Energy Resources, Economics and Environment
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Lecture 3 P1
Energy and Quality of Life.

Today we are going to look at Energy and Quality of Life, we have already seen for a country and for the world as a whole, what is the overall energy balance? What are the issues related to energy and environment? So, if we think in terms of what do we mean by quality of life?

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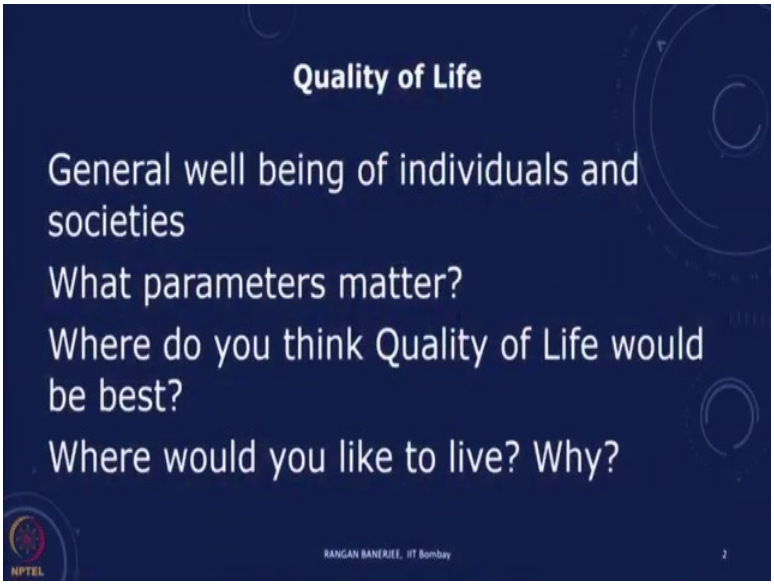

So, when we look at quality of life, we think in terms of the general well being of individuals and society.

So, what are the parameters? If you look at your own day-to-day life, what do you think affects your quality of life. You may also want to think about, if you had a choice, where would you like to live? In India, would you like to live in a city, would you like to live in a village? Which city would you like to live, and why would you like to live in that city? And if not in India, anywhere in the world, if you had the option, what would be your choice?

So, looking at this, we visualize what aspects of life that we would like to see this, we would like to see how these factors, the parameters that affect the quality of life are linked with the energy use. So, there are many different indices that people have proposed for quality of life.

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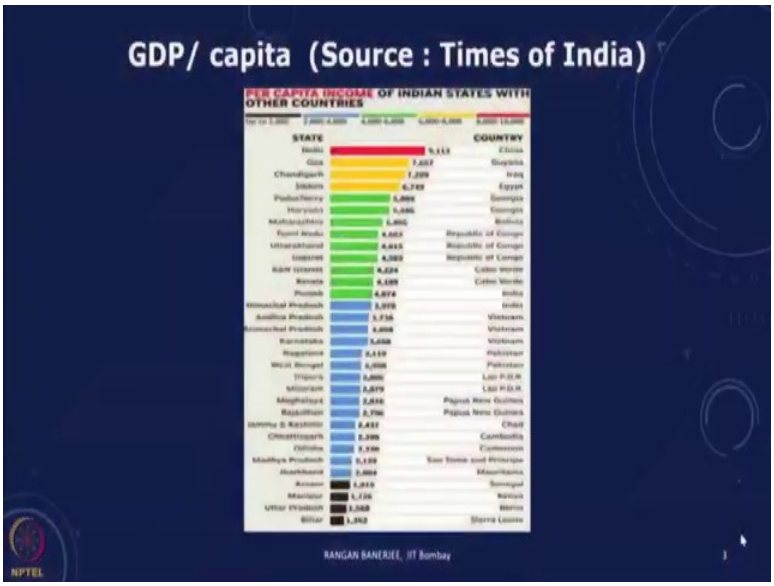

If we look at for instance, this is a graphic, one of the indicators that is used commonly is the Gross Domestic Product and we try to see what is the gross domestic product per person. So, in general if you look at the GDP, if you look at any country, a country is producing steel, cement, mobile phones in all of these if we see what is the value addition that has been provided, and we add that up that gives us the gross domestic product.

So, typically a country that is more affluent will have more of an income per person. And we generally tend to see that income per person is one of the parameters that affects and shows how well of a particular country or community is, and if you see this, you will see that in the different a per capita income of Indian states and different countries, different states within the country we have a number of, we have a wide variation in terms of income.

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And if you look at this map, this is a map which was given in The Times of India, it was you try to compare different regions of the country in terms of their income per capita and compared it with other countries of the world. So, some parts of the country are underdeveloped and have low income and in other parts are well off and can compare with high-income countries.

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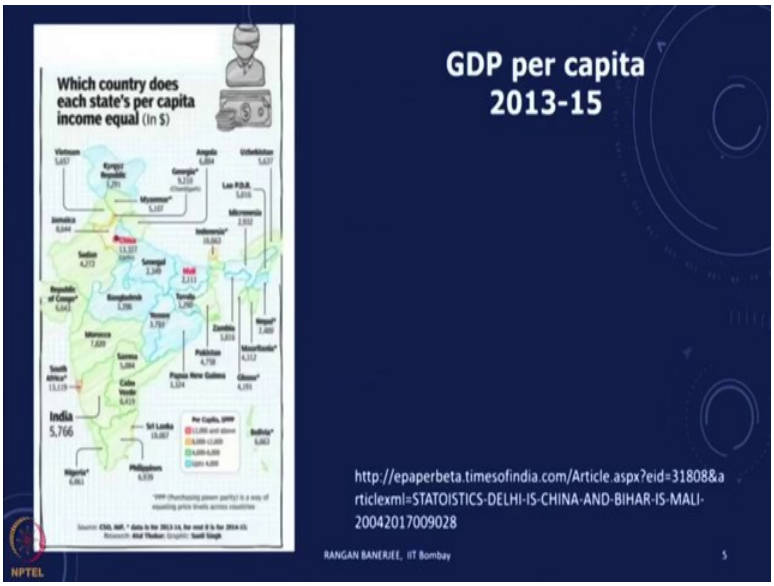

So, for instance, this metric shows that different states, some states have income equal to some of the medium developed and developed countries, some are poor and comparable with some of the less developed countries.

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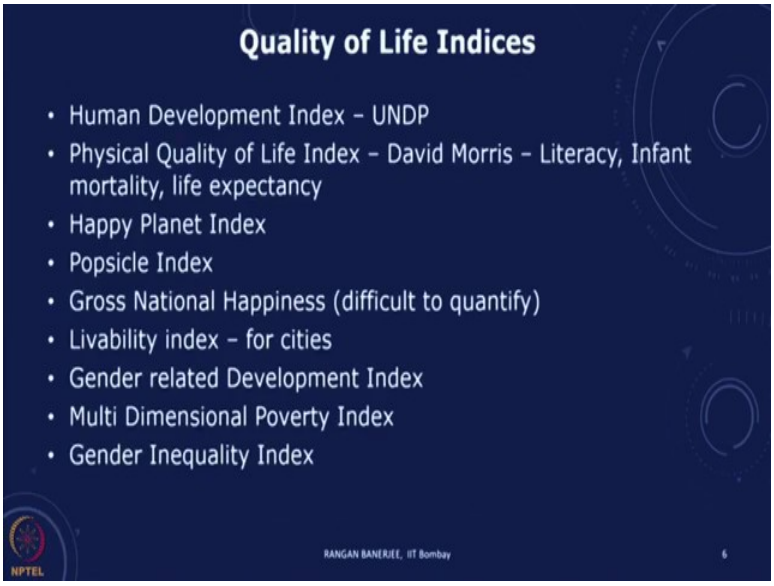

So, this is the variation in the GDP per capita, and there are the income per capita is one metric, but that is not necessarily the best metric. So, the United Nations created a metric

called the Human Development Index. There are also many other metrics which have been proposed by different researchers for instance, David Morris provided an index called the Physical Quality of Life Index.

So, typically what happens is if you would like that, there is a good quality of life you would like that all the people are educated, there is literacy, the health is good and then infant mortality that means number of infants who are dying per thousand is small, life expectancy is good at birth. So, these are some physical quality of life indices.

And there are also other indices called the Happy Planet Index, The Popsicle Index is a an interesting index, which has been proposed, which is a an index of safety and it just says that if you ask people, what percentage of the children can go in a 10 you know, go out and buy a popsicle and come back safely, and what percentage thinks that the country is safe enough for people to go and that, that if that percentage is high, it means that there is a intrinsic safety and the quality of life is high.

Gross National Happiness, this has been proposed by country like Bhutan, of course, it is difficult to quantify again there are different kinds of metrics, you will find that there is an index called the Livability Index, which has been used for different cities and it tells you based on the kind of services which are there in the city, the kind of expenditure and the kind of costs there are also many Gender related Development indices and Multi Dimensional Poverty indices and Gender Inequality index.

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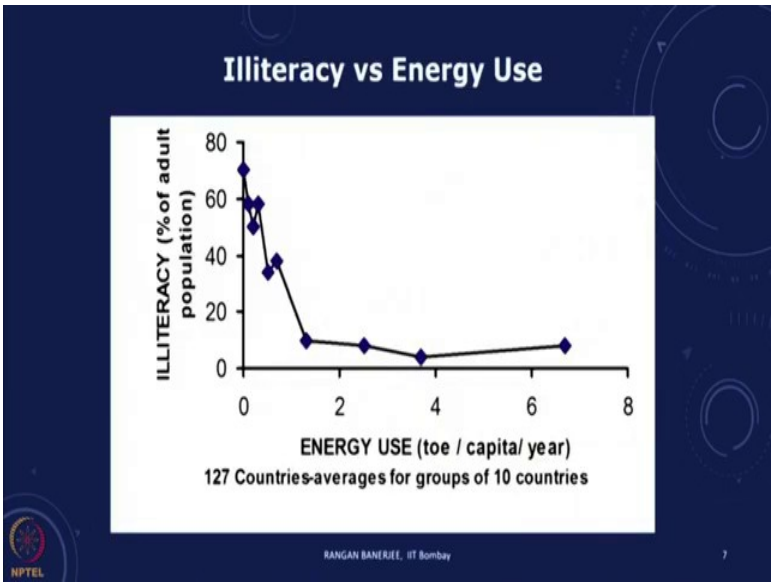

So, we will look at the Human Development Index in more detail, in the Human Development Index, there are essentially three different parameters, one is the Gross Domestic Product, the GDP per capita the other is in terms of the education or the illiteracy.

So, typically if you look at the percentage of the population, adult population who was not literate, who cannot read or write and you will find that when you plot this, this plot, which you see here is a plot of 127 countries and the groups of 10 countries with the best, the ones which are using the lowest energy per capita to the highest energy per capita and you can clearly see that the countries that have a higher energy use per capita, typically are better off in terms of the literacy or have a lower illiteracy rate.

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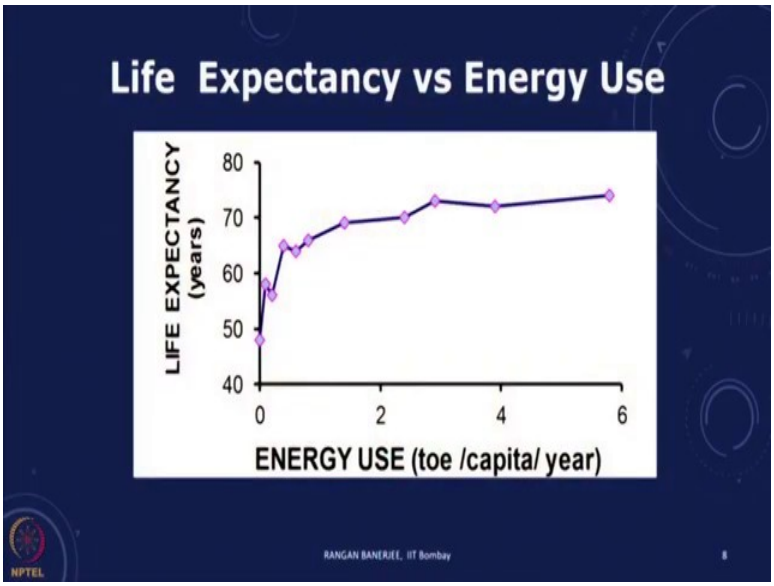

Similarly, the life expectancy versus energy use, you will see that, beyond the point you know, when you look at two tons of oil equivalent per capita per year, as you go ahead beyond that most of these countries, the countries which have higher energy use per capita also are the countries with higher life expectancy in terms of number of years at birth. And this is again another metric which is used in many of the quality of life indices.

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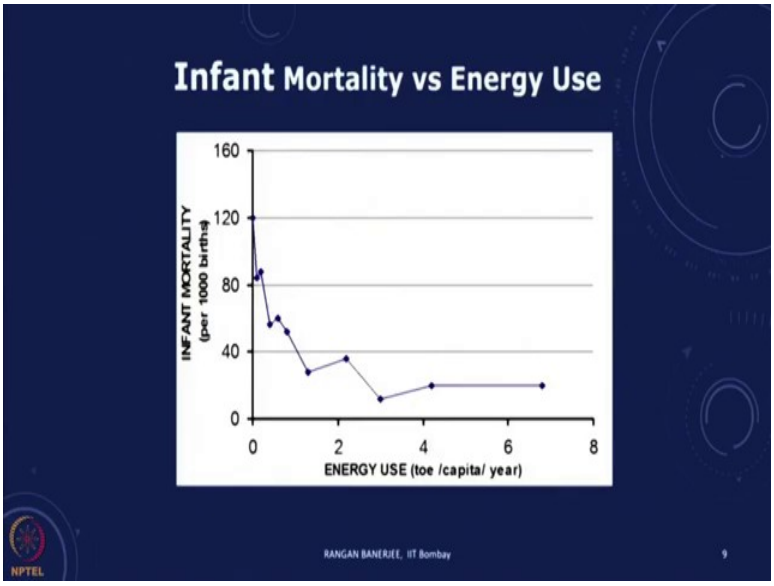

So, infant mortality, that means number of deaths of infants of age up to 5 years per thousand births, and you see that those countries where there is a significant where the energy use is relatively high, when we talk of 3 to 4 tons of oil equivalent per person per year, you find that the number of infant mortality has also declined and this is better quality of life.

So, we can see very clearly that typically, a certain amount of energy use or energy service which is provided per person if that increases, all of these indices whether you talk of literacy, whether you talk of the life expectancy, infant mortality, all of them tend to do better.

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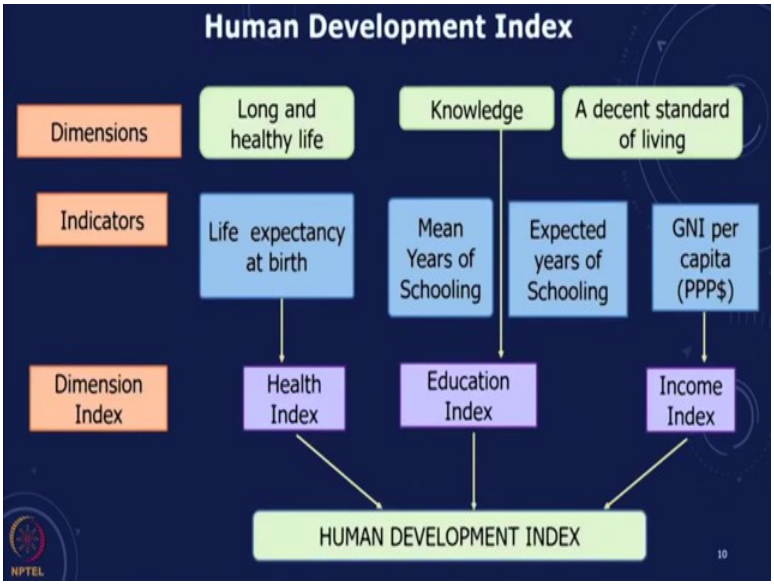

So, the Human Development index which is proposed by the UNDP has the combination of three dimensions. The first is we the life expectancy at birth, long and healthy life. So, there is a Health Index, there is a knowledge in terms of both the means years of schooling and the expected years of schooling, which gives you an Education index, and the third one is a decent standard of living, which is given either in GDP per capita or recently it has been in terms of the Gross National Income per capita on the purchasing power parity basis, and this gives us the in Income index.

So, in all of these three indices, we have basically three indices, the Health Index, the Education index, and the Income index. For this Human Development Index, all of these indicators are then normalized to go from zero to one, and then based on this, the average of these three, either earlier it used to be taken as a arithmetic average, now it is taken as a geometric average, is taken to give the Human Development Index.

So any country, all the countries are ranked with one being the best and zero being the worst, so, you have a score between zero and one, and the closer you are to one in the Human Development Index is preferred.

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So, the energy is generally needed for development and for improved quality of life. These factors that we were talking of, the life expectancy at birth, education, literacy, infant mortality and income, these are all put in terms of this Human Development index.

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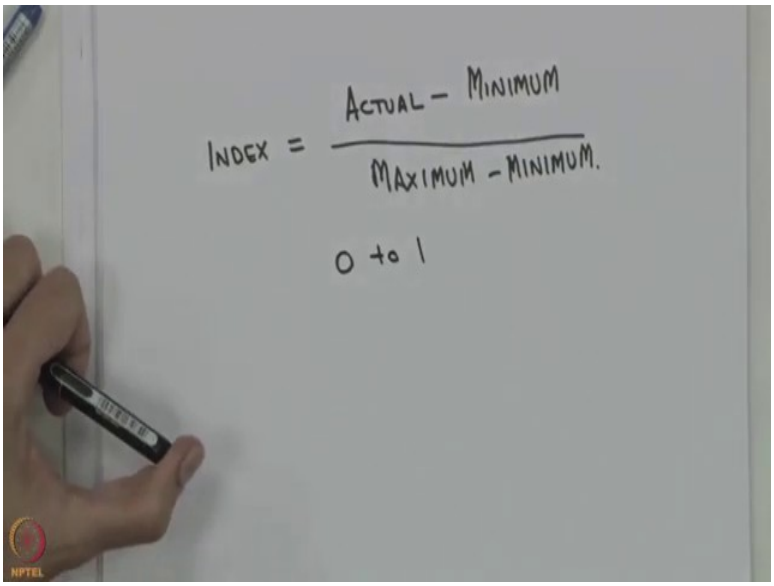

$$INDEX = \frac{ACTUAL - MINIMUM}{MAXIMUM - MINIMUM}$$

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For each of these indicators, the index actually calculates, the index is calculated in terms of, you have an index, which is actual minus minimum divided by maximum minus

minimum with the idea that for each of these parameters, one of the countries has the maximum possible value and then you have a minimum possible value.

So, basically this index ranges from zero to one and in all of these, we calculate each of the indicators and then take the average of this.

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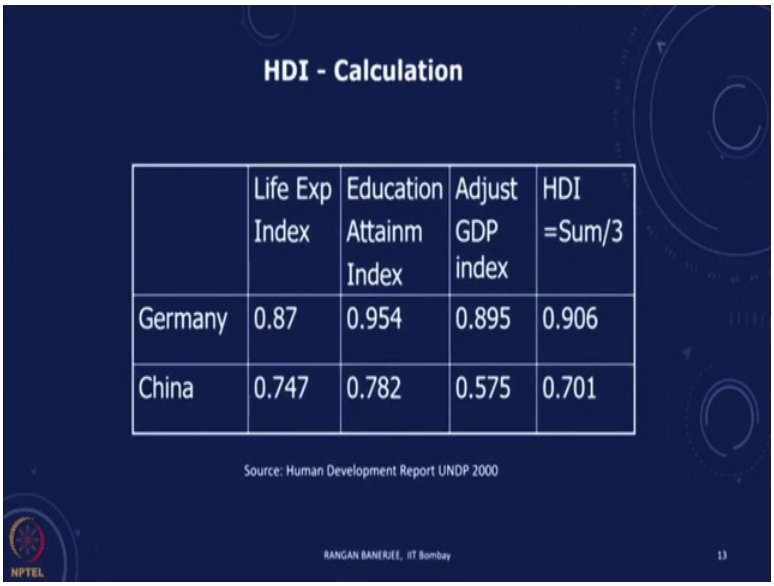

For instance, in the case of Germany and China you find that, we find the life expectancy indicator 0.87, education 0.954, GDP 0.895 and this the average of these three gives you the overall Human Dimension Index HDI for Germany, HDI for China.

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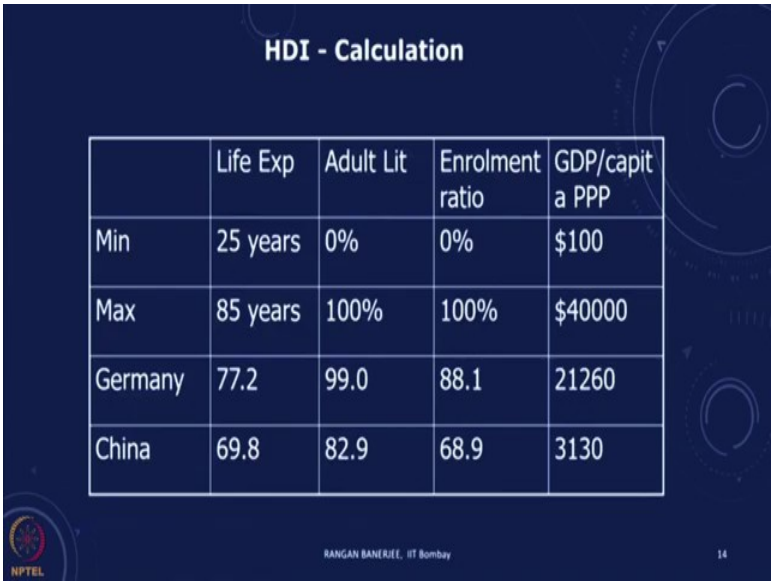

This is calculated by taking values of minimum and maximum as we did, and you can see for life expectancy the lowest life expectancy is 25 years for one of the countries, maximum is 85 years and this was for a particular year, and then if you see Germany is 77 and China 69.8 while adult literacy going from the minimum is zero and maximum is hundred, Germany is pretty much near hundred where you get 99, and then similarly, the Enrollment Ratio and GDP per capita.

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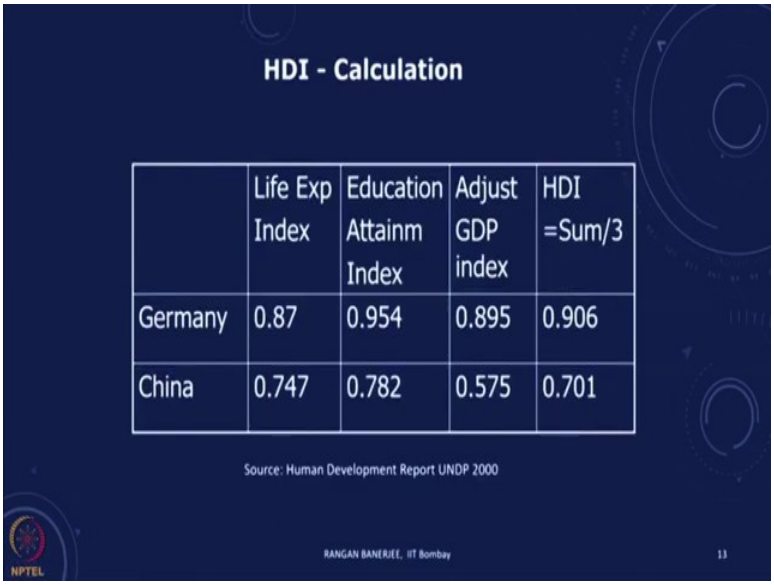

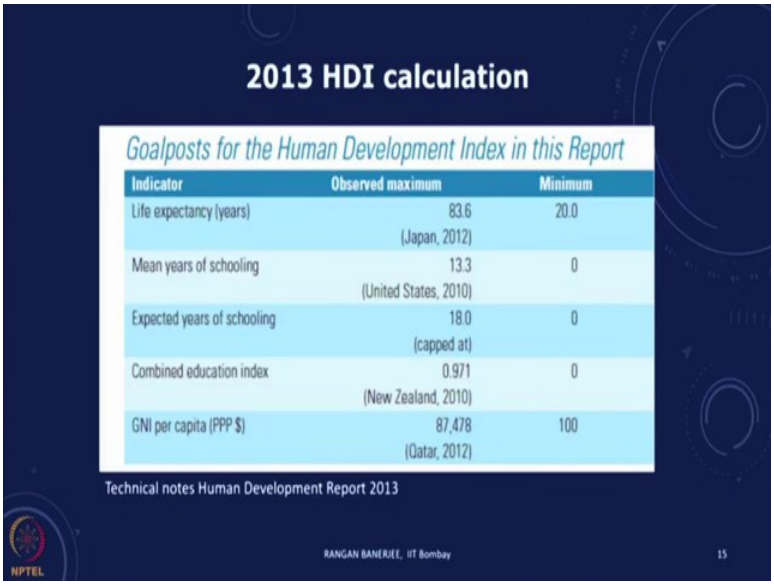

Based on this, we get these calculations, each of these indices when you take the actual minus minimum divided by maximum minus minimum you get these values and this is how this is done, in for another year that was for the previous year.

In 2013, if you see the life expectancy, the maximum was taken as a life expectancy in Japan which was 83.6 and the minimum was 20. And then similarly, you have the GNI per capita, the maximum was for Qatar, which was some at 87,500 dollars, US dollars, minimum was 100 dollars per capita.

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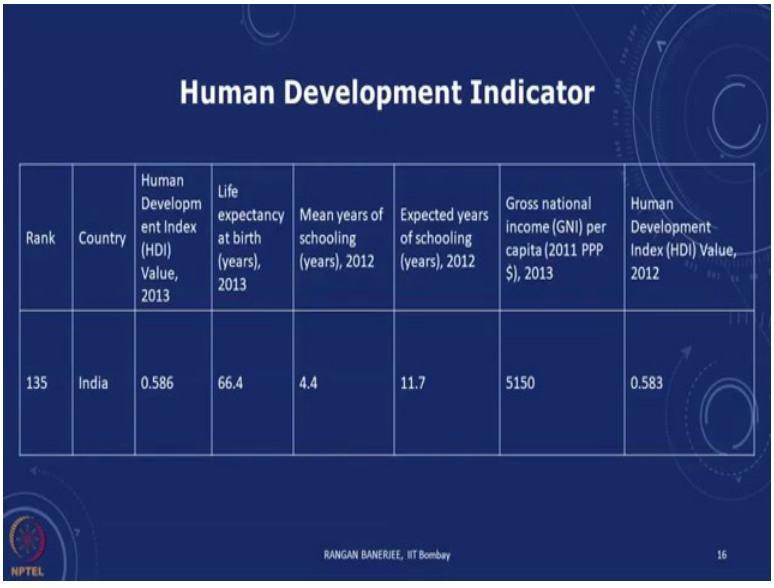

And when we take all of this, in the case of let us look at what are the numbers for India, in 2013, our rank on the Human Development index was 135, and the HDI value was 0.5, around 0.59, life expectancy at birth was 66, and the GNI was about, this was in 2013. The Gross National Income was about 5,000 dollars per person per year.

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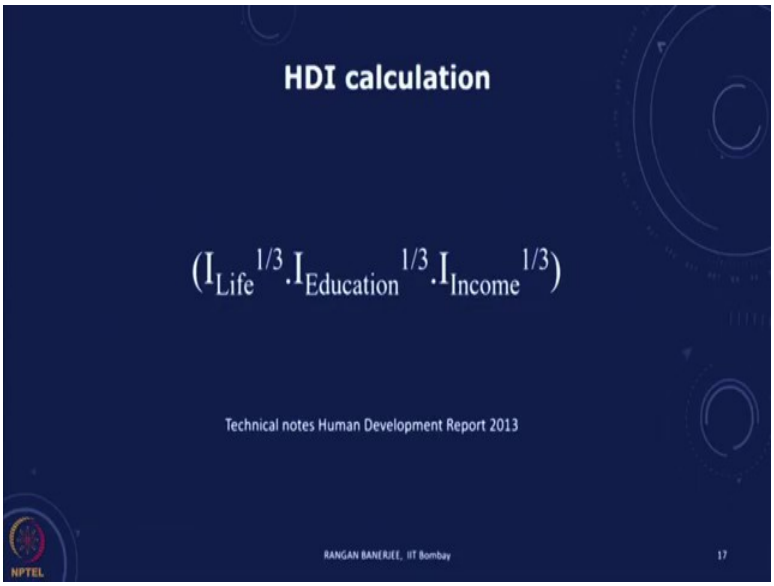

This has improved compared to previous years, and we are on the trend of increase. Recently UNDP modified this where they are now taking the indicators in terms of the geometric average. So, that means you take each of the indicators and take the cube root of that, and then multiply all these three to get the final value.

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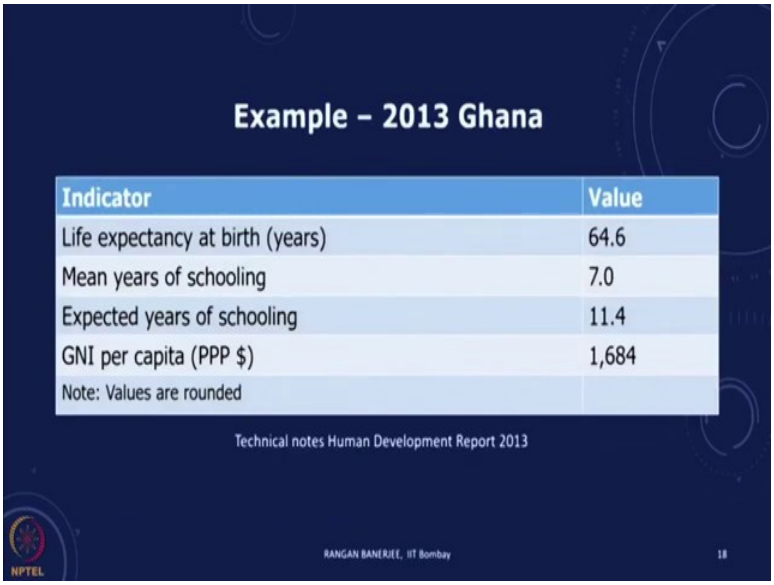

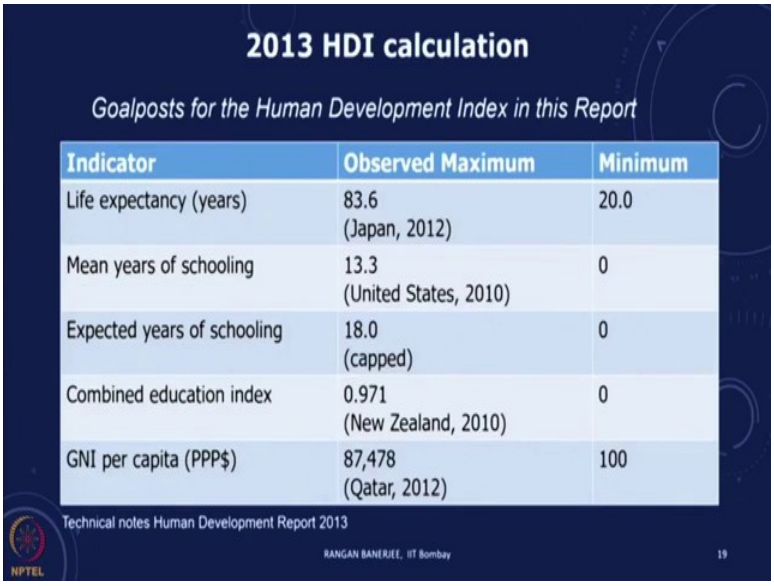

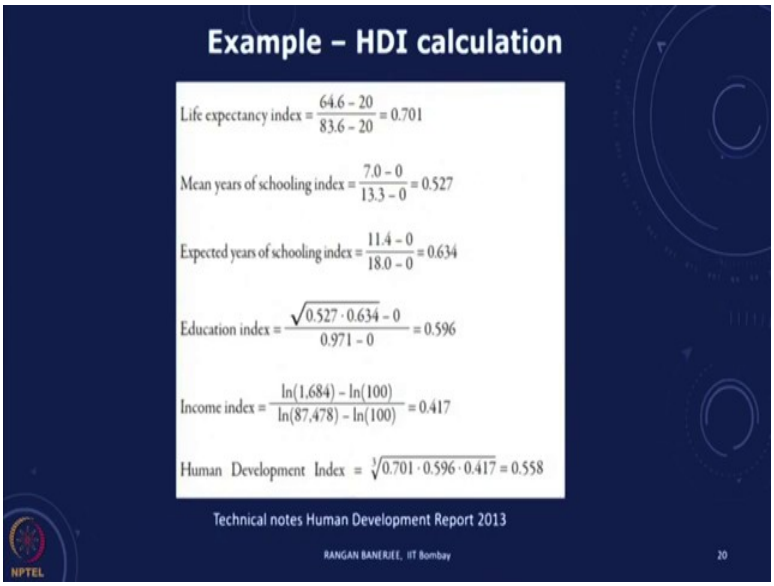

And to give you an example for Ghana, you can do the calculation yourself, the values we had already given the minimum and maximum values, and if you look at the life expectancy at birth 64.6 and the GNI per capita and based on this if you see these were the minimum and maximum as we said and be using these values in the technical notes of all these Human Development reports.

You will find the values of calculation, we did it in a similar fashion just like we had done the actual minus the minimum by the maximum minus the minimum you get the kind of indicator values, and then the geometric mean of all of this gives you the Ghana HDI of 0.558. Slightly lower than that of India and similar.

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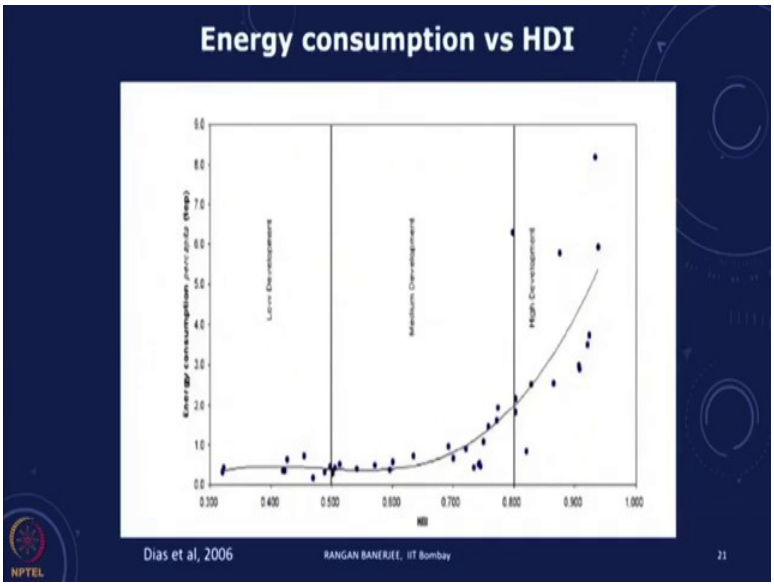

You can see on this plot, the link between the energy use and the energy consumption and the HDI and you can see that typically the ones with the high HDI, high energy consumption often have an improvement in the HDI.

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You can look at, if you look at the UNDP data, you will get all the data for all the different countries and you can make these calculations yourself.

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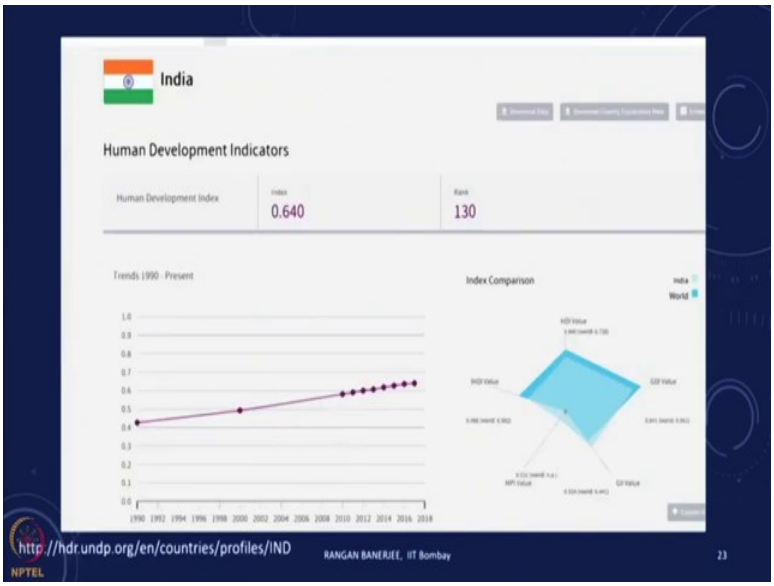

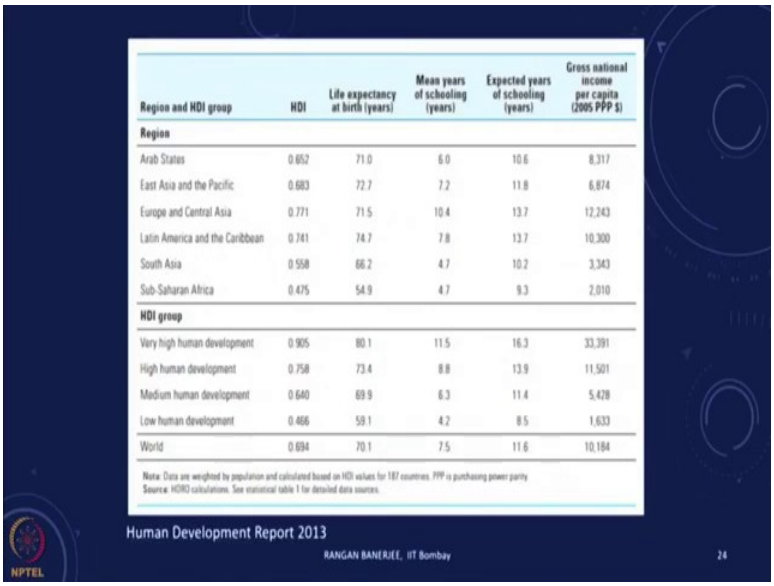

You can also see this is for India over a period of time, the Human Development indicator has been increasing and now it is of the order, it is a little more than 0.6 and we are of course moving forward in that.

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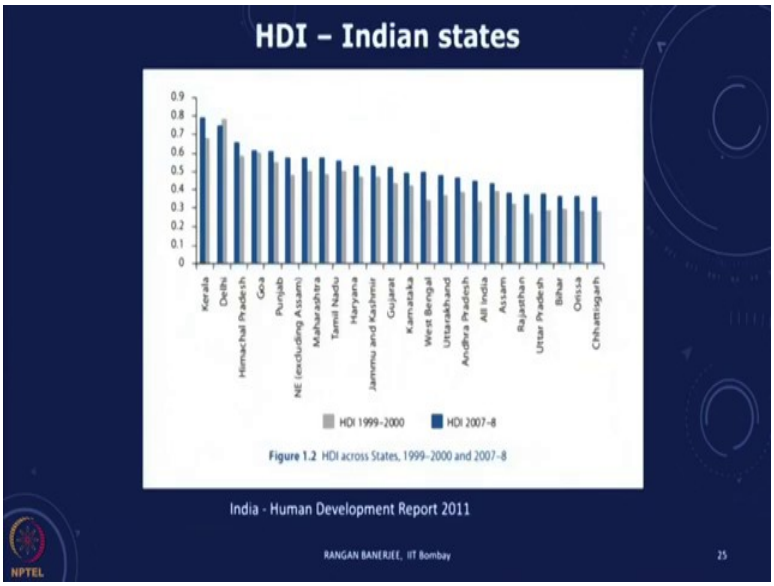

Within this you can also look at the Human Development indicator for different states and we have not had every year this is not published, but there for previous years if you look at it, Kerala, Delhi, Punjab all seem to be doing well in terms of the Human Development indicators. If you look at the Uttar Pradesh, Bihar, Orissa they are relatively still poor in terms of the quality of life and as we look at the development and the energy use, the HDI can improve.

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States	Prevalence of Calorie Under Nourishment (per cent)	Proportion of Underweight Children Less than 5 years of Age (per cent)	Under Five Mortality Rate (Per 100)	Hunger Index (HI)	Rank as Per HI
Punjab	11.1	24.6	5.2	13.63	1
Kerala	28.6	22.7	1.6	17.63	2
Andhra Pradesh	19.6	32.7	6.3	19.53	3
Assam	14.6	36.4	8.5	19.83	4
Haryana	15.1	39.7	5.2	20.00	5
Tamil Nadu	29.1	30.0	3.5	20.87	6
Rajasthan	14.0	40.4	8.5	20.97	7
West Bengal	18.5	38.5	5.9	20.97	8
Uttar Pradesh	14.5	42.3	9.6	22.13	9
Maharashtra	27.0	36.7	4.7	22.80	10
Karnataka	28.1	37.6	5.5	23.73	11
Orissa	21.4	40.9	9.1	23.80	12
Gujarat	23.3	44.7	6.1	24.70	13
Chhattisgarh	23.3	47.6	9.0	26.63	14
Bihar	17.3	56.1	8.5	27.30	15
Jharkhand	19.6	57.1	9.3	28.67	16
Madhya Pradesh	23.4	59.8	9.4	30.87	17
India	20.0	42.5	7.4	23.30	

There is a lot of this data, there are other indicators also, apart from this is that you may have an overall good quality of life, but you may have a problem in terms of hunger. So, there are indices in terms of what proportion of the population do not get the required nutrition and there is this index called the Hunger index, which again is something which you may want to look at.

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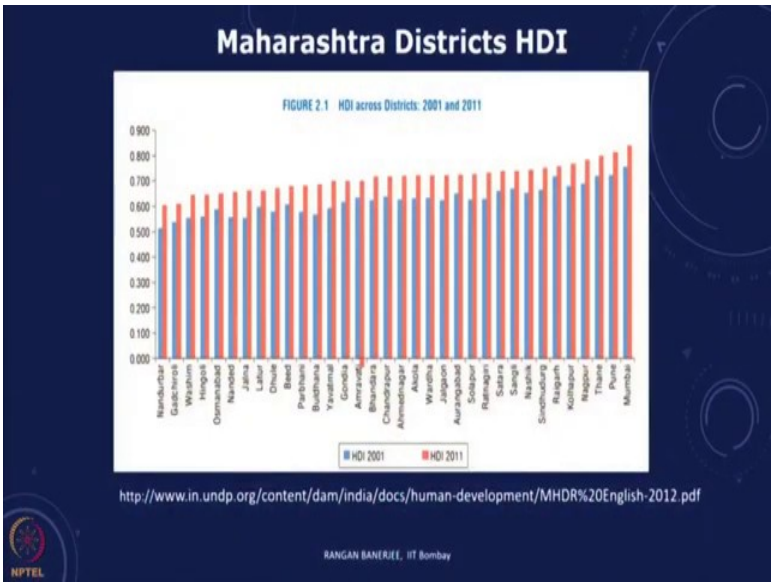

Within a state, some states there are studies where you we computed the Human Development Index and this is showing you a plot of the HDI for various districts in Maharashtra. And this is another thing where you can try and see how the energy use and the HDI combines.

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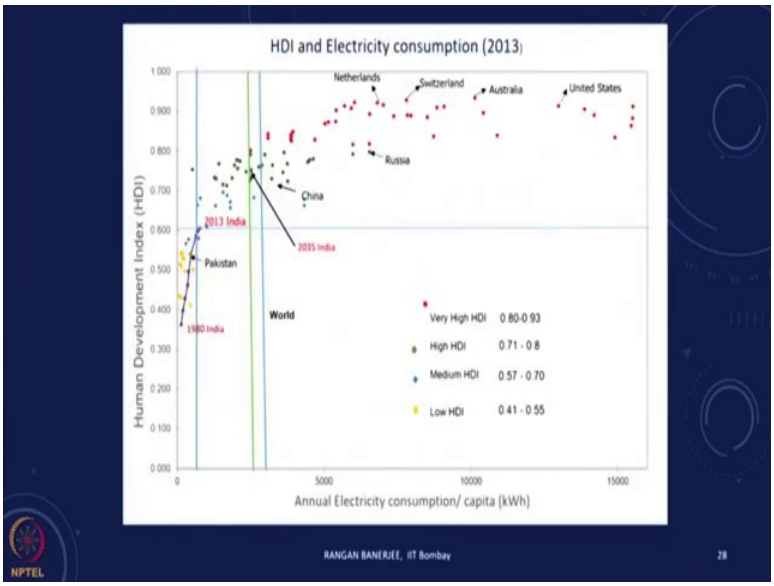

Now, this plot which I am showing you here, is a plot where we talk about each country is shown as a on the x axis is the annual electricity consumption, kilowatt hour per capita and on the y axis is the Human Development Index, HDI going from zero to one. And if you look at this, you will find that this is the plot for India, you can see that India has over a period of time has improved in terms of the HDI and the electricity use per capita and the corresponding period has also been increasing, we currently use about a little less than 900 kwh/person/year.

And you can see that that is much lower than the world average, as we go from this 0.6 or 0.65 and we want to go to the region of 0.8 or 0.9, we will need to increase our electricity consumption by a factor of two or three. And you will also see in this case that there is a trend in general there is a scatter.

So, for the same level of electricity consumption you can find countries with different ranges of HDI, so there are countries which are more efficient and those energy services they have a better quality of life for the same amount of electricity use. You can also see that beyond there is a minimum amount of electricity requirement for having a particular quality of life, but beyond that, there is the curve sort of becomes flat.

So, that beyond the point then this electricity use does not necessarily result in improvement of quality of life and this could be, for instance, if you see US, Australia, some of the Saudi Arabia and others you will find that they have not clearly increased the quality of the, that electricity use has not necessarily contributed to improvement in quality of life.

So, essentially what happens is, when we think in terms of what is the implication of this, when we think in terms of a country like India, where we are at a particular point and we want to improve the quality of life, we will need to increase the electricity services, the energy services, and so we have a target and then the per capita energy use will need to increase and we need to design our energy systems to go for this.

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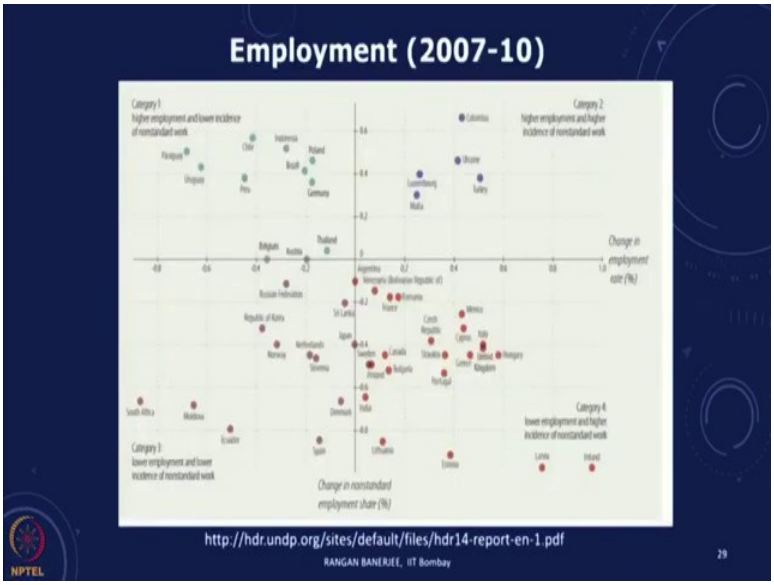

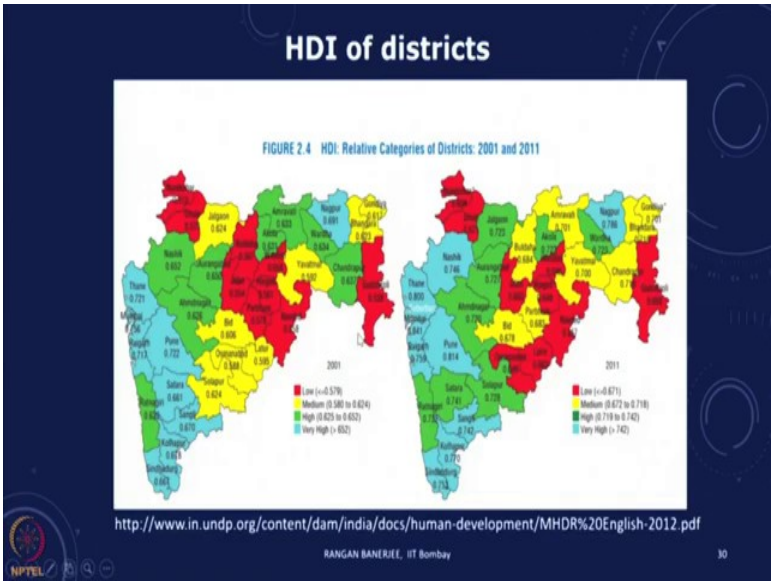

The other issues related to this are also, we can also look at what are the issues, impacts in terms of the employment and this is a plot which shows I told you about the Maharashtra situation, this is showing you the Human Development indicators for Maharashtra and it shows you a plot of the different types of HDI.

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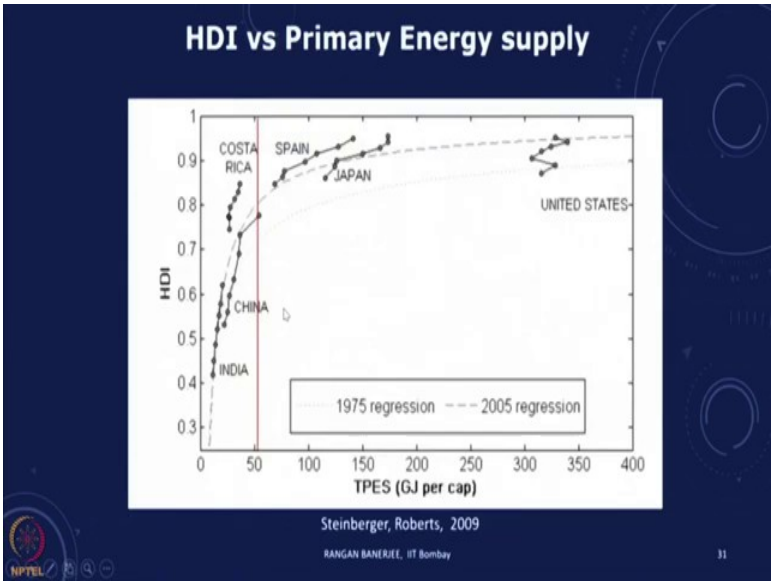

We talked about countries as they develop, you can see this is a time trajectory of the HDI versus the Primary Energy Supply, you can see that all the countries have been moving in a path where the HDI has increased, and correspondingly the primary energy

users also increased, which means that there is a link though which is decoupled as we said that beyond the point there is a plateau and you can see that also in this kind of projection, where you see beyond a point when you start using energy more than a certain amount, this is not reflected in any improvement in the quality of life.

So, it means that up to a point, we do need a certain basic energy services which is required for provision of the kind of services which are required for improving the quality of life but beyond that it sort of stagnates and stabilizes and then does not really result in any improvement.

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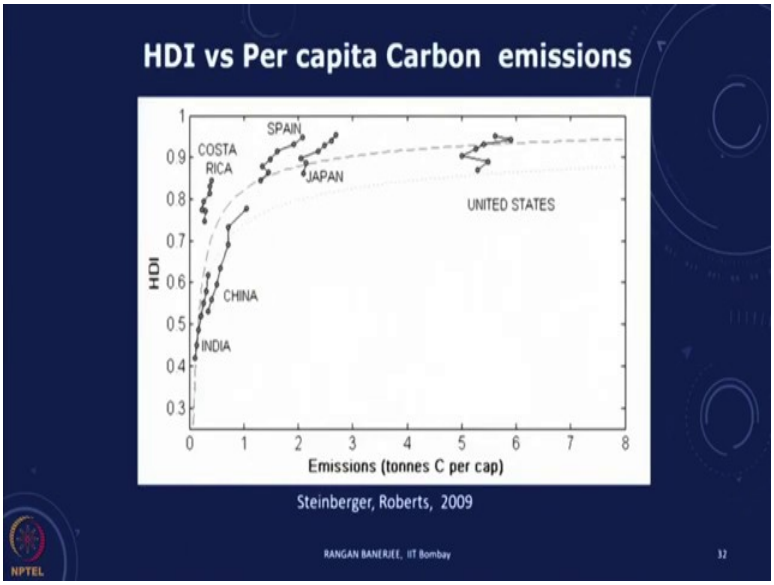

Similar kinds of plots have been done in terms of carbon emissions. So, you can, of course, see that, as we saw last time that the same amount of energy services can be provided. And depending on the fuel mix, you can have different kinds of carbon requirement for that energy, but historically, if you see the different countries and you see the HDI versus the CO_2 emissions, you see a sort of trend in terms of the usage. As we go forward, if we de-carbonize our energy sector, this trend can be decoupled and we could really have improvement in quality of life without increasing our carbon footprint.

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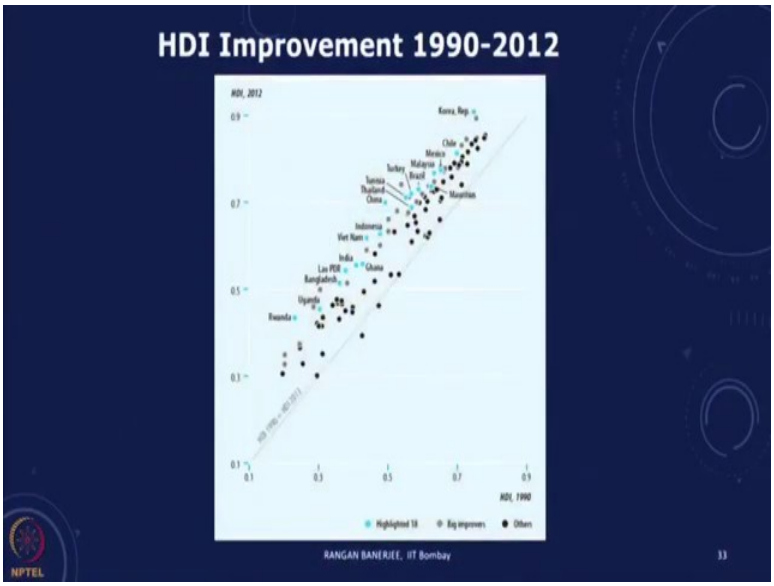

And most of the countries if you see over a period of time, they have been improving their HDI. And this is what development is about and this is where we need to think in terms of increasing the energy services and improving our energy system.

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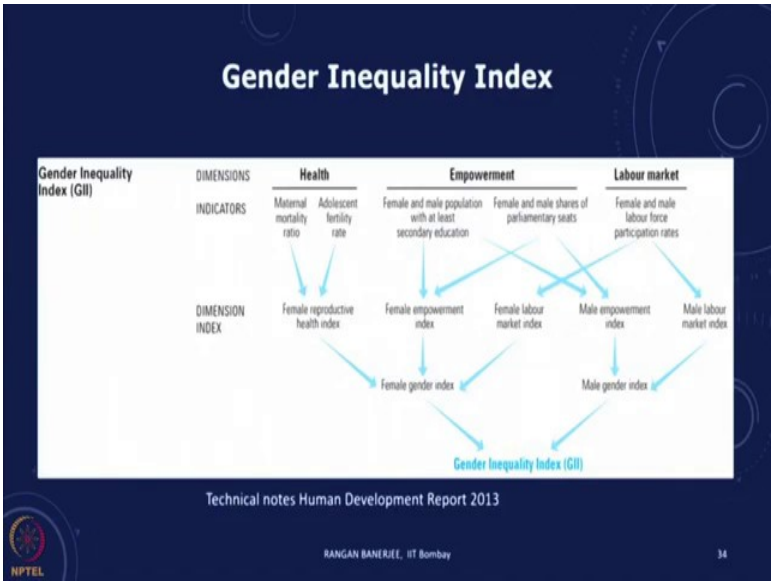

There are other indicators which are also important from an overall point of view and one of the indicators where you look at developed country, we also want to see that there is

less inequality between genders. And in terms of this, there are different kinds of Gender Inequality indices very similar to the indices that we do for the HDI. And these indicators can be in terms of health, empowerment and labour market. In each of these cases, what is done is, we compare the average kind of services and the average kind of health for men and women and then we use this in the form of an index, we look at, if men and women are doing a particular job, are they getting the same amount of pay?

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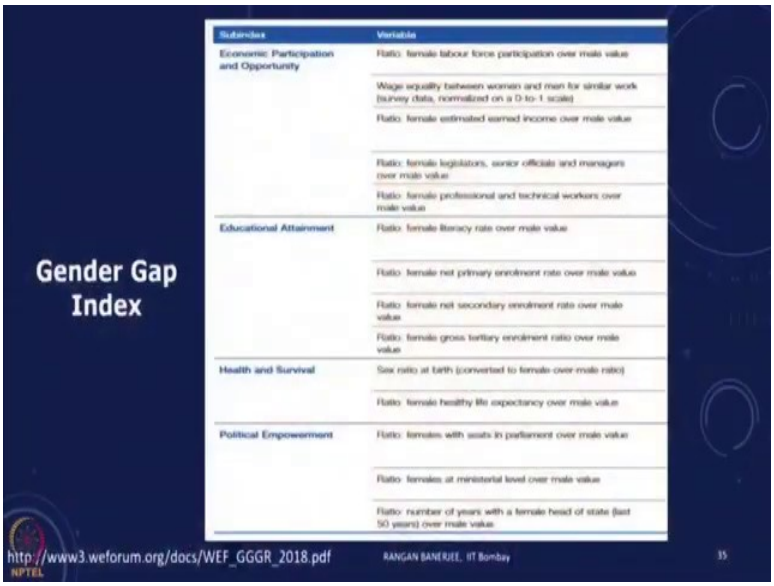

What is the proportion of the women who are in the labour force? And these are some of the indicators on which we identify the gender gap in terms of economic participation and opportunity, the educational attainment, health and survival, and the political empowerment, what percentage of the MPs are women? What percentage of the leaders in the cabinet are women and so on.

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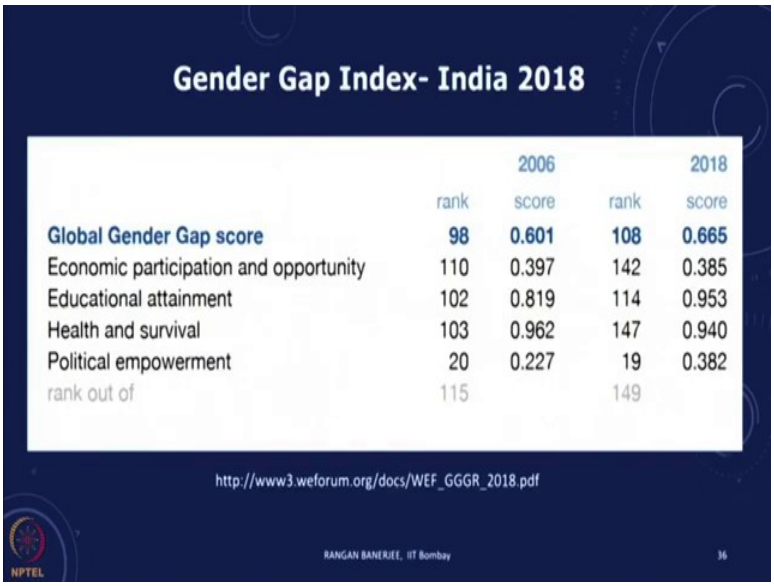

And if you see in the Indian context, ranking of about 149, we do not seem to be doing too well in terms of the gender gap, but we are still on a path of improvement and if you look at compared to some of the Scandinavian countries were relatively they are much better off in terms of relative gender equality, you can see that this is, so when we talk in terms of overall development and quality of life, equality in gender is also one of the parameters.

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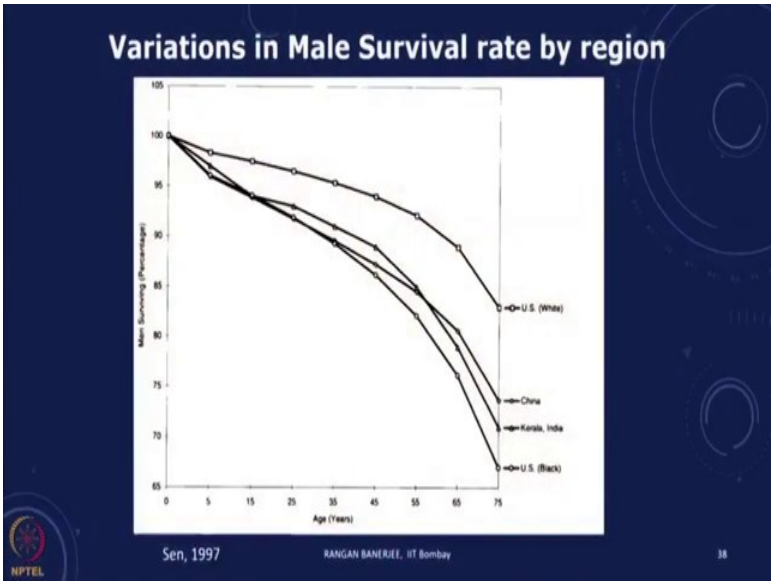

You can also see that within the country there are different. So, this was a study by Amartya Sen the Nobel laureate in economics, and this study showed that you compare Kerala with different parts of the world and compared with US, China, and you find that in terms of health, Kerala seems to be doing better than China and in some parts of the US.

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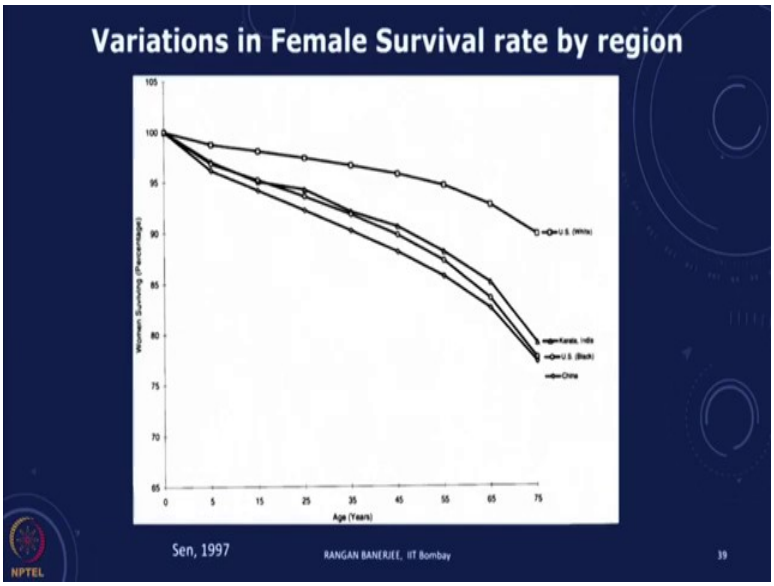

And similar things in terms of the women health and survival rate by age.

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So, all of this, what we have done so far is, we have looked at the different kinds of indicators for the quality of life, we focused on one particular indicator which is the Human Development Index and the HDI as proposed by the UNDP, we saw that all the countries are rated and this is non-dimensionalized from a factor of zero to one.

We saw also that, the HDI varies with the energy used and the electricity use, we said that, in order to improve the quality of life, we need to increase the energy services, but beyond a point, then there is a saturation and this will be useful to us when we think in terms of making projections of what kind of future development we should have and how our energy systems should work.