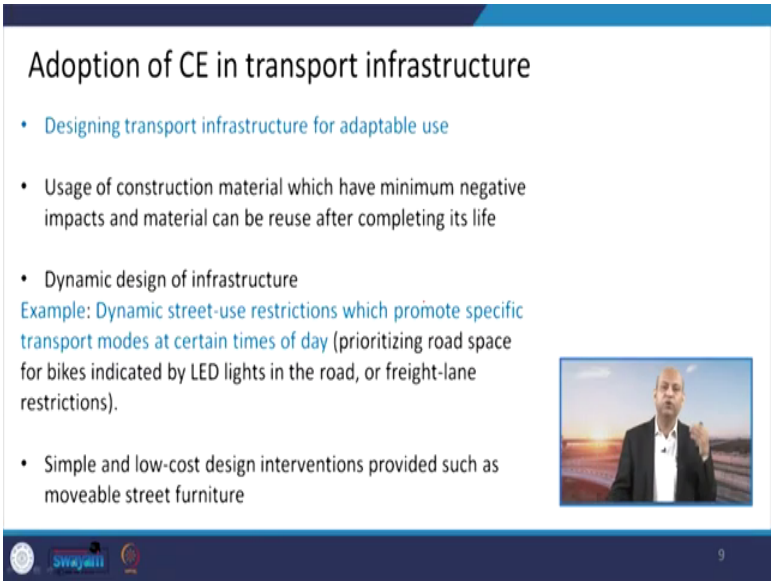

When we talk about the infrastructure of the transportation sector, so how can we adopt this circular economy in infrastructure. So, again this usage of construction material which have minimum negative impact and material usage can be minimum and it can be reused, and it can be reused up to the completing of its life, up to the end of the life.

For example, like design of the infrastructure can be dynamic in street use related restrictions, so that you can propagate only one kind of vehicle category so that mixed population is not there otherwise sometimes it results in reducing of the speed and congestion, those kind of things.

Then simple and low-cost design interventions are needed for that infrastructure or street furniture also. So, that walk-ability is not affected, easily it can be moved, when somebody is moving and walking in the street like restaurants are there and only walking is allowed in that way. So, those integration of other service-related issues should also be considered.

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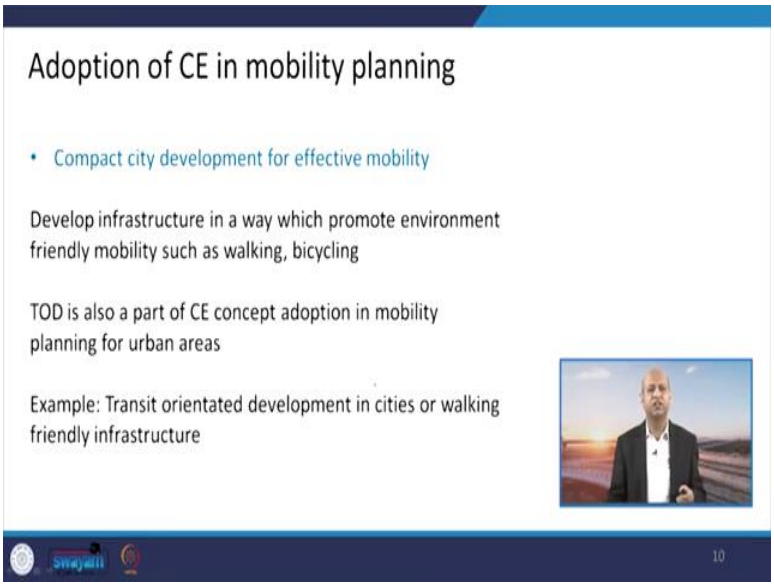

When we talk about mobility planning, so basically, we develop this infrastructure in a way which promotes environment friendly mobility, like walking, bicycling, so it is also healthy, we have discussed this issue earlier also, and this transit-oriented development is also part of circular economy concept, because it helps in utilization of resources in optimum way.

Most of the population are nearer to the public transportation system, high rise buildings and then open grounds and all those resources, optimization is achieved, and then also like you can

have walking related tracks or cycling tracks, it also help in kind of interaction and community based activities.

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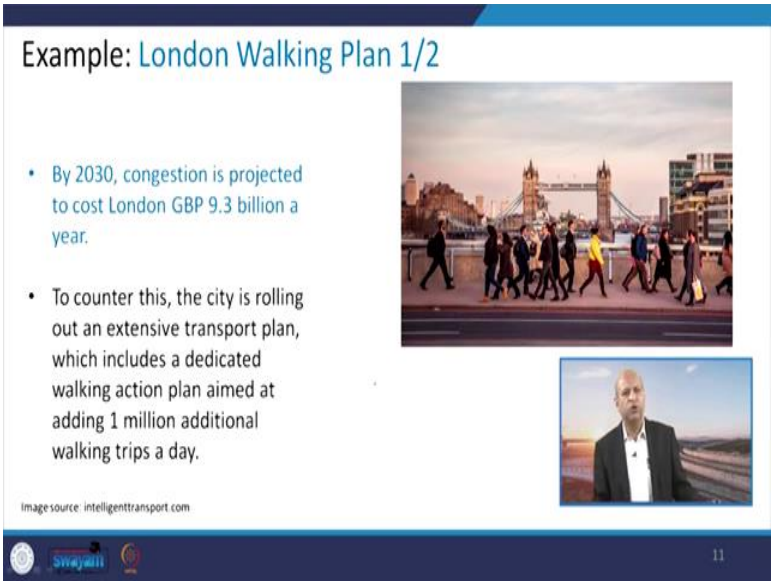

When we talk about one example of London which is planning for walking street or walking stretches, so by 2030 they are projecting that this congestion of traffic, it can cost around 9.3 billion of the Great Britain pounds per year, it is a huge cost. So, how to address those kind of congestion related issues.

So, to counter this kind of problem which will be there otherwise, so they are rolling the city into extensive transport plan, which includes like dedicated walking action plan and 1 million additional walking trips a day, that kind of aim and objective is there. So, this is a very ambitious plan so that this congestion related things can be avoided.

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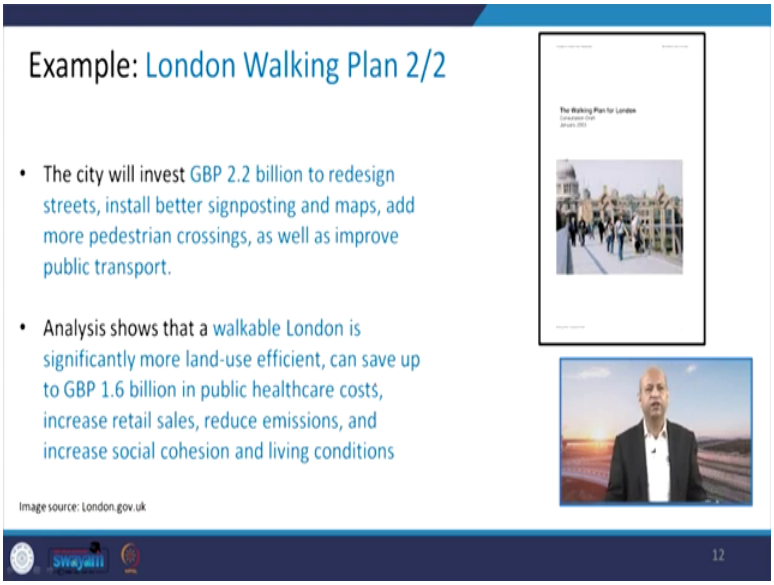

Well, so in this particular plan or action plan and it is also like with the concept of circular economy. So, it will be required around 2.2 billion investment for redesigning of the streets and installing some better sign posting and maps, so that people do not get confused or they have proper signage, movement becomes smooth, and more pedestrian crossings can be added and public transport related systems can be improved, so a lot of investment is needed.

But that loss of 9.3 billion can be avoided with this kind of investment. So, still it is beneficial strategy you can say. Then this walk-able London significantly think about land use efficiency and it can save around 1.6 billion pounds in public healthcare, because when people are walking they are becoming healthy. They will visit less to the doctor or hospitals. And like this retail sales, reduction of emissions and increase of social cohesiveness and the living conditions, so that way a lot of benefits can be received through this particular planning.

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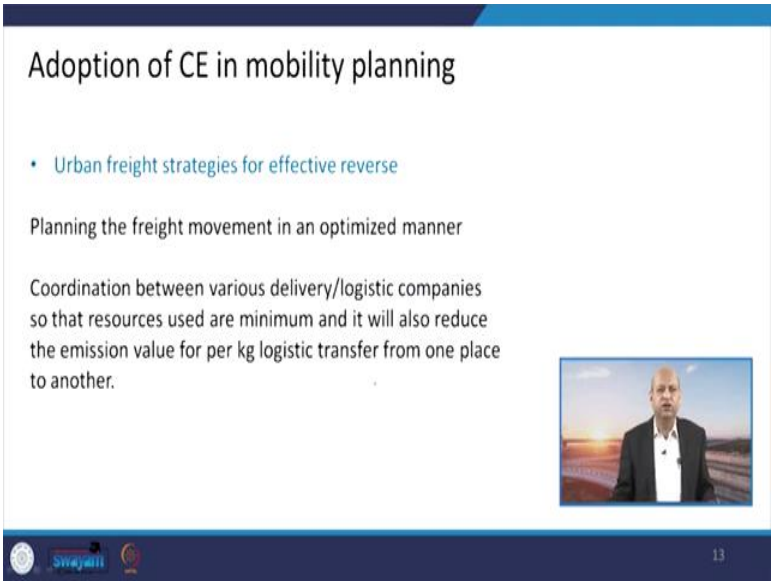

When we again continue about this adoption of circular economy in mobility planning then the freight movement is also one way where, one area where optimization is needed. So, the coordination between various delivery and logistic companies, so that resources are minimized, the utilization of resources are minimized and it can be reduced, those emissions reduce like per kg logistic transfer from one place to another. So, that integration kind of thing is needed to apply the concept of circular economy.

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When we talk about one example, the related example, so one is like Paris is aiming for logistic hotels and inner-city green freight kind of a thing. So, this is a fancy name of warehouses but basically, they are bringing back those logistic related facilities back into the city with the use of logistic hotels and high-density kind of areas there, but they will do in a very innovative way. So that they can reduce the heavy vehicles usage, they will not allow those heavy vehicle there, so there will be another kind of logistic infrastructure.

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Like they will have, in suburban areas some logistic centers where they will pool, then they will take to these warehouses or logistic hotels and from there if you want to distribute. So, only the single point of the collection is there, those heavy vehicles will not roam around in the city so that this traffic congestion related problem can be avoided, emissions also avoided.

So only in these warehouses or these logistic hotels, things will be put and from there, like from post office, postman goes and gives door to door letters and parcels. Similarly smaller vehicles, small sized vehicles which emit less, rather electric vehicles electric tricycles kind of a thing, they can carry 180kg weight, those kind of things. So, that will be used. So that way we will not have much emissions and it will be very environment friendly. So, this is one innovative way in that sense.

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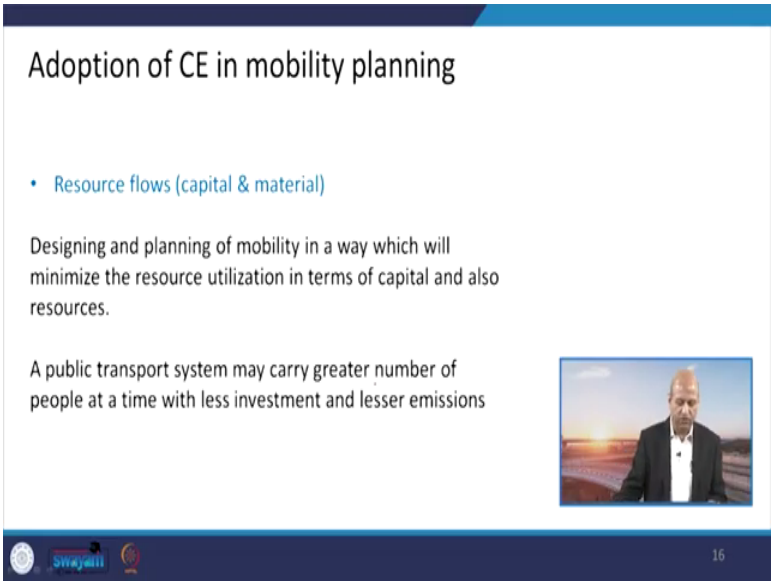

The another thing, if we talk about like designing, planning of the mobility in a way so that the utilization of this capital is also minimized, not only the resources but other related activities, and the public transportation system can carry greater number of people at time, with less investment and less emissions.

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So, when we talk about like how much benefit can we get out of this application of circular economy, so one example can be there which is from China. They are going in a big way to apply circular economy concept in transportation sector and they have calculated that this

circular economy opportunities, to reduce the total cost of access to the mobility is around like U. S. dollar of 2 trillion in 2030.

And improvement of 36 % over the current development path. So, that is the big advantage. Also, by implementing this circular economy opportunities it would result in decreasing of consumption of known renewable resources like fossil fuels, by 49 % in 2030 and 71 % in 2040. So, you can visualize the great benefits when we implement the circular economy concept in transportation sector.

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Another example is like reversing car centric mobility in Sao Paulo. So, they are also having one very ambitious plan in this 2014, urban master plan of Sao Paulo, they are focusing on the urban mobility systems to expand the public transportation system and the active transportation modes, and this will help in the residence, increase the number of residents living near public so a lot of people which are like only 25 % in 2015. So, that will increase 70 % in 2025.

So near public transportation system in 2015, 25 % people living but 70 % will be in 2025. So, a lot of people would be shifted towards those localities or high-rise buildings which are near the public transportation system. So, that less amount of energy is wasted when you are commuting to access the public transportation system.

Also, they are going to allocate 30 % of urban development funds towards these efforts. So they are very serious for reversing this car centric mobility and going towards public transportation system in a big way.

So, this will be a great opportunity for affordable housing, improving economic opportunities for urban residence and many other benefits related to economic or societal or environmental opportunities that this plan will give.

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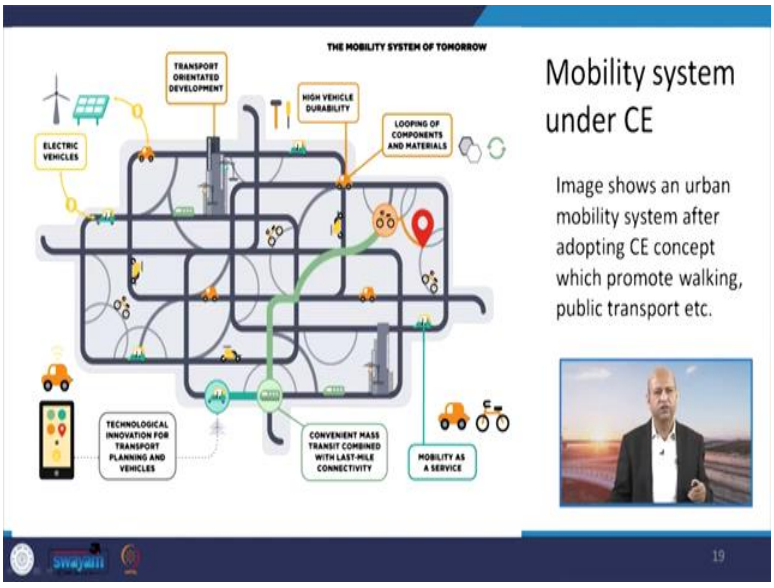

When we see in pictorial representation. How this mobility system under circular economy functions, so you can see like electricity, electric vehicles are getting charged from the renewable resources like solar and wind energy, it is not based on the fossil fuel. Then TOD, transport oriented development is promoted so that most of the people are near to the public transportation system and they can access it easily.

So, you can see when this cycling and walking and all these things are promoted and public transportation system is promoted so that way you go for consumption of less energy and more mobility in that sense.

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When we talk about the policies and regulations which help us to adopt this circular economy then we talk about recycling of vehicles or giving incentive on vehicle scrappage and high standards of vehicle manufacturing can ensure less pollution so if scrappage of vehicles go after certain years then this gives the boost to that kind of economy.

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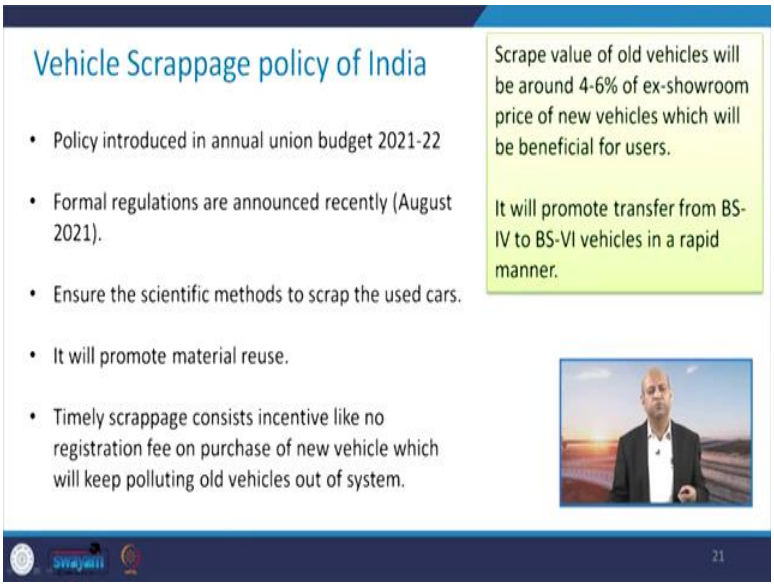

And recently, only in this month government of India has announced this scrappage policy and this is a wonderful example because they are aiming for, like after certain years when we vehicles will be taken back and around 4 % to 6 % of the ex-showroom price will be given, there

are certain benefits also like, if you scrap your old vehicle and you get the new vehicle you do not need to give this registration charges. There are many other these kind of incentive related policies.

And this huge benefit will be to the government. They are estimating that around 40,000 to 50,000 crore rupees will be there from this economic activity new economic activity will be emerging out of this policy, and it will also promote like transfer of Bharat Stage IV technology to Bharat Stage VI kind of vehicles. So in a rapid manner we will go for very nice technology which will emit very less amount of air pollutants and greenhouse gases.

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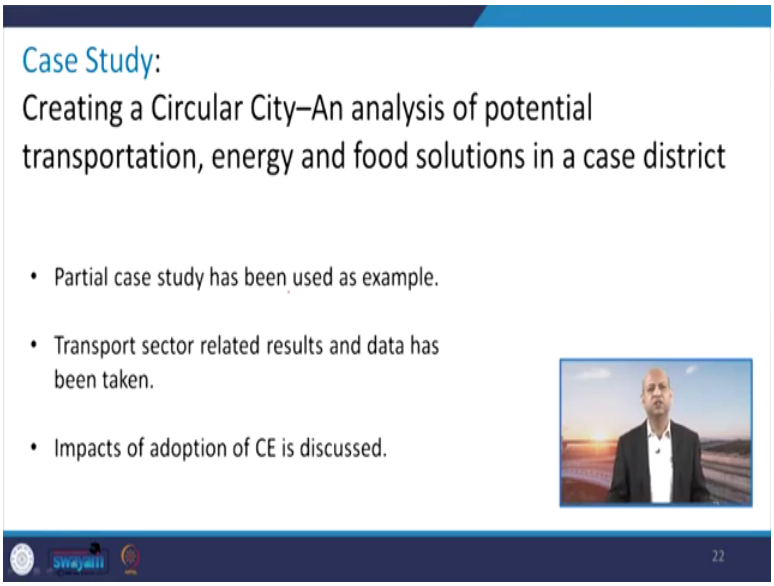

Now, we come to one case study, which is like a circular city creation and analyzing this transportation energy and food solutions in case of a district which is of Finland and this is a part of the city of Espoo and name of this area is Kera.

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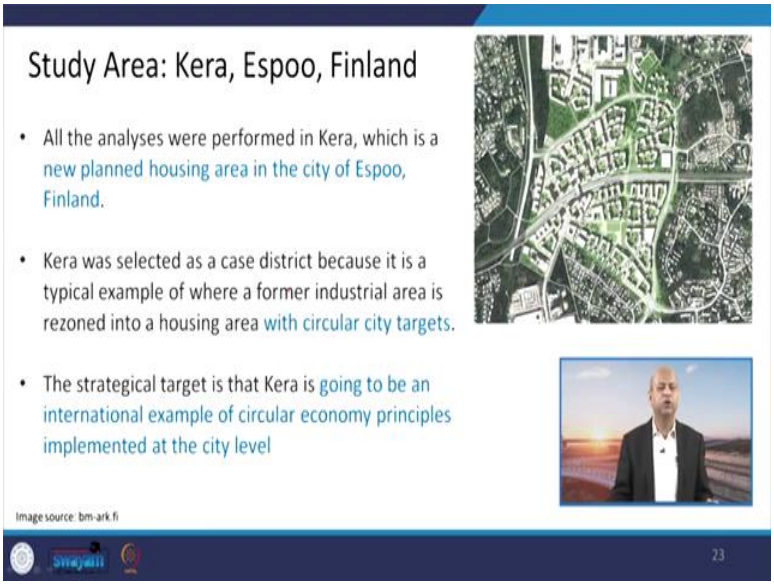

So, in this city they are promoting this new plant housing area and they are selecting this particular location because this was former industrial area and it is now rejoining as housing area. So, the circular city targets are better planned in that way, and it is going like an international example of circular economy, principle's implementation at the city level.

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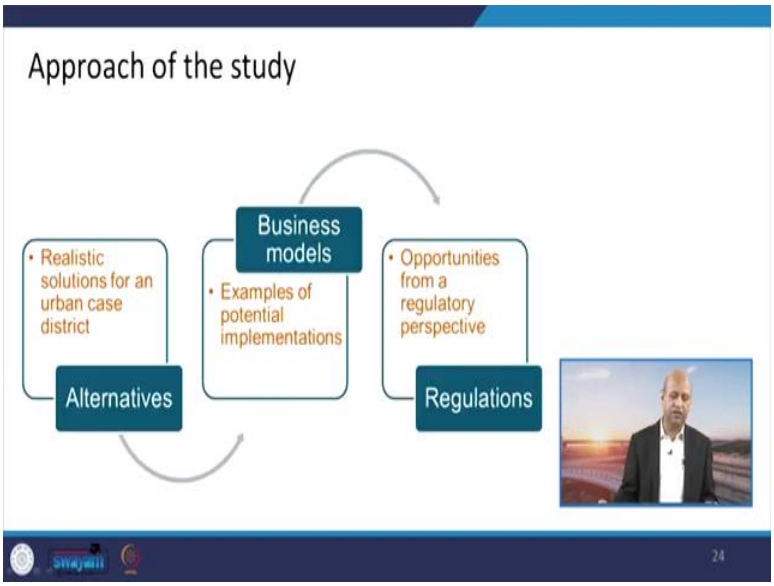

The approach which they are using is realistic solutions for an urban case district, so the alternatives will be used and the business modes, different kind of examples and potential of implementation that will be taken into account and then the opportunities from a regulatory

perspective, regulatory framework. So, that will be taken, so all these things will build in one system.

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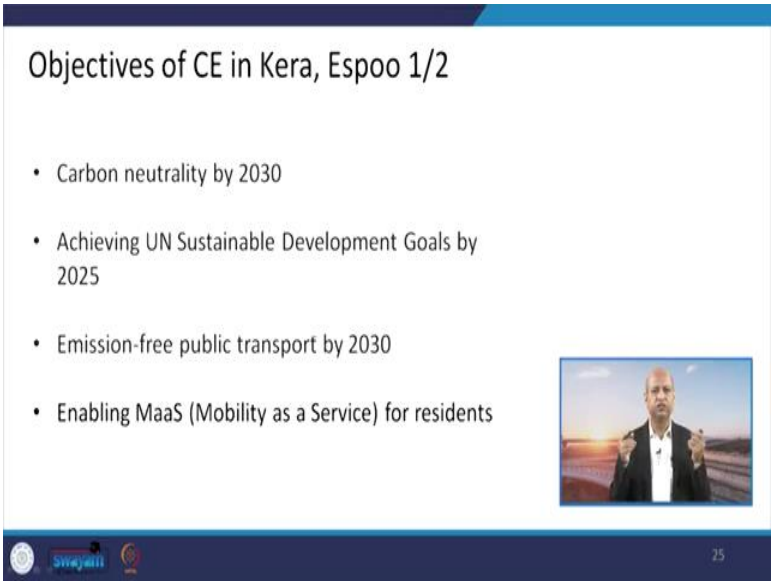

And the objective of this circular economy in Kera, district of Espoo City is basically like they want to achieve carbon neutrality by 2030 and they want to apply or achieve all UN sustainable development goals which you know we have studied, so by 2025.

And emission free public transport by 2030, so this is a great ambitious plan and then enabling this mass that is mobility as a service for residence. So, this is as a service rather than kind of other burden or something like that.

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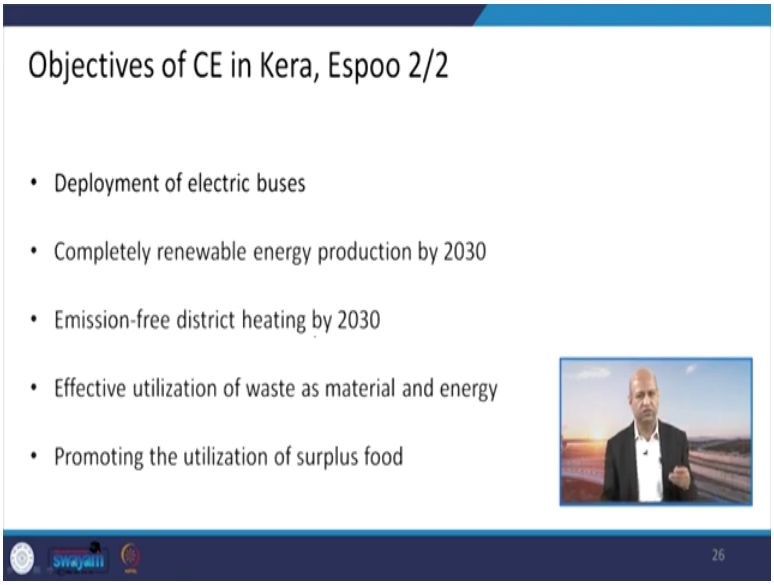

The complete approach is changing and the deployment of electric buses is the part of this particular case where completely renewable energy production by 2030, this is also a big ambitious plan, and emission free district hitting, because in Finland several months are very cold. So, they need to heat their houses, interiors, so emission free means without fossil fuel.

I can repeat here one example, I think which I have quoted in other lecture, like in Linkoping city of Sweden, the whole public transportation system is based on this bio-gas which is generated by anaerobic digestion of organic waste including the slaughter house waste and the heating is done by other solid waste like paper, etc. So, they burn it and then through steam they generate the electricity as well as this hot water is circulated in entire city.

So, those kind of things are there. These are the approaches which are, as per environment friendly approach and circular economy kind of a thing you can say. So, there also in this Kera district of Espoo city in Finland, they are aiming that this district heating, by 2030, should be emission free, that means renewable resources and those kind of things.

And the effective utilization of waste as material and energy, so maybe like Linkoping city, they are also aiming that they will burn this, which is having a lot of calorific value, those waste material, solid waste, they can burn and get the electricity generated plus, that hot water they can supply. That kind of idea may be there. Promoting the utilization of surplus food. Means it is not

wastage but utilizing it to generate energy or converting into some other better products or services.

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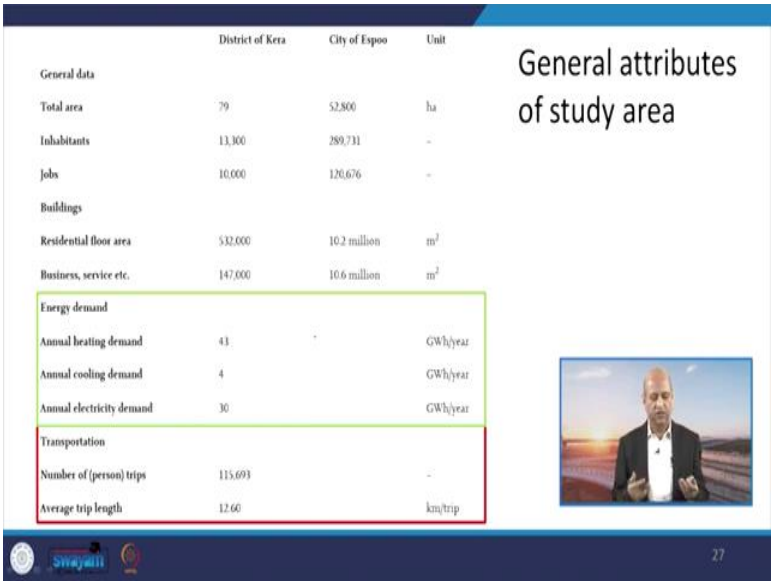

When we talk about this attributes of the study area, so you can see the total area value is there, how many jobs are there, then residential floor area and how much transportation related like how much trips are there. So, those are the values which have been considered when designing this particular policy of circular economy.

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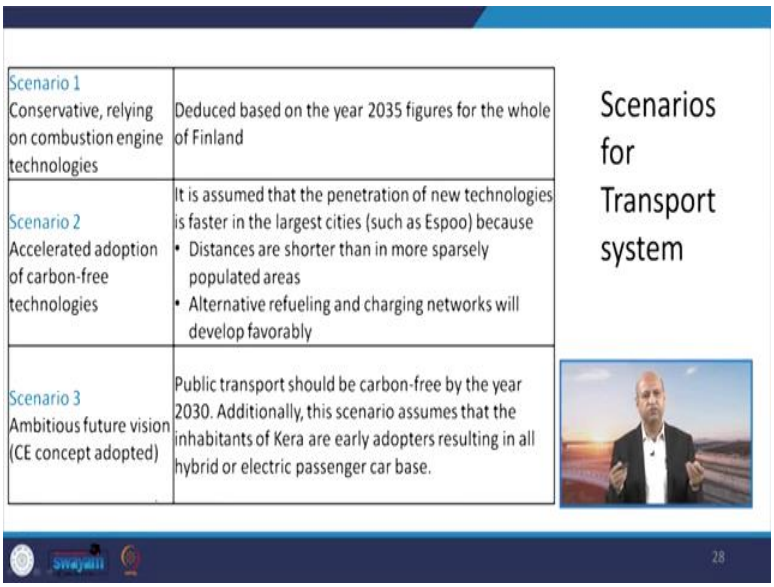

And then they have created three scenarios, like first scenario is conservative one, where they are relying on combustion of, combustion engine technology that is fossil fuel based. So, they have deducted based on the year 2035, that approach, they have deduced that they have assumed, so 2035, figures as a, in the whole Finland, that figure they have used for this scenario one.

For scenario two basically, they are like accelerating adoption of this carbon free technologies or circular economy you can say. So, that is like, they are having distances shorter than, in more sparsely populated areas and alternative refueling and charging networks will develop favorably. So, that more and more those kind of facilities they can utilize.

Scenario three is ambitious one. So, here this C concept will be adopted properly, complete integration, in scenario two it was carbon free technology but the full C was not there. Here this full C that is the circular economy concept is being implemented and they are saying that the public transport should be carbon free by year 2030, and additionally they are also aiming that, like these inhabitants of Kera district should adopt for hybrid and electric passenger car if they are having those personal cars, then they should be hybrid or electric rather than fossil fuel based or petrol based.

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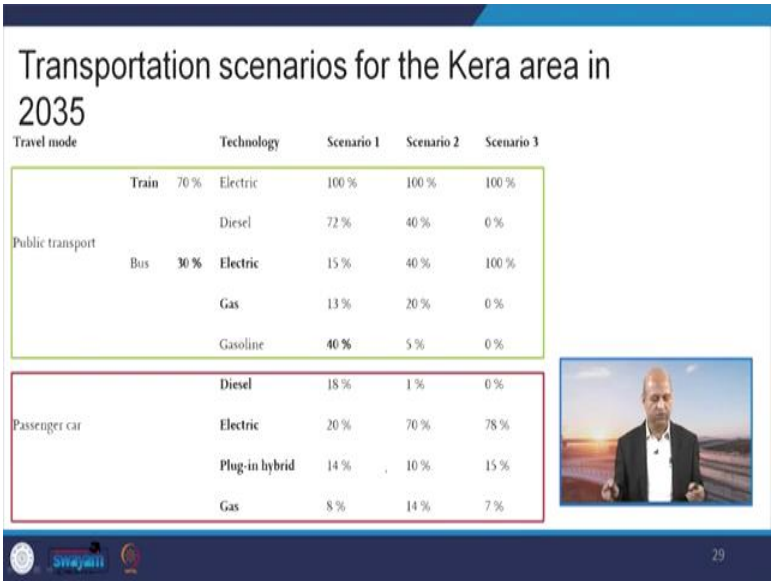

Then the scenarios for this Kera area, for 2035 you can see like train 70 % public transport, so the scenario one, scenario two and scenario three, so those values you can see, they are having like electric 100 %, train, in each scenario they are assuming. The diesel related trains, 72 % in

scenario one, 40 % in scenario two and 0 % in scenario three, because every train would be 100 % electric based in scenario three.

Similarly, like if you talk about the buses so electric buses or gas buses or like CNG, etc., and gasoline buses, so those values you can see and again in scenario three it is like all those buses which are based on gas or gasoline they will be removed from the fleet.

When we talk about the passenger cars, so the diesel car and electric cars and plug in hybrid and gas related, so they will increase in this scenario three, this electric and plug in hybrid, and diesel will be 0. Diesel based cars will be 0 in scenario three.

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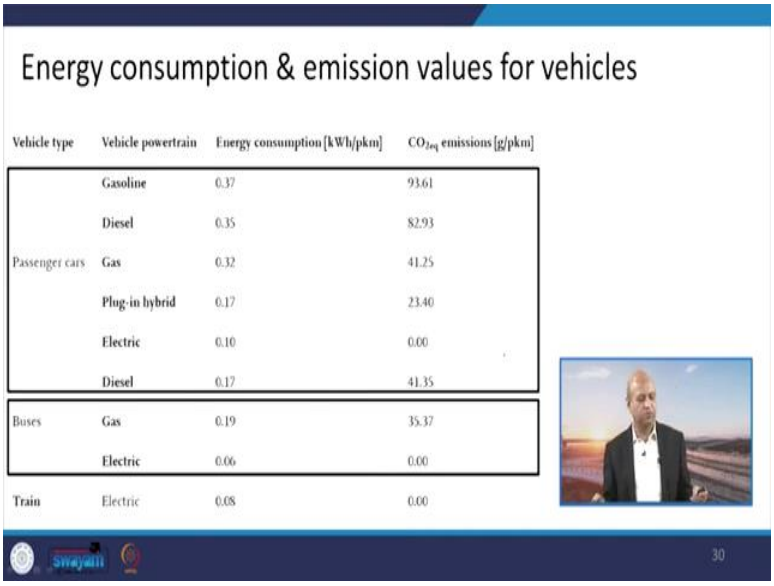

So that way you can see the ambitious plan and this will result in energy consumption and emission related values reduction. So, here you can see how much the CO2 equivalent emissions are there from gasoline and from electric vehicles like it is 0, we are talking about exhaust emissions, not the electricity production emissions, they will be there but if renewable resources are there then this will be very less. Buses, electric buses so 0 emissions of course, and electric trains again 0 emissions in that sense.

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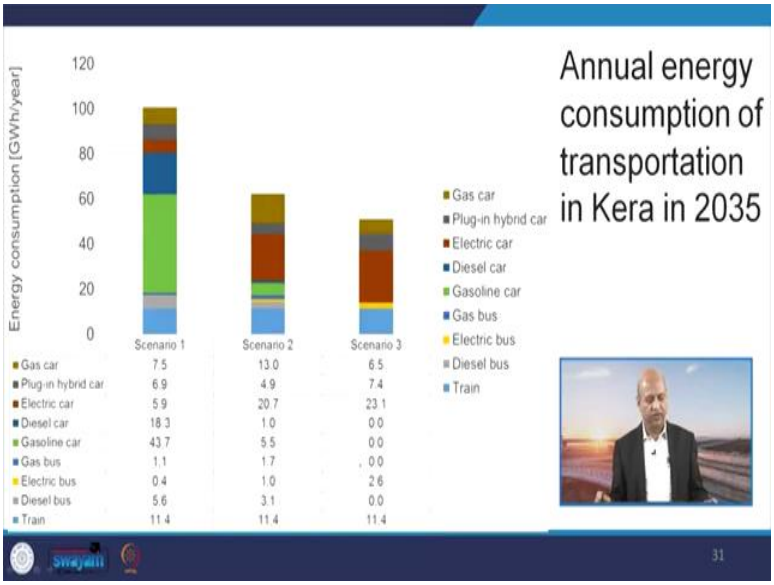

If we talk about energy related consumption, annual energy consumption of transportation in Kera district in 2035, that estimated values, so in scenario one and scenario two and scenario three you can see, this reduction is there. If you go for scenario two or scenario three. So, that is why scenario three although ambitious but very beneficial.

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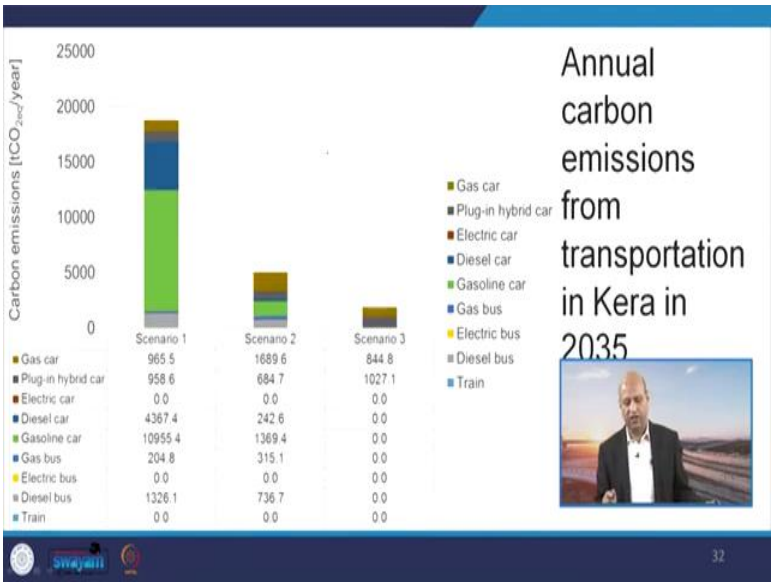

And carbon emissions from transportation, scenario-based analysis says that it will be very less in scenario three, so that is why this is very good and this is based on circular economy so that, in fact this visual evidence is there that is you go for circular economy-based transportation policy

and implementation of the infrastructure then the benefits in terms of environment related emissions will be much, because the emissions will be very, very less.

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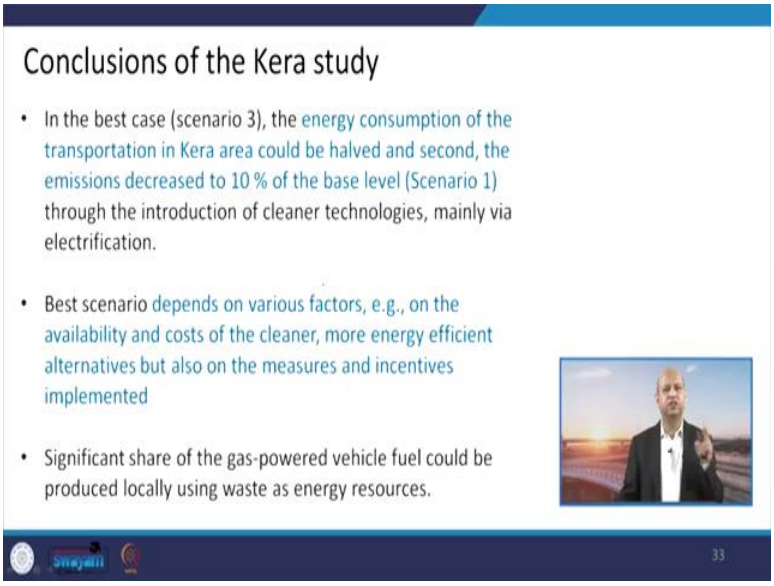

So, in conclusion we can say, that the scenario three is the best one, from energy consumption point of view, from emission's point of view and it will basically decrease to 10 % of the base level, that means 90 % reduction, it is a big difference between scenario one and scenario two. If you go for electrification as a part of a circular economy.

Then it also, other factors like cost of the cleaner, more energy efficient alternatives, so best scenario will depend on those issues also, and which can be measured and incentives can be implemented from policy perspective like some subsidies for electric vehicles, those kind of things are important to promote this scenario.

And there will be like a significant share of the gas-powered vehicle's fuel, but at the local level and the waste or energy resources interlinked like waste can be used for generating the energy resources. So, at the local level that policy can be implemented easily.

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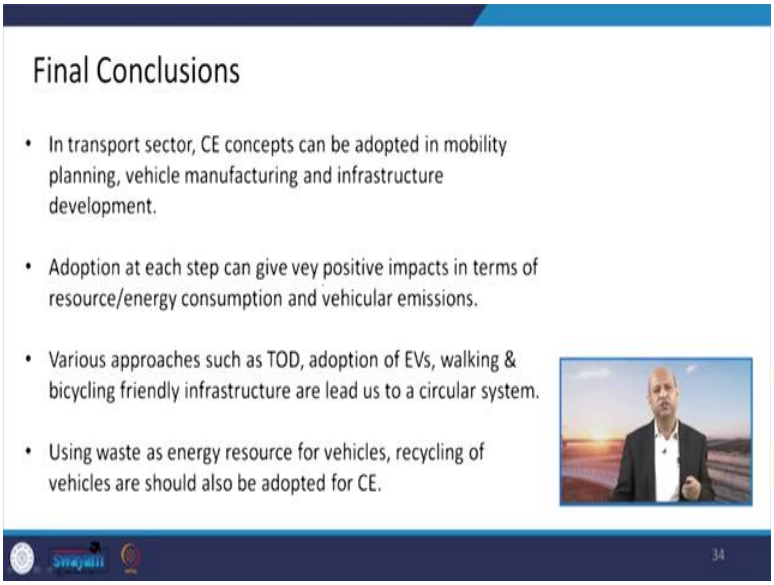

So finally, we can say that the transportation sector has a great scope of implementation of circular economy and this concept, if we adopt in mobility planning or vehicle manufacturing or infrastructure development related to transportation sector, there are many benefits basically. So, we should go for that and this, even TOD is the part of this circular economy and adoption towards electric vehicles, walking and bicycling and improving the infrastructure for those kind of activities related to walking and bicycling, those all are part of the circular economy.

And using the waste as energy resource for vehicles like bio-gas as I gave example of Linkoping all those things are helpful for adopting the circular economy in transportation sector. So, that is kind of application part of circular economy in transportation sector for, in today's lecture. I hope you are not completely, this picture is clear for you that how circular economy concept can be implemented in transportation sector for reducing emissions and reducing energy consumption and having better mobility. So that way this is all for today's lecture. So, thank you for your kind attention.

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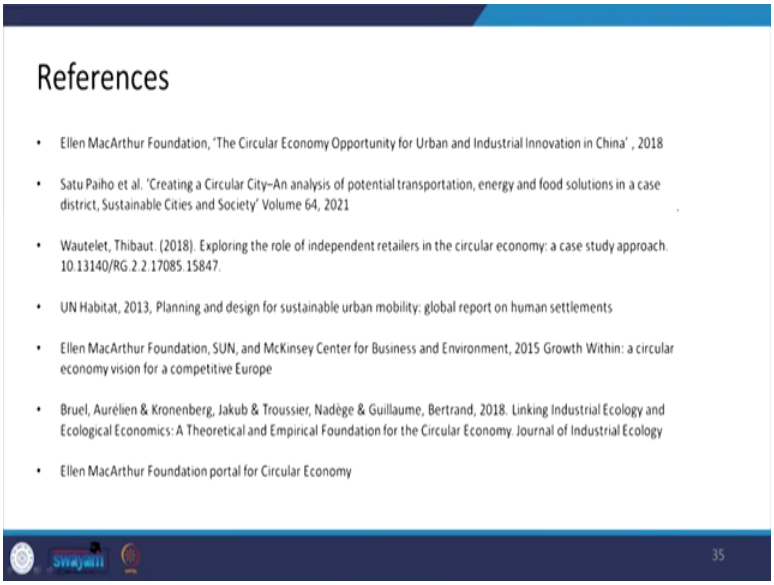

And you can go through references which have been used for making this presentation, so thanks again, see you in the next lecture, thanks.