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I would like to focus on the developing and least-developed countries, because there is a direct link between energy availability and poverty, and there are enough studies to show that energy, poverty and economic poverty are almost directly related. The 50% poverty reduction goals in the MDGs can almost be translated to clean energy availability. The focus is on poverty reduction in a developing country like India, as in many developing countries, and the vehicle that was taken for poverty reduction was increasing incomes. Increasing incomes means more energy availability, and it also means pushing the 50% of your population which is without commercial energy into using commercial energy.

The use of commercial energy, unfortunately for a country like India, is dependent on coal. Coal is a mainstay; we import 80% to 85% of our petroleum requirements, and the drop in oil prices is a boon for the Finance Minister. However, be that as it may, we have set ourselves very ambitious targets for the new renewables, as we call them, because large hydro is also renewable. The target for 2019, which has been scaled down from 2022, is 100,000 megawatts of solar capacity, but be that as it may, the fact remains that the percentage of households with electricity increased from 56% in 2001 to 67% in 2011, and 45% of rural households in 2011 still did not have an electricity connection. We launched a massive rural electrification programme, where 125,000 villages were taken up, almost 105,000 have already been electrified, and almost all the homes below the poverty line were given free access to connected electricity.

We had thought that our generation capacity would come down drastically in respect of coal, but the fact is that as of March 2014 the coal capacity was 60%, 3% higher than the projection for 2000, and by 2030 we expect that coal will be 42% of capacity and 58% of generation, oil being zero, natural gas being 3%, hydro 3% of capacity and 11% of generation, renewables 33% of capacity and 16% of generation, and nuclear 9% of capacity and 12% of generation.

Given this kind of scenario, I would like to bring into focus a fact which is often repeated by people who come from the part of the world that I come from: the share of countries like India in per capita emissions is among the lowest. To talk about an equitable world and a sustainable future, which means a sustainable future for the entire population, more so the poorer sections, you must provide them with an opportunity to grow. The world average for 2011 was 4.5 tonnes of CO<sub>2</sub> per capita; it was 16.94 for the US, 1.41 for India, 5.92 for China, 5.04 for France and 4.75 for Sweden.

Global emissions have of course gone up; in India they have trebled between 1990 and 2011, while for the world as a whole they have only gone up by about 50%. This figure has, of course, gone up four times for China.

We clearly understand that the world needs cleaner fuel, and for that purpose we started measuring units of CO<sub>2</sub> produced per unit of energy. This has gone up for China, India and Bangladesh between 1990 and 2011, but has gone down for France, Sweden and the US. It is constant for the world, but the US and global figures are still higher than for India. However, this is not a measure of satisfaction for us, and I think we want to drastically improve in that sphere. Another area of worry for us is energy density for every Dollar of GDP growth, and for India every tonne of CO<sub>2</sub> emitted generates USD 0.76 of GDP. The figure for China is USD 0.55, for the world USD 1.67, for the US USD 2.5, USD 2.21 for Mexico, USD 6.85 for France and USD 9.28 for Sweden. That is the kind of image that some of us in India are looking at.

How do we achieve that? One of the low-carbon strategy objectives that we have taken up as a high priority is the National Mission for Enhanced Energy Efficiency, which sets targets for emission reduction and energy intensity reduction for eight major sectors covering over 400 industries in the country, including the power generation sector. We have evolved a scheme called the Perform, Achieve and Trade Scheme, where if you exceed your reduction targets you get some credit points and can trade them in the future. We feel that a device like this will help us in the future.

Coming back to poverty reduction, what should be the strategy? I have talked about rural electrification and intensive electrification. Some villages have a few connections, and we have figured out that what you need is to spread them out across every habitation in the village. There are about 602,000 villages which need to be attended to, and we have covered 50% of them already. Another area we need to look at, particularly in the context of non-fossil fuels, is improving cooking stoves, because 76% of the population of the country still used wood for cooking in the 2009 and 2010 censuses, as did 17.5% of the urban population. The target there is to improve thermal efficiency from 10% or 15% to about 25% or 35%, because these people will continue to use these biofuels for quite some time.

The other issue is, if you are going to continue using coal for a while, and we have no other options, we should start using cleaner coal technologies. There are about 25 supercritical plants with about 70,000-megawatt capacity, and we intend to get to the supercritical stage, which is 40% efficiency as opposed to 33% for sub-critical, and ultra-supercritical at 46%. We have a five-year plan system in the country, which the new Prime Minister may dismantle, but at the current level we are on the 12th five-year plan, which is 2012 to 2017, and in this plan it was emphasised that 50% of the capacity that would be added would be supercritical, and in the 13th plan, 2017 to 2022, 100% of the capacity will be supercritical. All coal linkages from the state public sector undertaking, which is a monopoly coal supplier at the moment, will only be supercritical plants. The others are given a disincentive of having to import at a higher price.

The other emphasis is on demand-side efficiency, and there are 12 focus issues we have taken up there, because we feel that if you do an overall matrix of what is the least offensive method of achieving growth with current energy use, it is to go in for demand-side management in energy efficiency. I have already talked of 100,000 megawatts for solar. There is a misconception when we talk about gas versus coal; I think we have to separate energy use between electricity and heat, and there we need to use gas more intensively for heating and for cooking purposes, and similarly for solar. The use of solar is not only for heating, but also for lighting, and this is an area we need to concentrate on much more.

Another area of concern for us, which we discussed a little earlier, is vehicular pollution and particulate matter PM10 particularly. 50% of PM10 is estimated to be from power plants and 30% from automobiles. Clean Air Asia conducted a survey for 300 Asian cities in 2012 and found that PM10 concentrations were in safe limits in only 16 of those; 94% of cities sampled had air that was unsafe for breathing. The OECD said in 2010 that seven out of ten world cities most exposed to climate change are in developing Asia. This is an area we also want to address, not only power but conversion of vehicles to electric cars and mass rapid transportation systems.

What should be the plan in the future? First and foremost, not only for India, but for all coal power generation, all inefficient coal capacity should be retired as soon as possible, so that inefficient coal use goes off the map, then introduce smart grids to integrate renewables. We have talked of renewables being brought about, but as Richard mentioned they are intermittent and are not timed to the time of use, so you have to integrate them with the other conventional power. However, you must not only integrate them but also develop energy management centres at the focal points of renewable generation. That is when you need to develop weather forecasting systems, so that the wind and solar producers can know what their generation is going to be at least 24 to 48 hours ahead, so that programming can be done for grid management.

India has one of the largest interconnected AC grids, and we have to convert this into a smart grid, which will mean that quite a substantial proportion of this grid may have to move from AC to DC, particularly where you have direct use from renewables. This entails a huge amount of expenditure, but it has to be done. We have made a beginning in this sense: we have started building green energy corridors, and for this you also need storage facilities, so not only optimising your hydro use but also pump storage, where excess power is pumped up and then you can utilise it again.

We have also been working with some of the developed countries in the nuclear sphere. We have our indigenous programme, and by the next year we should be using our fast breeder reactor, which is one of the first large reactors. Then we should work on LED for lighting as a universal proposition so that those who live in remote areas in particular will not have high energy bills, because we have a massive problem with distribution companies running into huge losses from non collection of electricity dues, so we want to reduce their consumption at the bare subsistence level as much as possible through LED lighting.



We should use mass public transport and electric metros in towns and cities, as otherwise the cities will become unliveable, and reduce fossil fuel subsidies drastically, because this is leading to an uncontrolled increase in the number of vehicles, SUVs, etc., and the rich are using those subsidies more than the poor. We should give direct cash subsidies to the target beneficiaries. Finally, something we have not touched on today is that energy use and climate change have a direct bearing on water availability, and this may be the next emergency we will see in the next two decades if not earlier. Water consumption in energy use is very high, particularly in power generating plants and mining, including shale gas and other on-land mining. Water usage is huge and water pollution is also huge, so water is an area we should start addressing immediately in relation to energy and climate.