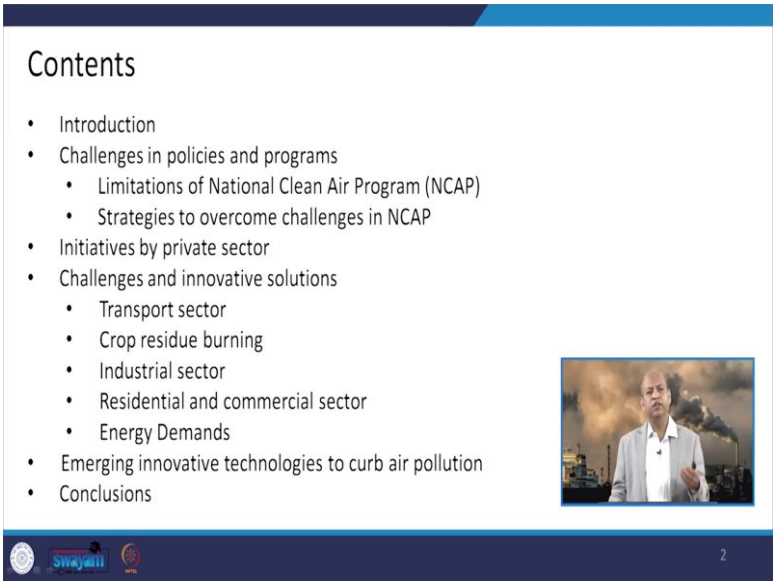
Air Pollution and Control
Professor Bhola Ram Gurjar
Department of Civil Engineering
Indian Institute of Technology, Roorkee
Lecture – 54
Challenges and the Way Forward

Hello friends. So, far we have discussed various aspects of air pollution and how to control it. So, like different kinds of sources from different sectors, how dispersion of air pollution occurs, how do we monitor air quality, how do we model it, what are its effects, all aspects of air pollution and control we have discussed.

So, today's lecture is basically concluding lecture, but in that lecture, we will also look into various challenges to address the issues related to air pollution and also the way forward means the new solutions which are coming up to deal with the air pollution related problem.

(Refer Slide Time: 1:16)

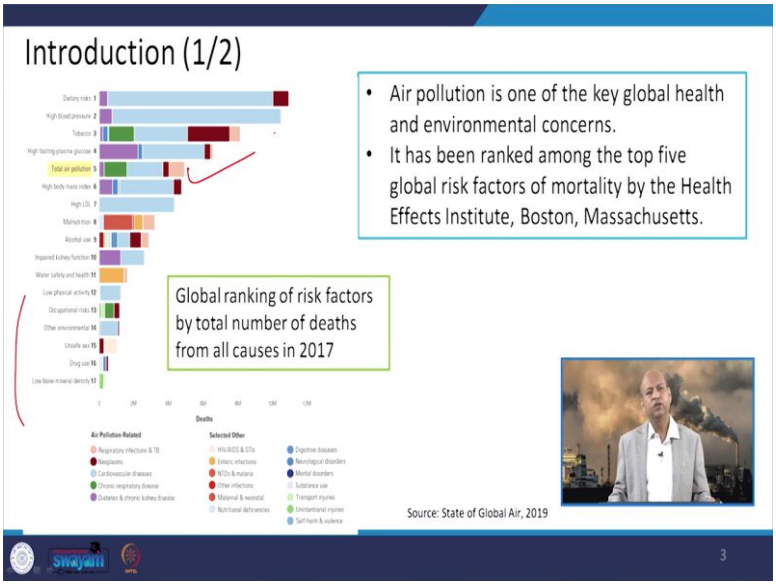


So, in this lecture basically, this is the content, which we will discuss today like brief introduction about the problem. And then, we will look into several challenges which are in terms of policies or programs focused on air quality improvement or reduction of air pollution emissions.

So, in that context, we will look into Limitations of the National Clean Air Program which is a big national level program in India. And then we will also look into some strategies which are needed to overcome those challenges which are related to NCAP. Then we will see some initiatives which have been taken by private sector to improve the air quality and to reduce the air pollution.

Then we will focus on challenges and innovation solutions or innovative solutions, which are focused on different sectors like transport sector or crop residue burning or industrial sector, then residential and commercial sector, then related to energy demands what are the new challenges and how to tackle those challenges. Then we will see into like emerging innovative technological solutions to curb the air pollution and after that we will conclude.

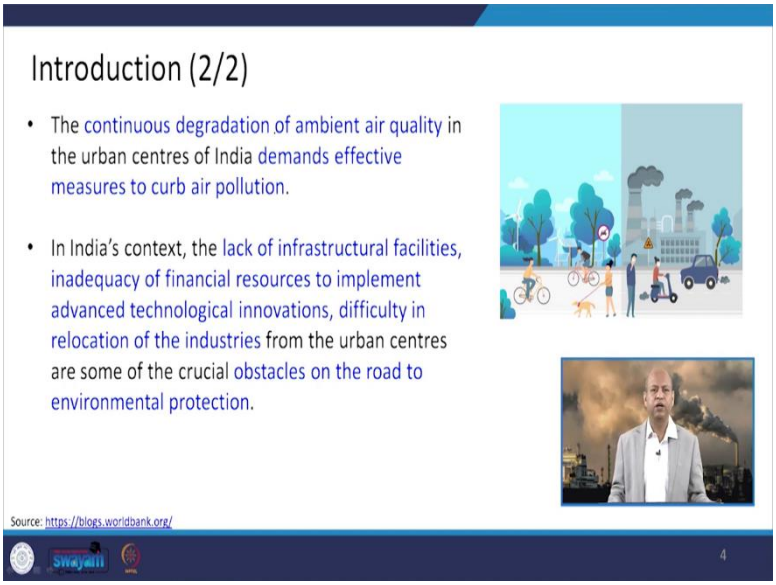
(Refer Slide Time: 2:21)

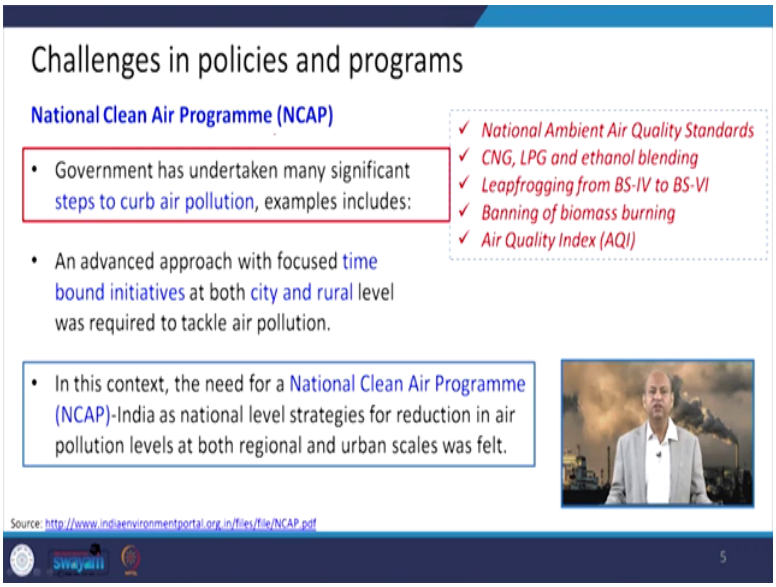


So, if we look into this year pollution as this is a problem not of the local scale, but regional and global scale also and if we look into this air pollution related problem and link it with the health risk, which we have discussed in detail in several lectures basically. So, this is one of the key critical parameters or important parameters, which is related to human health as well as the environmental issues.

So, it has been like this air pollution has been ranked as one of the top five global risk factors of mortality by the health effects of this the data which was analyzed by the Health Effects Institute in Boston, Massachusetts, and the global ranking of risk factors by total number of deaths from all causes in 2017 are given in this particular chart. And you can see at the fifth location or fifth rank, this air pollution is there, which has significance in terms of human health effects and environmental health effects.

(Refer Slide Time: 3:28)





If we talk about like, what is the region and the region is so, many emissions from fossil fuel burning and continuous degradation of air quality, because of those emissions from various activities, which are related to burning of fossil fuels and using those kinds of sectors based on fossil fuel burning.

So, if we look into the regions in Indian context, there are several regions for this air pollution, emissions and degradation of air quality and they may be related like infrastructural facilities, which are quite limited in terms of quality, although slowly as economy is growing, so, infrastructure facilities are also growing, but over the past several decades, the regions which are linked with air pollution, emissions and degradation of air quality are linked with infrastructural facilities.

And in inadequate amount of financial resources, which are required to do something to intervene in terms of better technology, better policy measures, implementations of several programs to improve the, this ambient air quality.

And there are difficulties in relocating industries from, cities to other places, because it requires a lot of resources and there are limitations in resource allocation. So, there are several regions which are in terms of challenges, you can perceive that and can we address those challenges in a very judicial way so, that we can do those interventions and improve the air quality.

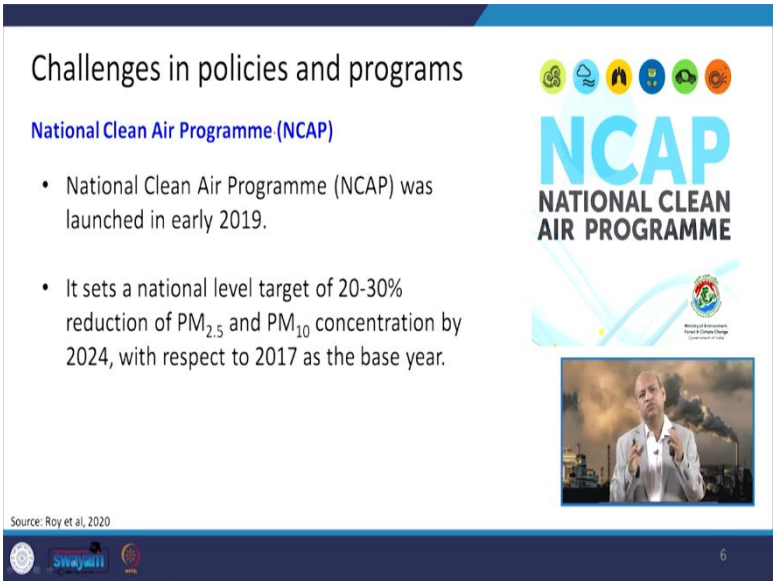
If we look into policies and programs related challenges so, one example is National Clean Air Program (NCAP) basically and before that government of India and state governments as well as other agencies, which are concerned about air quality improvement, they have taken they have taken so, many steps to curb the air pollution basically like National Ambient Air Quality Standards (NAAQS) were prescribed time to time then CNG LPG or ethanol blending related policies were implemented.

There are like leapfrogging from BS-IV to BS-VI that was great decision. So, that rather than going from BS-IV to BS-V we could go directly to BS-VI so, that we can have stringent norms and that way very less amount of air pollution emissions from transport sector to improve the air quality then there was like burning of this biomass and air quality indices related issues or ways to manage the air quality in and around urban areas.

So, there have been several ways and policies and programs, but an advanced approach which could be focused on time bound initiatives, so, that we could fulfill those requirements in a time bound manner. And for both cities and rural areas, we could address the air pollution related problem. So, that need has been felt basically.

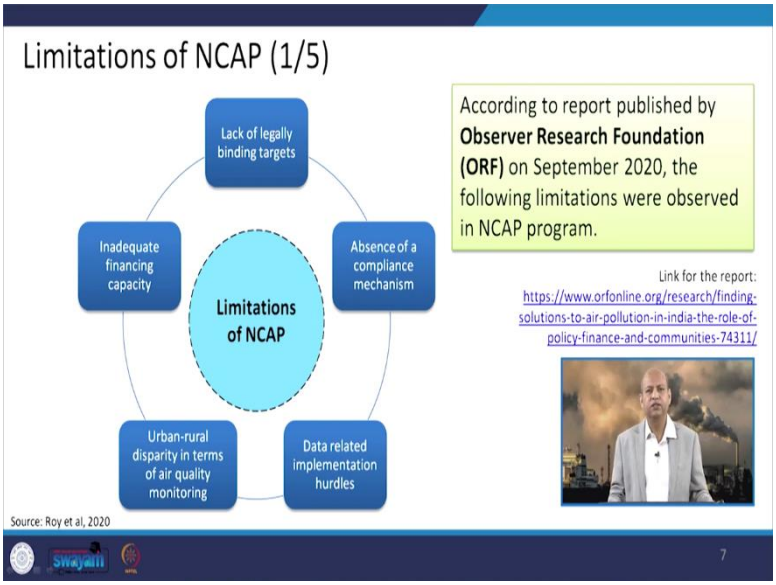
So, in this context the need for National Clean Air Program (NCAP) India as a national level strategies for reduction in air pollution levels at both regional and urban scale, it was felt very seriously.

(Refer Slide Time: 6:50)



So, that is the reason this National Clean Air Program (NCAP) was launched in early 2019 with the focus on reducing these emissions or these $PM_{2.5}$ and PM_{10} concentrations by 20 to 30 percent reduction to achieve this target by 2024 with respect to the their levels in 2017. So, this was decided and it was implemented at a larger scale.

(Refer Slide Time: 7:18)

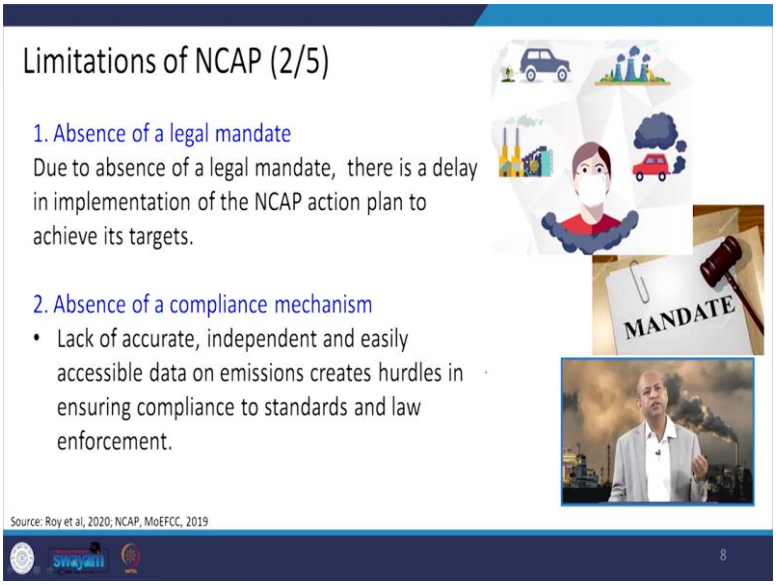


But several limitations have been observed in case of NCAP like according to the report, which was published by Observer Research Foundation (ORF) on September 2020. The following limitations were observed in this particular program, which is of national scale like lack of legally binding targets are there means targets are there.

But if suppose, we do not achieve those targets then is there any penalty or other legal issues, those things are missing basically, then absence of a compliance mechanism that how to see whether it has been compliant or not or how to achieved those compliance then data related implementation hurdles are also felt, then urban and rural disparity in terms of air quality monitoring is there.

So, many air quality monitoring stations are concentrated in only urban centers or urban areas in cities, but rural areas are not covered by them. So, there is a big disparity in that sense. So, you do not know what is the air quality of rural area is basically, if you look into rural and urban air quality. Then there are inadequate financial resources for doing for implementing certain programs or having certain technological interventions to improve the air quality.

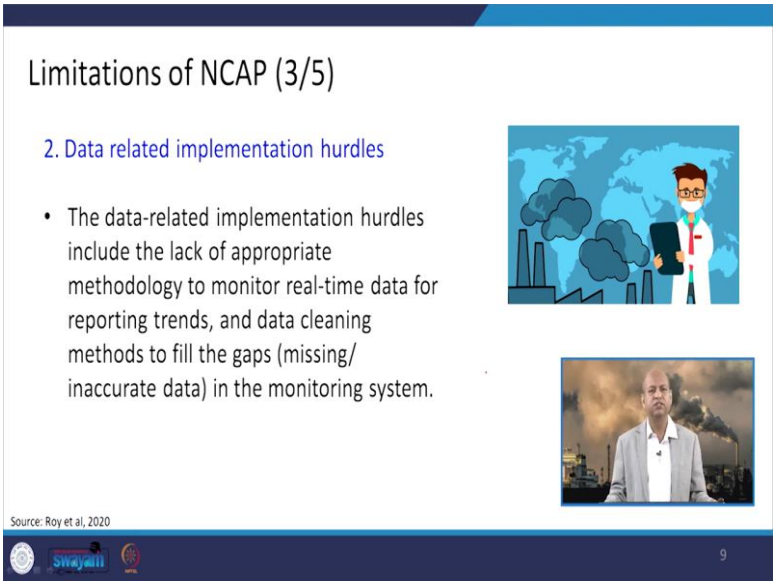
(Refer Slide Time: 8:43)

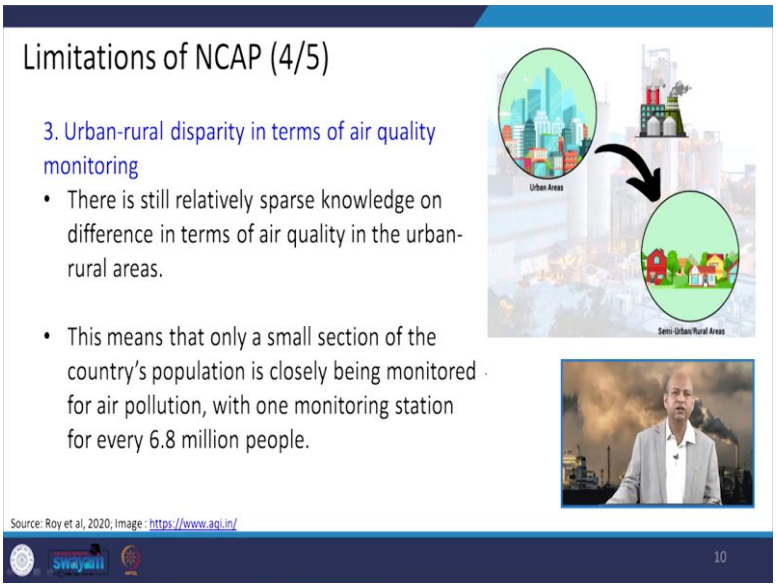


So, there are limitations which have been, discussed here, like one by one absence of legal mandate, because of this absence of a legal mandate, there is a delay in implementation of NCAP action plan to achieve this target because, it is not a kind of legal binding.

So, if even if it is delayed people feel okay we can look into in another way around. Absence of compliance mechanism is also there like lack of accurate or independent and easily accessible data on emissions, which create hurdles in ensuring compliance to standards and law enforcement. So, this is also one gap or limitation.

(Refer Slide Time: 9:25)

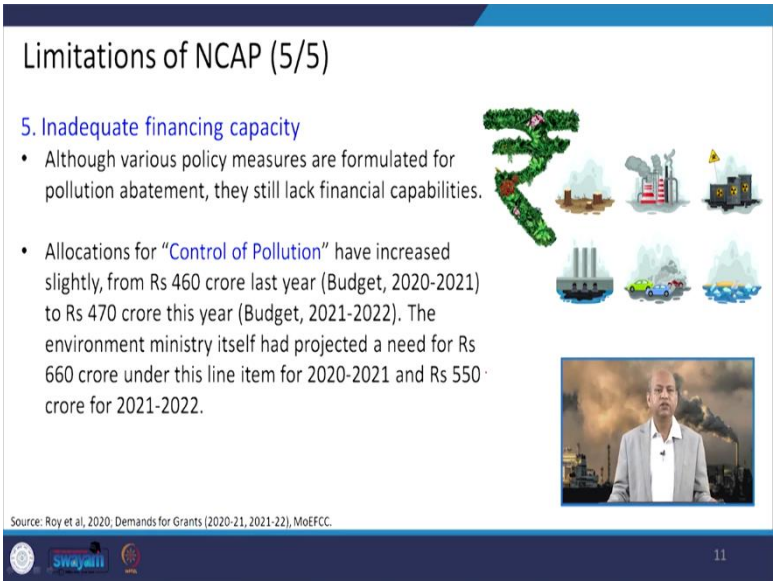




Then there are data related implementation hurdles. Because this includes like lack of appropriate methodology to monitor real time data for reporting several trends and data cleaning methods to fill the gaps, which are related to missing accurate data in the monitoring system.

Of course, there are ways like statistical tools are also there and various agencies are using them, but it is still it was felt in this report they say that data related implementation hurdles are there. Then, urban and rural disparity in terms of air quality monitoring is huge and it requires a lot of resources to put in air quality monitoring stations in rural areas. So, that this disparity can be filled in or addressed properly.

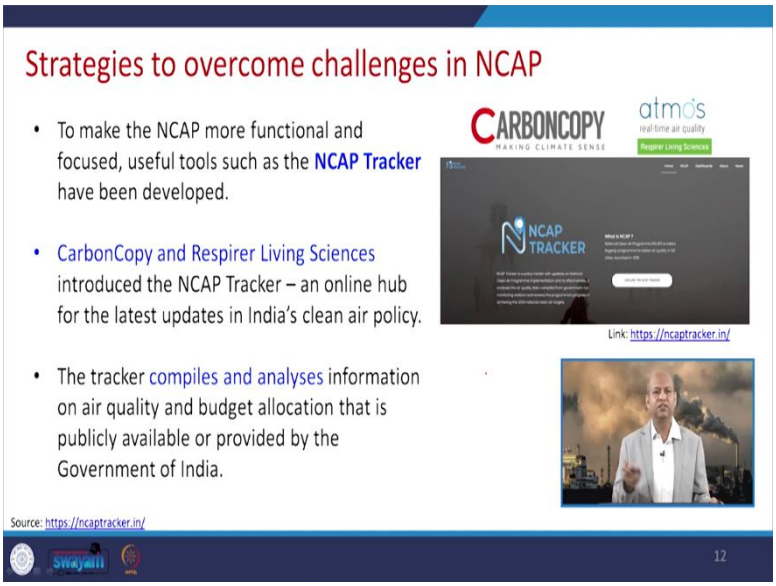
(Refer Slide Time: 10:12)



Then inadequate financial capacity are there because like various policies and programs are, framed and implemented, but to achieve the targets sometimes there is a need for that much of financial resources which are not available.

For example, allocation of control of pollution have increased the funds for control of air pollution, from 460 Crore last year of 2020 to 2021 budget to 470 crore. So, this is a very slight increase otherwise, this need or estimated budget was like 660 crore in 2021 and this 550 crore in 2021-2022. But it was not met means there is a little bit gap in those projected amount of the financial resources and the allocation which was given.

(Refer Slide Time: 11:05)

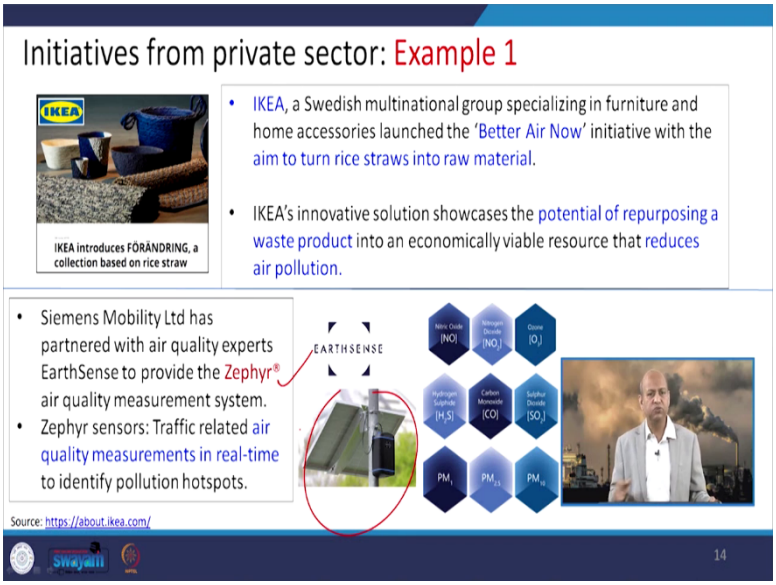


Then we can look into now strategies to overcome the challenges or some other challenges. And like there have been several initiatives in terms of let us NCAP tracker. So, this is basically carbon copy and raspier living sciences both have joined hands to launch the NCAP tracker. So, this Tracker basically compiles and analyze the information on air quality and budget allocation to tackle the air quality related programs. So, that is available publicly and they process those data and then they give some information about that.

(Refer Slide Time: 11:52)

Apart from government initiatives private sector has also come forward with several initiatives to improve the air quality basically. And this private sectors role is very important in designing and financing also those programs, cutting edge innovations and unique technology solutions, which can be used for addressing the challenges in air pollution. So, those initiatives are also very important and we will discuss a few of them.

(Refer Slide Time: 12:20)

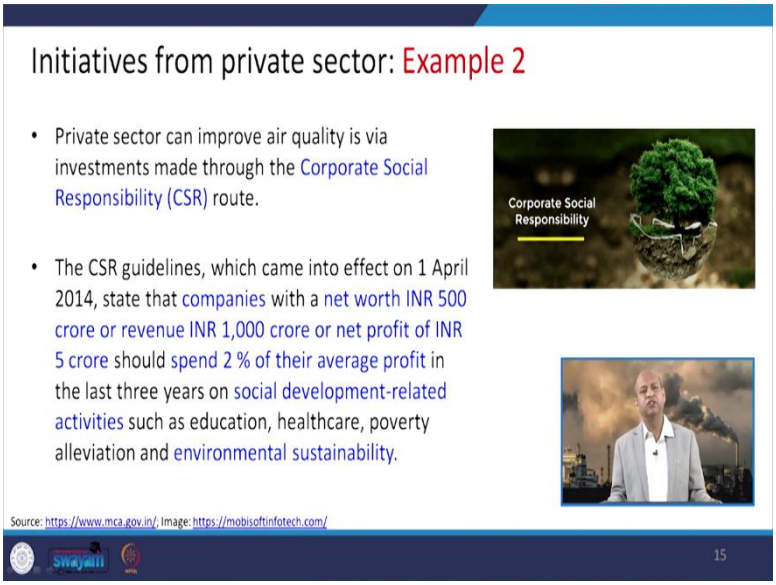


For example, IKEA which is a Swedish multinational group, which is having a specialization in furniture and home accessories, it has launched better air now, initiative with the aim to the turn rice straws into raw material for making furniture. So, this particular new initiative of IKEA, it has kind of showcase the potential re-purposing a waste product otherwise which if it is burned, then it will emit a lot of emissions.

So, economically viable resource and it can reduce air pollution. So, both ways means financially it is beneficial as well as it is affecting very less amount of the environment because it is reducing the air pollution emissions. Then similarly, like Siemens mobility Limited has partnered with the air quality experts Earth Sense to provide this Zephyr. This is an air quality measurement system basically, related to traffic.

So, the sensor based system you can see here sensors and different kind of pollutants which it measures. So, that traffic related air quality measurements in real time live to identify the pollution hotspots so, that traffic can be diverted, if a particular hotspot is there so reduce the air pollution or improve the air quality there you can divert the traffic. So, this traffic management system, Air Quality Management System has been launched.

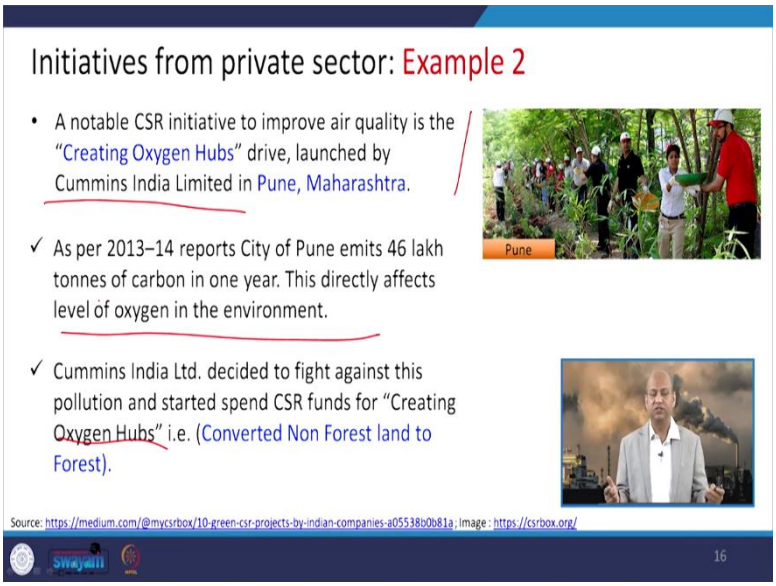
(Refer Slide Time: 13:51)



Then, there are other examples like through corporate social responsibility CSR, many industries are coming forward to invest money for innovative solutions basically and there are guidelines of the CSR you might be knowing that like the companies with a net worth of 500 crore or revenue of 1000 crore rupees and net profit of 5 crore they have to spend 2 percent of their average profit.

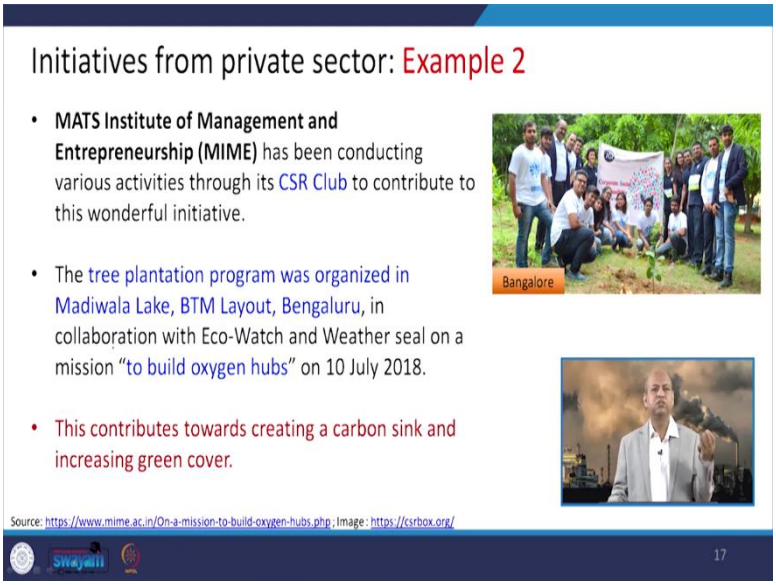
So, that they can support or sponsor the programs for several activities like education, health care, poverty alleviation and environmental sustainability also. So, within the framework of environmental sustainability initiatives can be taken into improving the air quality.

(Refer Slide Time: 14:43)



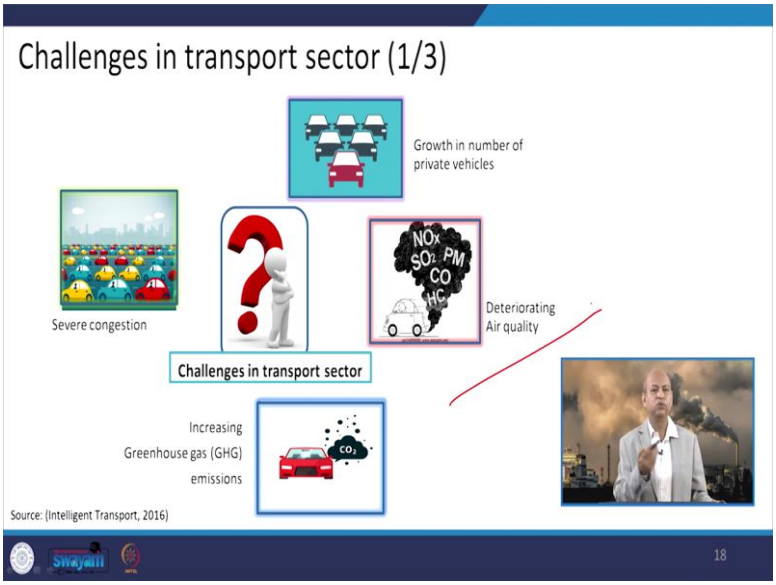
So, in that way one more example is very good in terms of like CSR contribution, one company Cummins India Limited in Pune. They have invested lot of money through CSR to create oxygen hubs. Basically, these oxygen hubs are nothing but converting non forest land into forest area so, that the greenery can absorb the CO_2 and they can produce oxygen. So, those kinds of initiatives are coming in a very innovative way.

(Refer Slide Time: 15:10)



Now, then there are like tree plantation related initiatives in Bangalore, some companies are coming up. So, to build oxygen hubs in that way means when we increase the greenery naturally capacity to absorb or sequestration of carbon increases, and to emit lot of oxygen is also one way with these kinds of initiatives. So, this contributes towards creating a carbon sink basically and increasing the green cover as well as producing a lot of oxygen.

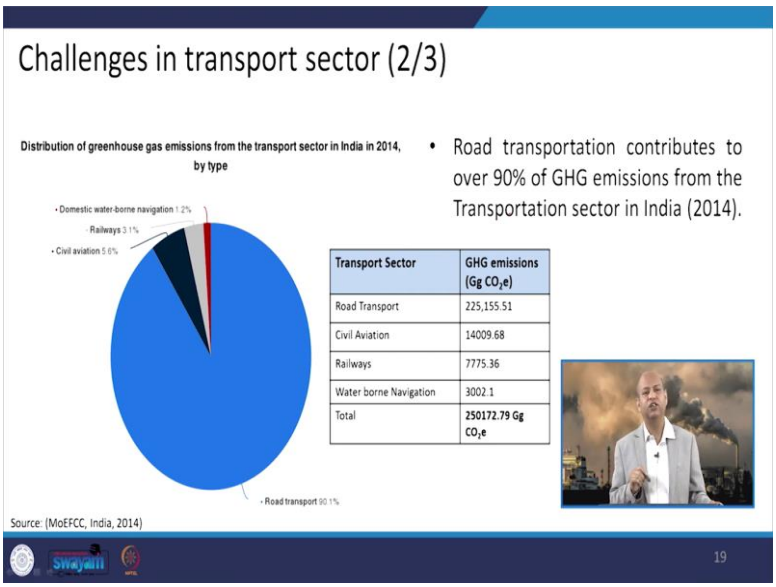
(Refer Slide Time: 15:42)



Then there are sector based challenges like if we consider transport related sector. So, there are several challenges for example, privately owned vehicles are increasing, we have discussed in several policy measures like how to reduce privately owned vehicles and promote the public transportation system.

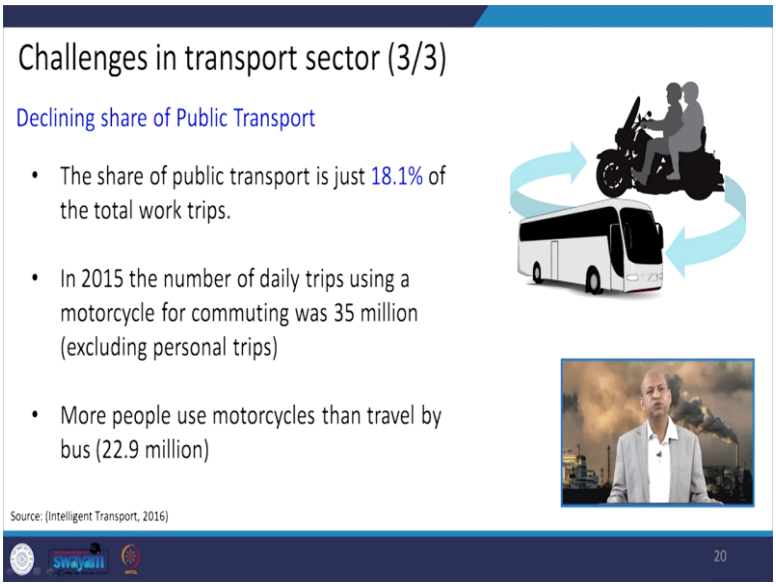
Then there are like deteriorating air quality which is a big in urban areas, big issue related to air pollution emissions from transport sector. Then increasing greenhouse gases as well because greenhouse gases and air pollution emissions are together. So, they are related to this transportation sector because congestion increases, then emissions also increases. So, we have to address those transport sector related challenges.

(Refer Slide Time: 16:23)



And like 90 percent of greenhouse gas emissions is emitted from road transportation basically, if we consider within the transport sector related GHG emissions. If we focus on road transportation emissions, we can really help in improving air quality by reducing air pollution emissions from the road transportation or vehicles which are applying on the roads.

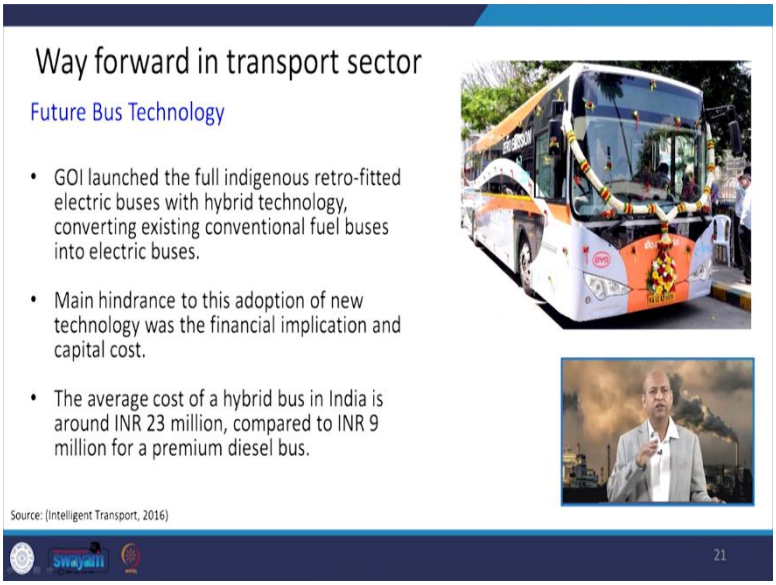
(Refer Slide Time: 16:50)



So, like declining share public transport is a worry some issue because it is just 18.1 percent of the total work trips basically in 2015 number of daily trips using a motorcycle for commuting was 35 million excluding personal trips. So, more people use motorcycle then they travel by bus.

So, that means there is a huge scope if you can transfer that population from two wheelers to these public transportation of buses etc that way we can reduce lot of emissions which are coming from two wheelers basically.

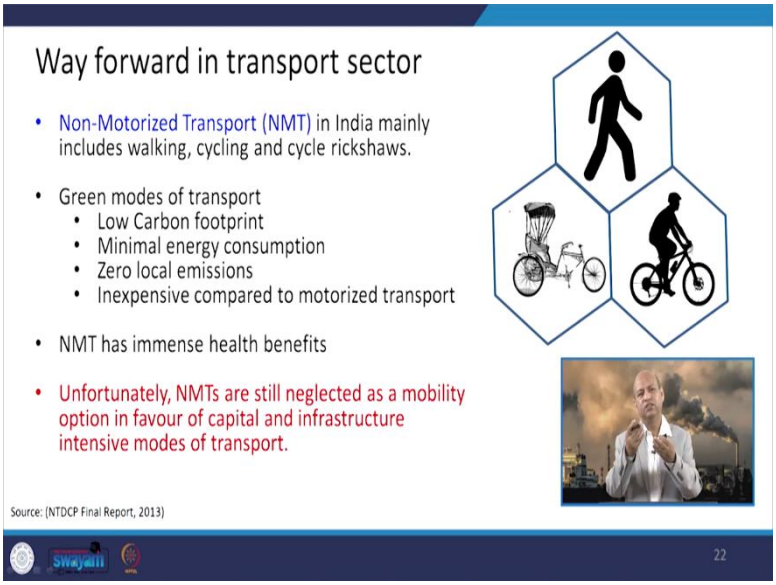
(Refer Slide Time: 17:27)



Now, the way forward if we look into in transport sector, so, Government of India has launched this full indigenous retrofitted electric buses and with hybrid technology also which are converted existing conventional fuel buses into electric buses. So, this is a new policy, but main hindrance is there to this adoption of new technology and this is because of less availability of financial resources basically and capital cost is also very high.

Because, if you compare like the average cost of the hybrid bus in India is at present around 23 million rupees compared to 9 million for premium digital bus. So, huge difference is there. But it is expected that the way fuel prices are increasing and the way government is investing lot of resources to increase the renewable resources of electricity. So, that way maybe in future we can reduce this gap and popularity of buses can increase, electric buses.

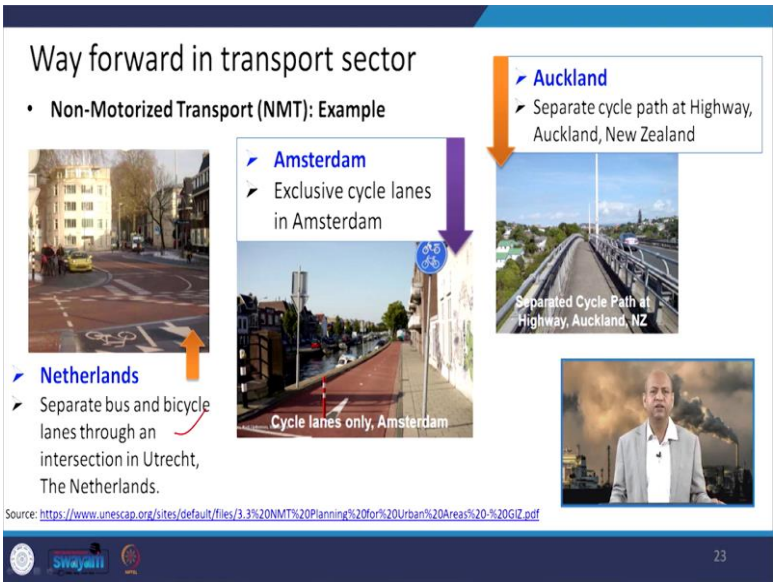
(Refer Slide Time: 18:33)



Then, there are like scope, huge scope is there to motivate people to go for non-motorized transport like walking or cycling or using this rickshaw, cycle, etc, which emit zero emissions basically only you need to have those infrastructure which can help them to have a comfortable journey in that way like dedicated lanes etc.

But, unfortunately these NMTs or non-motorized transport are still neglected as a mobility option in favor of capital and infrastructure intensive modes of transport, like lot of investment is there on metros etc but very less investment is there in these low hanging fruits which are related to NMTs non-motorized transport sector.

(Refer Slide Time: 19:29)

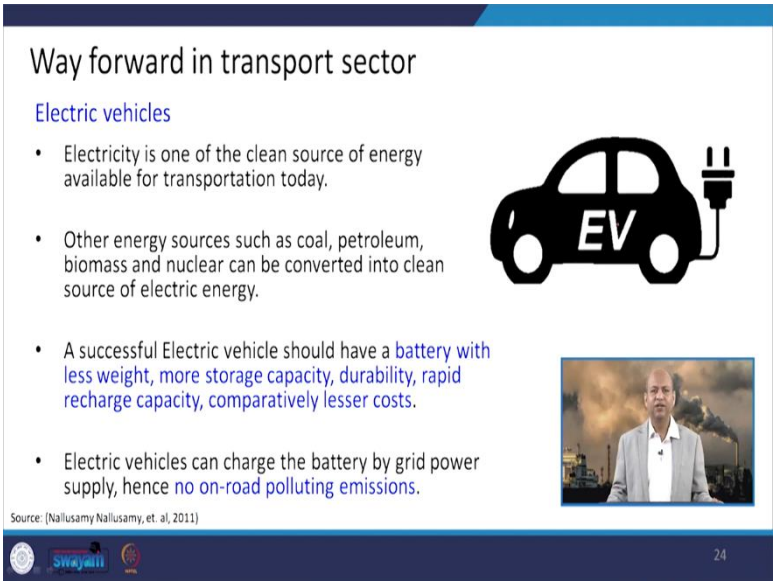


But if you look into like in foreign countries, huge infrastructure has been developed. So, we should learn because, there is nothing wrong in learning from best practices around the world. In Netherland separate bus and bicycle lanes are there through even these intersections. Exclusive cycle lanes are there in Amsterdam and Netherland.

Then separate cycle path at highways also means people who can go for longer distances using their bicycles or other means so, they are dedicated cycle paths are there so, that people feel motivated, they are not scared that accidents may happen if mixed traffic is there on the highways and highways of course, it is not allowed in our case highways are dedicated for certain kinds of vehicles only.

So, if we can have for few kilometers people are nowadays having like they want to cycle because of health benefits also and they are environmentally sensitive many people like to use the cycles, but if there is no dedicated lane or path for cycling, then it is difficult to use those kinds of NMTs.

(Refer Slide Time: 20:40)



Then there are way forward in transport sector in terms of electric vehicles for example hybrid bus and electric bus. Now, lot of focus and emphasis is on E-vehicles whether in terms of four wheelers or in terms of two wheelers also and only the challenge is that where this electricity is coming because those who are opponents having opponent views they always challenge that this electricity is coming from coal based power plants.

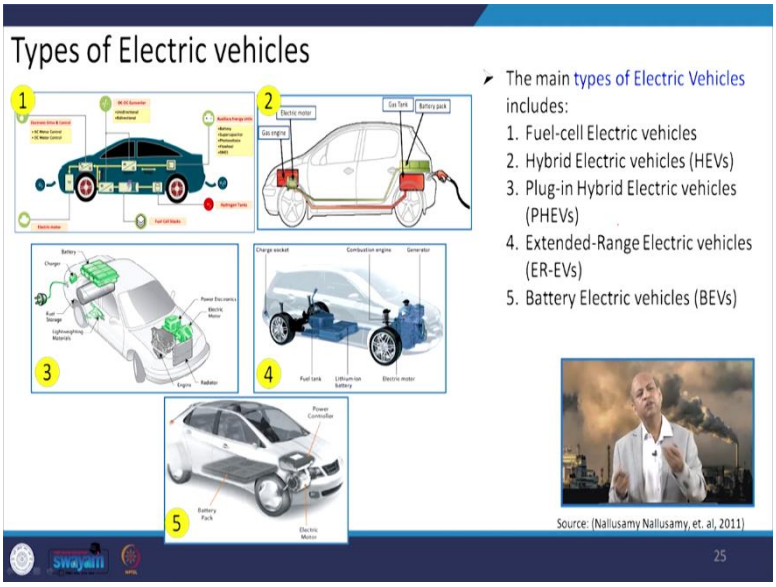
So, you are shifting the air pollution rather than reducing but catch is here because the emissions which are coming from motor vehicles or transport sector based on fossil fuel is

basically at the level of inhalation our respiratory system. So, if we can get rid of emissions of vehicles exhaust emissions that way we can improve, we can have the health benefits because that emission is not there.

So, improving air quality in urban areas, which are because of this transport sector is also a great benefit because coal thermal power plants or any thermal power plants, which are emitting emissions at very high these chimneys or stacks, then it gives dilution of the pollutants when it reaches to the ground level.

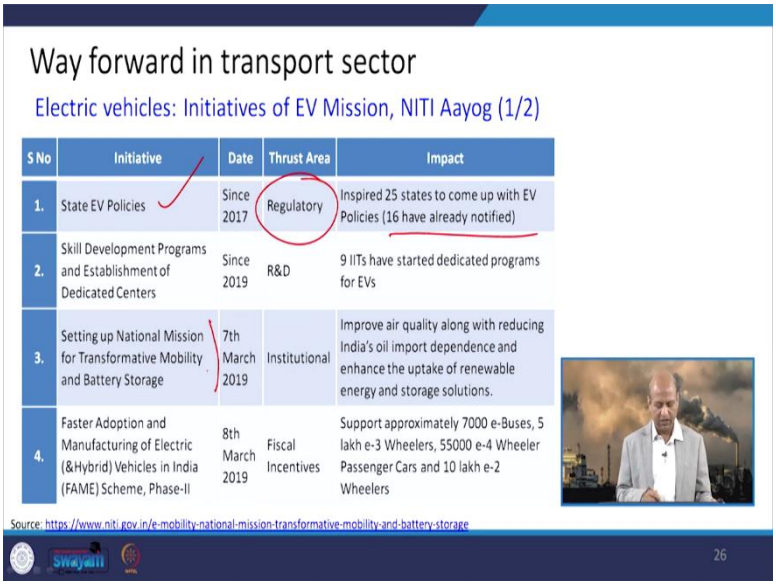
So, there is a big difference in that even if those emissions are coming to produce the electricity, but at the same time, government is enhancing and promoting generating the electricity from renewable resources like wind or solar etc. So, that way slowly I am very hopeful that this E-mobility will give great benefit in terms of cleaning the environment, having better air quality in urban areas and having health benefits.

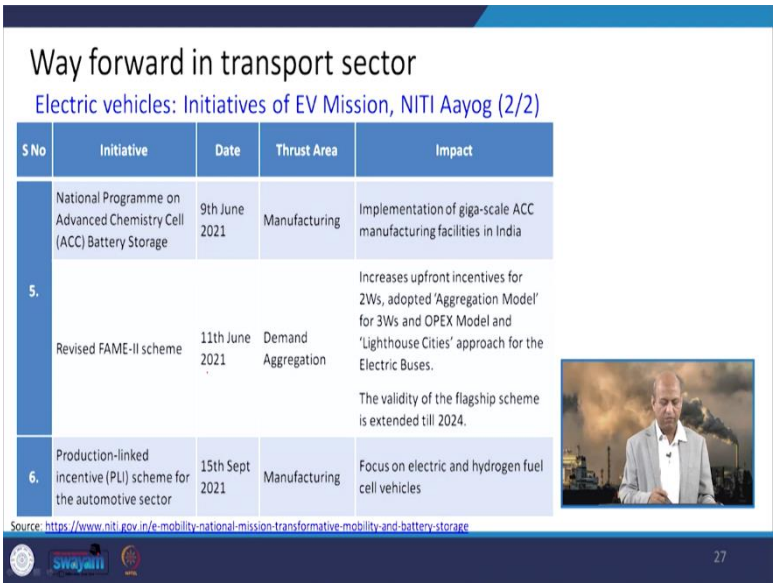
(Refer Slide Time: 22:24)



You can see like types of electric vehicles here, fuel cell electric vehicles are promoted, then hybrid electric vehicles as I just talked about that bus, then plug in hybrid electric vehicles PHEVs, extended range electric vehicles, battery electric vehicles, and several kinds of electric vehicles are coming and new technologies are coming. So, that way a lot of focus is on there.

(Refer Slide Time: 22:46)



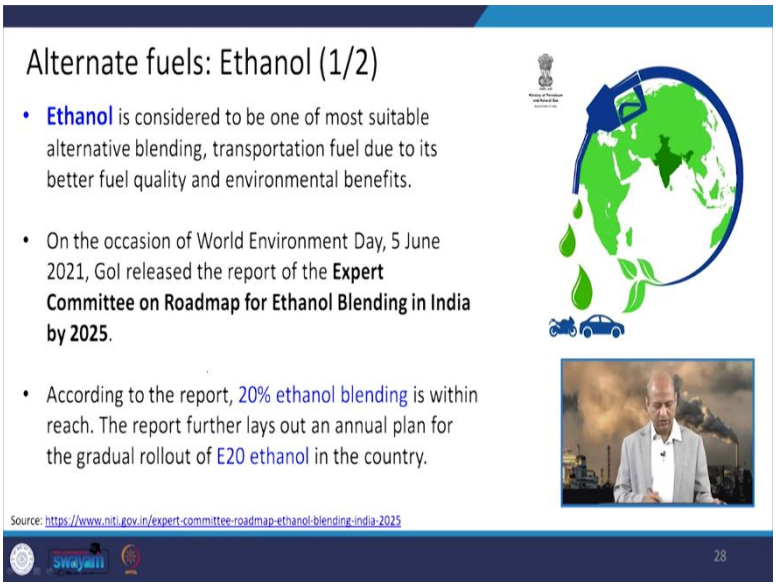


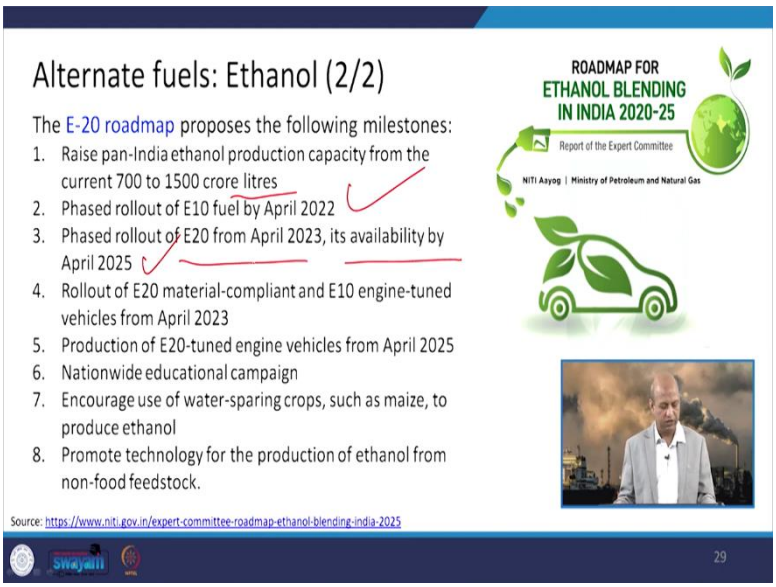
Also from NITI Aayog electric vehicles related initiatives have been there through electric vehicle emission basically. You can see like this state EVs policies have been there since 2017. And those areas are related to regulatory is basically at the state level. So, it has inspired around 25 states to come up with the EVs policies and 16 have already notified. So, this is a big huge motivation in that sense.

Skill development programs and establishment of dedicated centers, which can give better training how to go for this EV related infrastructure. So, 9 IITs have started these dedicated programs for EVs basically. Then setting up national mission for transported this transformative mobility and battery storage.

Because battery related issues are there huge issues, that we need to have lightweight battery and which can capture a lot of energy and it can be long lasting. So, those kinds of batteries are needed. So, that way several initiatives and programs have been launched by government of India through NITI Aayog. And these are giving boost in E mobility.

(Refer Slide Time: 24:05)



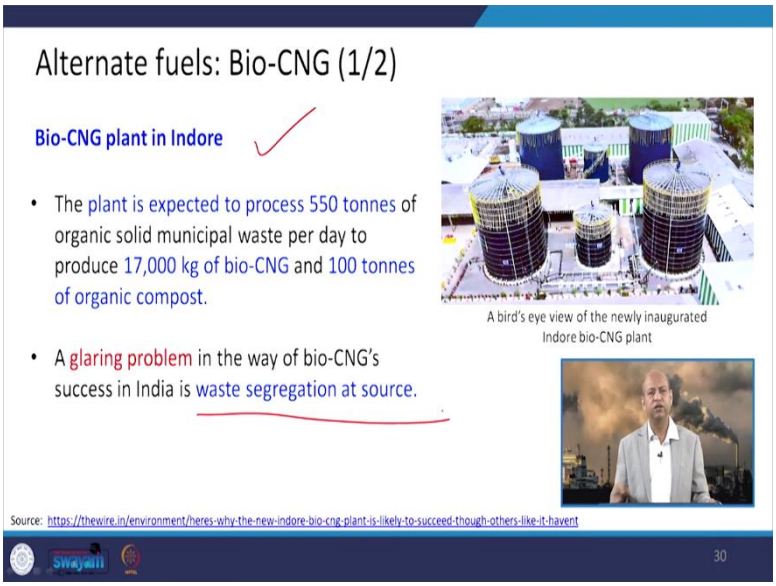


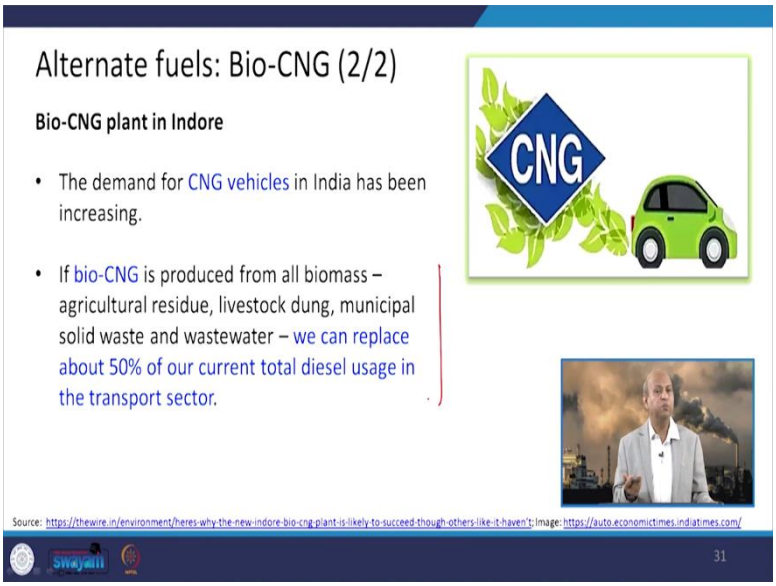
Then there are also focused on alternate fuels like ethanol, which is considered to be one of the most suitable alternative blending in this transportation fuel due to its better fuel quality and environmental benefits. So, on the occasion of this World Environment Day 5th June of 2021, Government of India released one report on the expert committee of the expert committee on road map for ethanol blending in India for 2025. This report was launched basically.

So, according to this report 20 percent of ethanol blending can be easily achieved basically. So, this E20 ethanol related policies are there and roadmap has been prepared how to go there like a lot of investment is there and this to produce 700 to 1500 Crore litre of the ethanol for this particular purpose.

Then E10 by April 2022 means 10 percent of the ethanol blending, 20 percent by April 2023 and availability by and this April 2025 means rolling out by 2023 and making it available by 2025. So, those kind of targets or step by step initiations have been promoted by the Government of India.

(Refer Slide Time: 25:22)





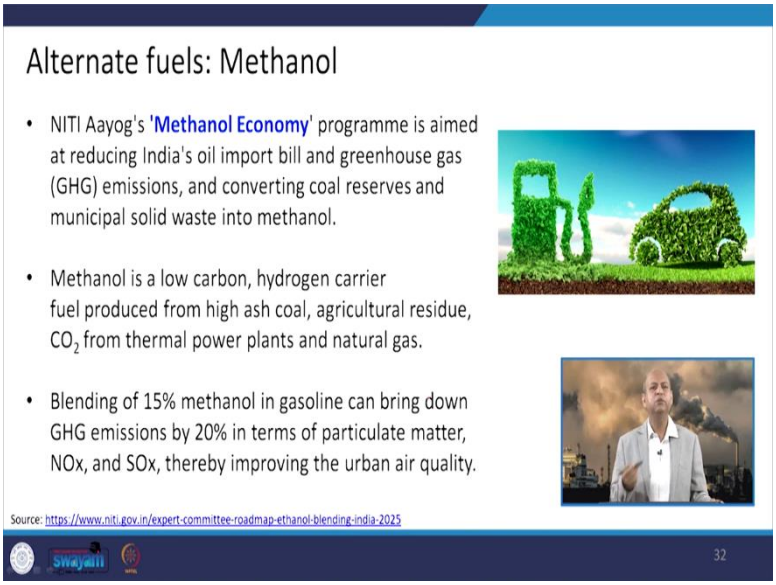
Then there is Bio-CNG related focus also, recently basically this in Indore Bio-CNG plant was inaugurated and this plant is expected to process 550 tons of organic solid municipal waste per

day to produce around 17,000 kilogram of the Bio-CNG and around 100 tons of the organic compost will also be a byproduct.

So, that way win win situation is there to clean the city as well as using the waste material into producing this biogas and compost material also. So, there is but little problem like in the way of Bio-CNG the waste segregation at the source is a big challenge. So, if we can change the behavior of the people and at the source itself we can segregate, this inorganic and organic waste and biodegradable waste, it can help a lot to achieve the targets basically.

So, you can see this plant in Indore, basically it is giving way we can replace basically about 50 percent of our current total diesel usage in the transport sector through Bio-CNG. So, huge scope is there means this is showing a way forward this Bio-CNG plant in Indore.

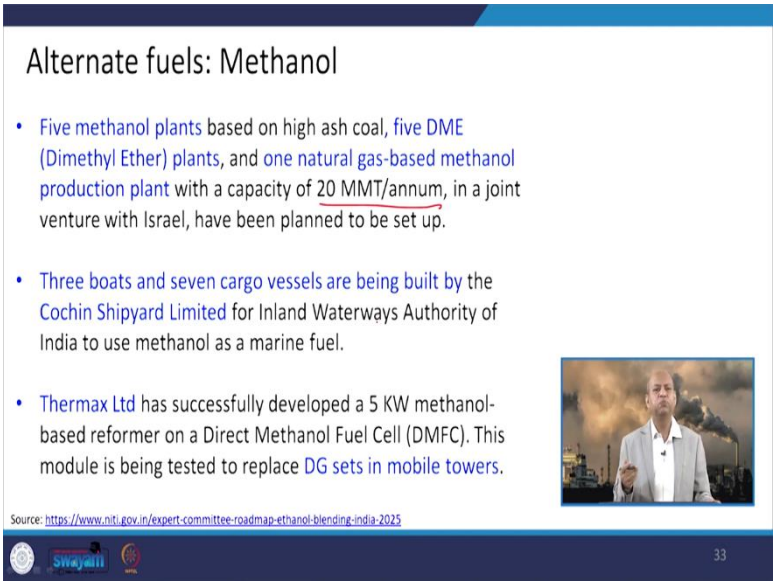
(Refer Slide Time: 26:43)



Then, alternate fuel also include this methanol. So, NITI Aayog's 'Methanol Economy' program is aimed at reducing India's oil import bill as well as reducing greenhouse gas emissions and converting coal reserves and municipal solid waste into methanol. So, this is also one more area where we can go for blending like 15 percent of Methanol in gasoline can bring down greenhouse gas emissions by 20 percent in terms of particulate matter NOx and Sox.

So, that way huge benefits are there we can go for so, we can go in multiple ways means only not one policy can be targeted. But multiple policies and programs can be launched to address those issues.

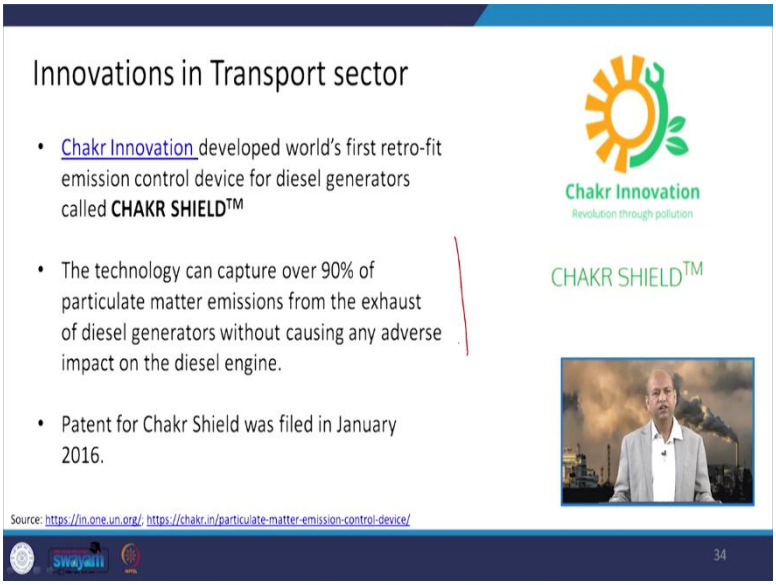
(Refer Slide Time: 27:27)

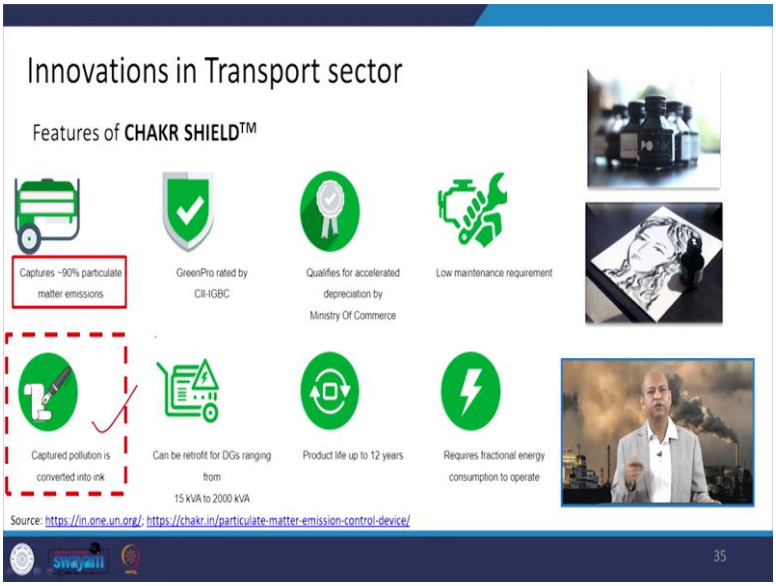


So, there are like in that way five methanol plants have been there and one natural gas based methanol production plant has been there. Which can produce 20 million metric ton per annum in a joint venture with Israel. So, those are in process. Then there are like three boats and seven cargo vessels are being built by this Cochin Shipyard Limited for Inland waterways Authority of India to use methanol as a marine fuel.

So, that way these are new initiatives which are giving new way forward for dealing these situations. Then there is this Thermax Limited which has successfully developed a five kilowatt methanol based reformer on a Direct Methanol Fuel Cell (DMFC). So, this module is being tested to replace the DG sets in mobile towers basically. Because lot of DG sets are there, wherever these mobile towers are there and a lot of fuel is burned but if it can replace them we can say reduction in pollution can be achieved.

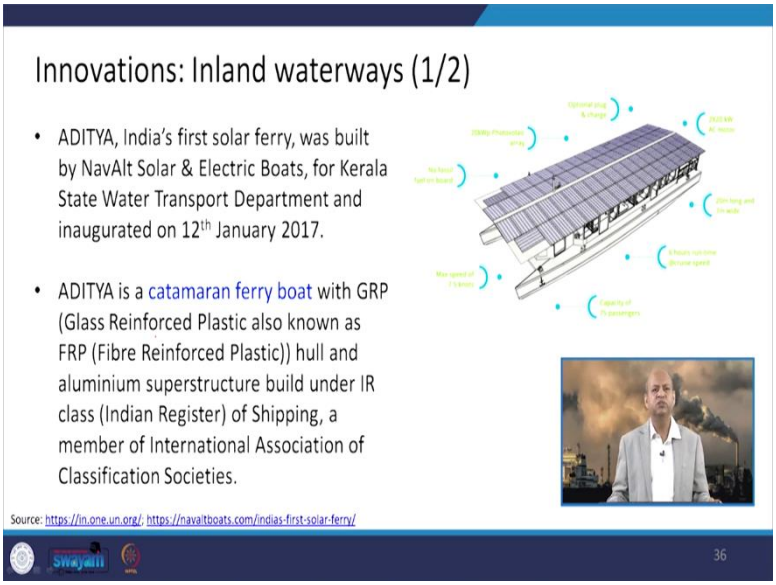
(Refer Slide Time: 28:26)

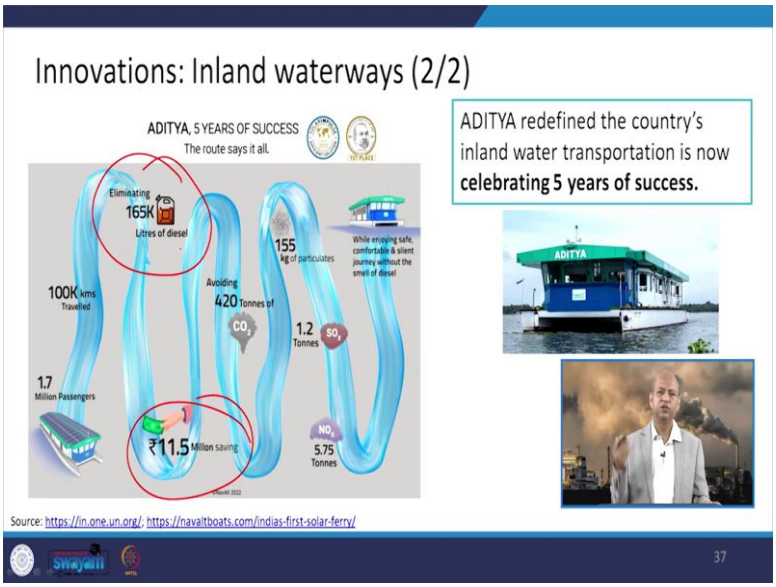




Then there are several innovations also in transport sector like CHAKR innovation is there, which is basically capturing this 90 percent of particulate matter in these diesel engines basically. And then converting those particulate matter into a kind of ink. So, valuable product is being manufactured by reducing the carbon emissions. So, those are the innovations.

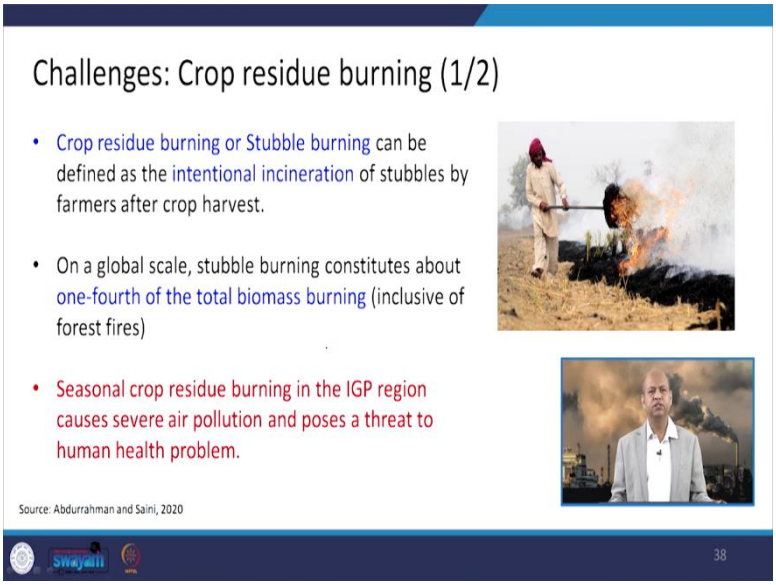
(Refer Slide Time: 28:58)

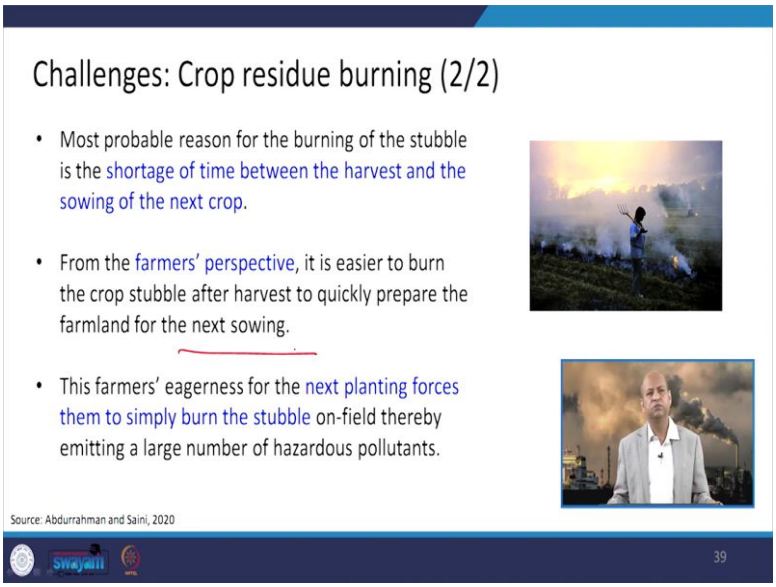




Then there are innovations Inland waterways also like rooftop solar panels are being used in these vessels also. So, that way energy is being produced. So, new innovations, new ways of dealing with these problems are coming day by day and that way you can see these five years success story this ADITYA which was, which is the vessel basically using these solar panels. So, it has like 11.5 million savings and this eliminating 165,000 litres of the diesel basically. So, huge benefits are there in saving fuel as well as reducing emissions.

(Refer Slide Time: 29:44)

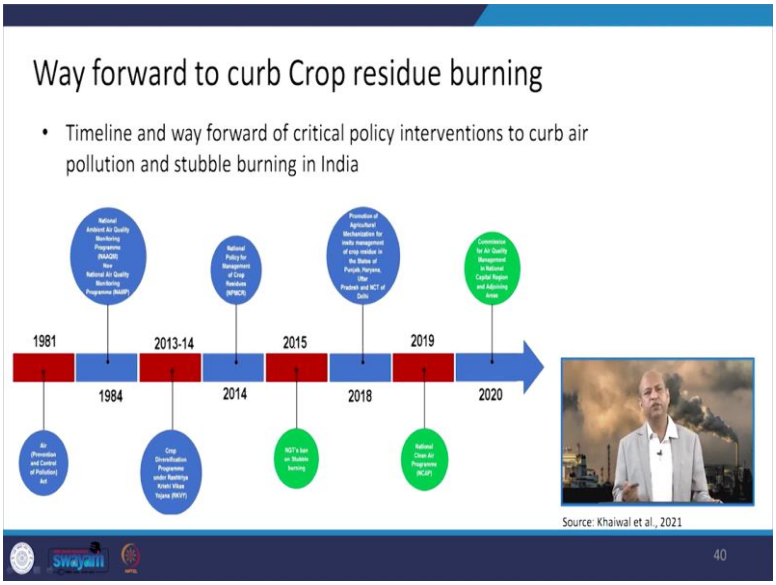


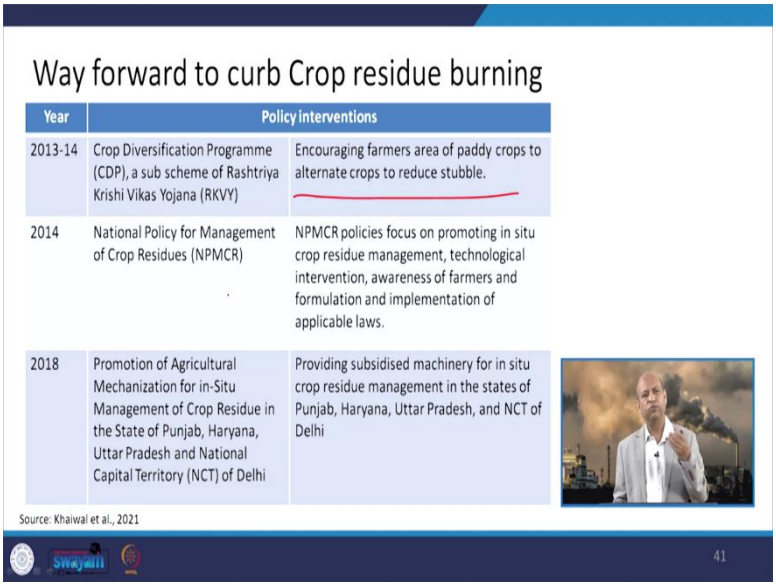


So, you can see means farmers in northern part of the India basically, they want to prepare their land for next sowing purpose. So, they need to burn to quickly dispose of this crop residue. This is one way, easy way for them. But it also causes a lot of air pollution in this at the regional scale basically.

So, this seasonal crop residue burning in this Indo Gangetic plain has been a big problem over the years basically. So, if we can give some solutions for this management of the crop residue that can be a wonderful way of dealing with this problem.

(Refer Slide Time: 30:22)





So, like there have been some policy interventions, which are shown in this particular timeline in terms of technological interventions to convert that crop residue in a valuable product also or dealing with an in other ways. So, there are several way forwards to curb this crop residue burning basically like there is crop diversification program from 2013 to 2014, it has been in place.

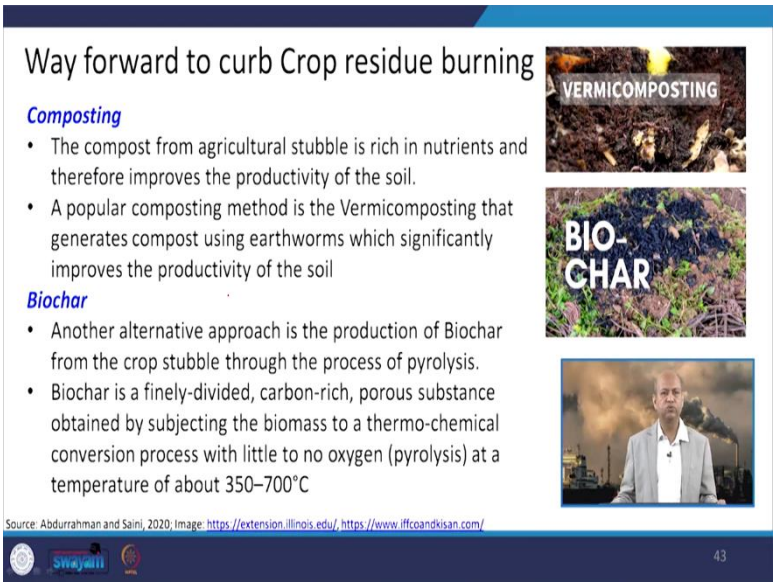
So, sub scheme of this Rashtriya Krishi Vikas Yojana has been there this crop diversification program. This encourages farmers this area of paddy crops to alternate crops to reduce the stubble. So, means a shift from rather than paddy to other crops so, that this kind of problem can be avoided. Then there is the national policy for management of crop residues.

So, they focus on promoting in situ crop residue management or technological intervention and awareness of the farmer so, that they avoid burning rather than converting into them converting into those valuable products.

(Refer Slide Time: 31:30)

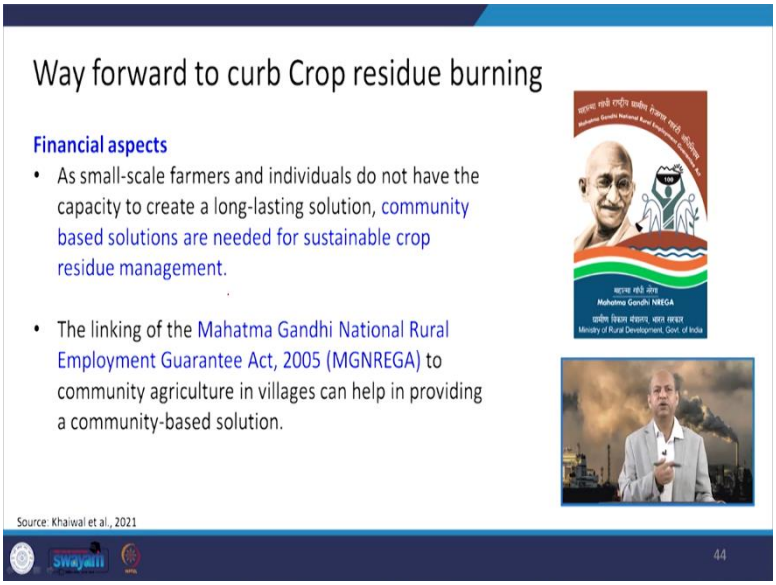
So, there are also technological interventions like happy seeder is there, which can quickly deal with this stubble and it can be converted into proper kind of maneuver and that way.

(Refer Slide Time: 31:44)



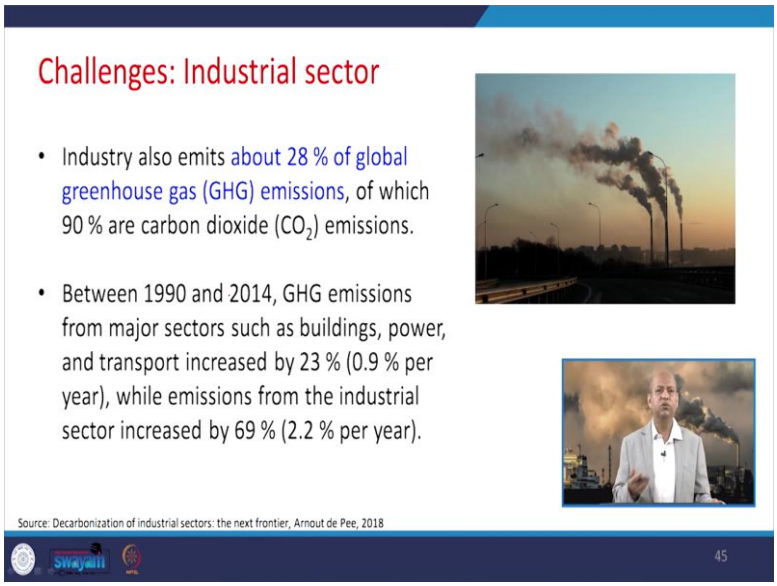
Then there are other ways also like composting is also biochar formation using these crop residues is also one way. But of course, this needs proper collection and then transporting that crop residue. So, challenges are there but possibilities of having these kinds of innovative solutions could deal with the crop residue burning.

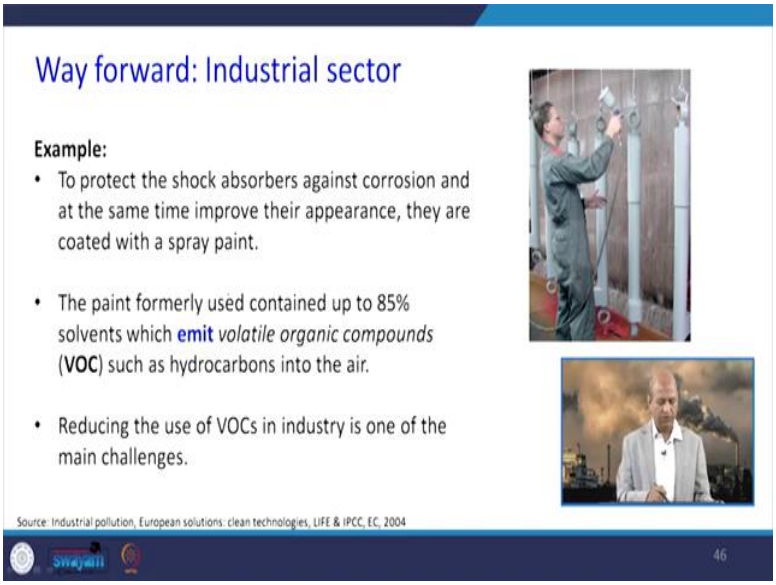
(Refer Slide Time: 32:05)

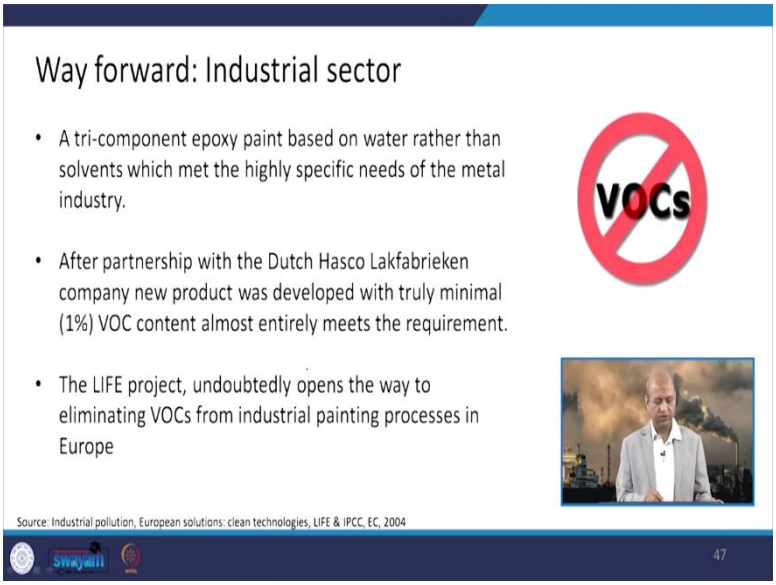


Then financial aspects are also there. So, policymakers and researchers have suggested that maybe with like Mahatma Gandhi National Rural Employment Guarantee scheme is their MGNREGA act is there. So, within that scheme if we promote the community based solutions or community based initiatives where a lot of farmers can join hands to deal with this crop residue burning and using that crop residue in terms of some valuable products. Then we can deal with the, we can avoid the burning of that crop residue.

(Refer Slide Time: 32:44)

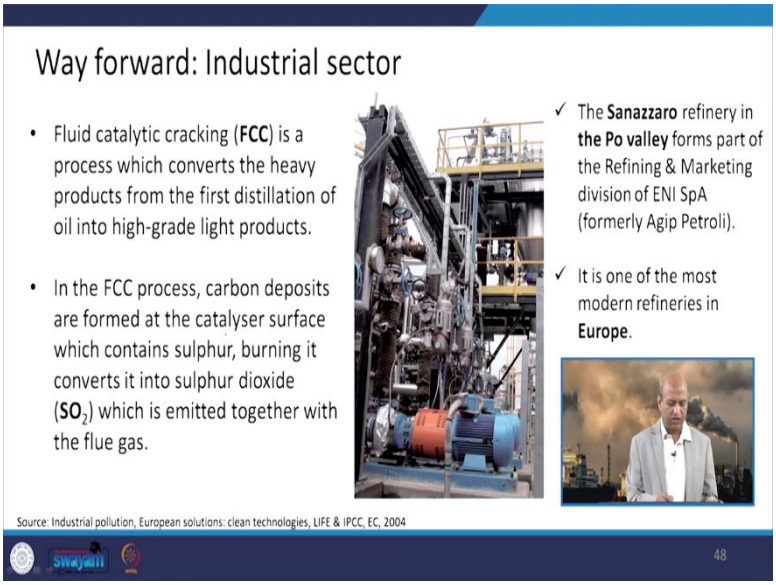


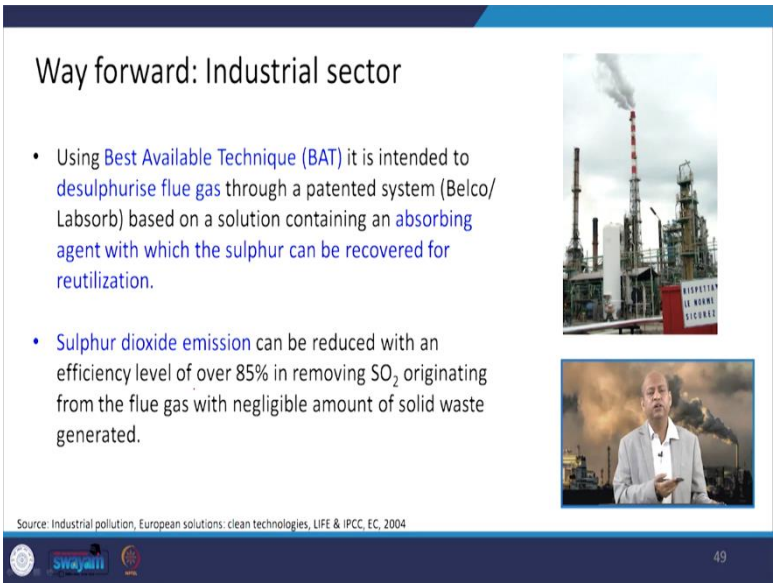




Then there are industrial sectors or other sectors where there are challenges like greenhouse gas emissions are there. So, a lot of solutions are coming in that sector also. For example, removing of the VOCs by some innovative the paints etc are there which emit lots of VOCs but new paints are being promoted which can emit very less amount of the VOC basically. It reduces the VOC industry in because of some other chemical free kind of paints are there which can be used for reducing these emissions of VOCs.

(Refer Slide Time: 33:24)





So, these are ways then there are like reducing of the sulfur there are technologies sulfur emissions can be reduced. And that way SO_2 emissions can be reduced and regional scale that acid rain problem related which is not in India, but in other parts of the globe are there. So, new technologies are coming to dealing with these emissions.

(Refer Slide Time: 33:44)

Way forward: residential and commercial sector

- In rural households of India, indoor air-pollution is associated with the ineffective combustion of biomass (firewood, coal, and dung cakes) due to faulty processing and drying.

- Around 83 % of rural households and almost 20 % of urban households use solid biomass fuels for cooking.

Source: Roy et al., 2020; https://www.downtoearth.org.in; Image: https://www.livemint.com/

50

Way forward: residential and commercial sector

- Inspired by the traditional Indian method of cooking on charcoal, Agnisumukh manufactures commercial kitchen equipment driven by innovative, energy efficient radiant heat gas burners.
- The good side of 'FIRE' is radiant heat that generates Far Infra-red Rays (FIR). FIR is the most potent energy format to transmit heat into the smallest water molecule.
- These waves cook food uniformly without burning and retain maximum moisture in food even after cooking

AGNISUMUKH

Innovate Disrupt Transform

Source: https://in.one.un.org/; https://www.agnisumukh.com/#about

51

Way forward: residential and commercial sector

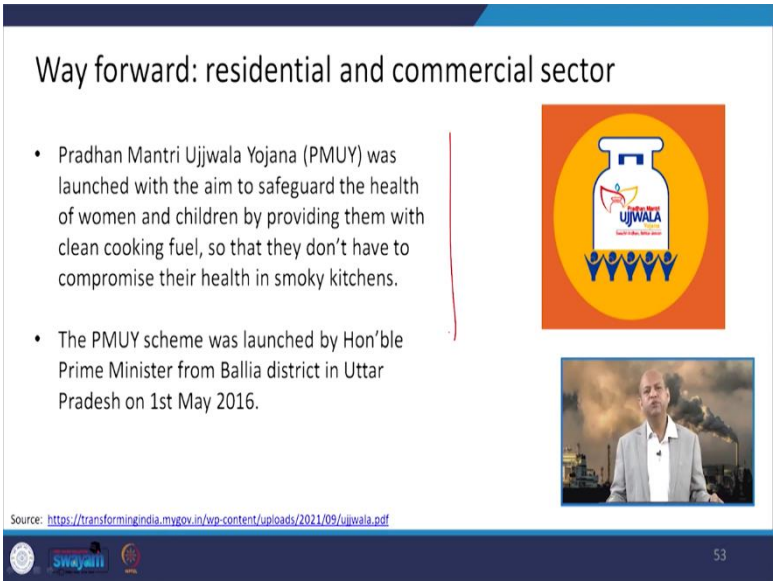
- **Agnisumukh** claims that by implementing the platform we would be decreasing carbon emissions by 10 million tonnes per annum which is equivalent to 50% of India's pledge to bring down the greenhouse gases by year 2020.

OVER 30% LPG SAVINGS ZERO CARBON SOOT EMISSION

- This translates to increasing the Green cover by 45 crore trees. Highest Energy Efficiency in renewable fuel.

Source: https://in.one.un.org/; https://www.agnisumukh.com/#about

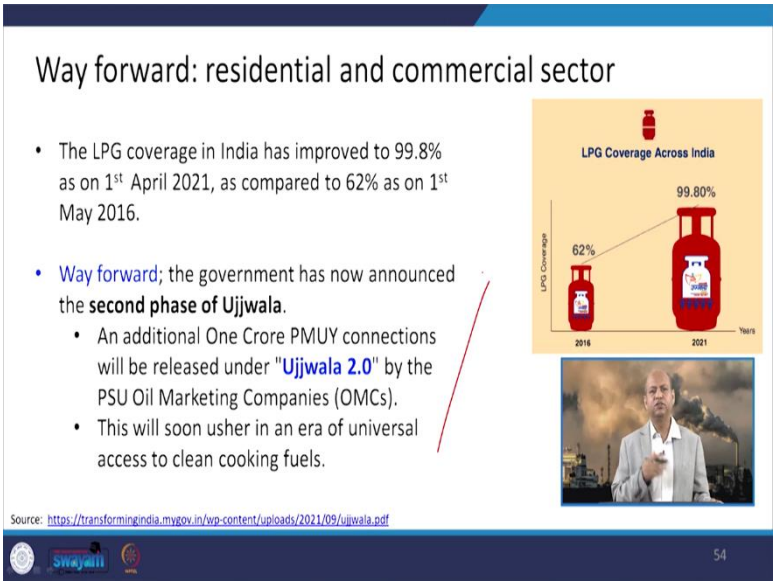
52



Then there are residential and commercial sector related challenges. For example, a lot of people still use bio mass they burn the biomass and to meet their energy needs. So, can we shift from biomass to better cleaning clean fuels. So, like there are this Agnisumukh manufacturing commercial kitchen equipment, which are driving innovative and energy efficient radiant heat gas burners.

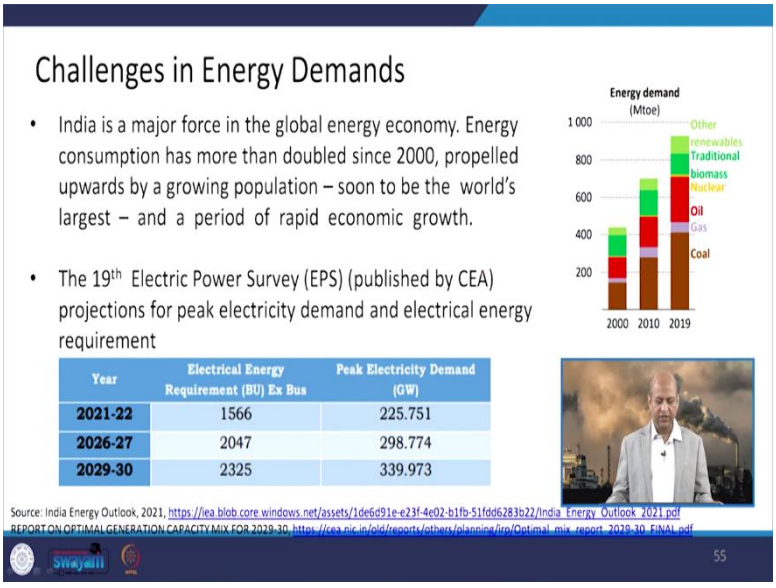
So, that way efficient cooking appliances are also coming there. Plus you can see this particular Yojana or program of government of India, which is Pradhan Mantri Ujjwala Yojana (PMUY). This has also given a big boost in reducing emissions, which are coming from biomass burning because a lot of rural population has been given gas connections. So, the clean fuel if is available then biomass burning is reduced. So, naturally emissions which are coming from biomass burning are greatly reduced in that way.

(Refer Slide Time: 34:46)



So, this is one big program which has been very successful and it has given our rural population to go for the clean energy rather than this polluting energy which is from biomass burning basically.

(Refer Slide Time: 35:03)



Way forward in Energy Demands

In continuing efforts to safeguard the environment and reduce emissions from power sector, India has made the following commitments in COP 21:

- India intends to reduce the emissions intensity of its GDP by 33 to 35 % by 2030 from 2005 level.
- To achieve about 40 % cumulative electric power installed capacity from non-fossil fuel based energy resources by 2030 with the help of transfer of technology and low cost international finance.

Source: India Energy Outlook, 2021, https://iea.blob.core.windows.net/assets/1de6d91e-e23f-4e02-b1fb-51fdd6283b22/India_Energy_Outlook_2021.pdf
REPORT ON OPTIMAL GENERATION CAPACITY MIX FOR 2029-30, https://cea.nic.in/old/reports/others/planning/irp/Optimal_mix_report_2029-30_FINAL.pdf

Way forward in Energy Demands

Promoting Renewable - Moving towards net zero carbon

- In order minimize the carbon footprints of mining and to progress towards the goal of net zero carbon emission, coal/lignite companies are keen on promoting renewable energy.
- Coal companies are going for both roof top solar and ground mounted solar projects. It has also been envisaged to develop solar parks in some of the reclaimed mining areas.

Source: https://coal.gov.in/en/sustainable-development-cell/promoting-renewable

Way forward in Energy Demands: Notable renewable projects

Neyveli Lignite Corporation India Limited (NLCIL): Solar Power Panel in Ramanathapuram District, **Tamil Nadu**

NLCIL : Wind Mill in Kazhuneerkulam, Tirunelveli District, **Tamil Nadu**

400 KWp Rooftop Solar Installation in Central Coalfields Limited (CCL), Ranchi, **Jharkhand**

60 kWP installed on rooftop in Ballarpur Area Office, Western Coalfields Limited (WCL), **Maharashtra**

Singareni Collieries Company Limited (SCCL): Solar Power Plant at Manuguru (30 MW), **Telangana**

Source: https://coal.gov.in/en/sustainable-development-cell/promoting-renewable

Then energy demands related challenges are also there and a lot of policies are coming like solar related or some other electric power generation from renewable resources. So, a lot of focus is there basically, in meeting those energy demands. We can say this net zero carbon related the policies there after certain decades we want to go for net zero carbon emissions.

So, that way huge shift is demand or huge shift is needed from fossil fuel based energy products into renewable resources based energy production. Example is there like notable renewable projects have been with large scale projects have been implemented in India like in Tamil Nadu this solar power panel, big plant is there in again Tamil Nadu at another place, windmill has been there in Rajasthan in Jaisalmer a lot of windmills have come then this 400 kilo watt power rooftop solar installation in central coalfields limited in Jharkhand has been implemented. Similarly, in Telangana, Maharashtra, huge plants are coming to generate energy from the solar power plants.

(Refer Slide Time: 36:20)

1. Mexico city (1/2)

Special paint gives Mexican murals super powers

- Mexico City may be infamous for its smog but it's also renowned for its **murals**, and now the two have come together in a startlingly innovative way.
- The **Absolut Street Trees** initiative involves artists painting giant murals in the city using **Airlite** paint, which purifies polluted air in a process similar to photosynthesis.

The "**Absolut Street Trees**" murals can be found on buildings in the neighborhoods of Cuauhtémoc, Juarez and Roma in Mexico.

Source: https://www.unep.org/news-and-stories/story/business-unusual-four-innovations-clear-air, Image: https://www.telesurenglish.net

1. Mexico city (2/2)

Special paint gives Mexican murals super powers

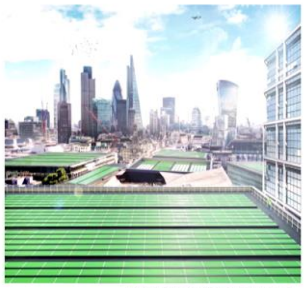
- Airlite copies nature to break down pollutants the paint acting as a catalyst, rather than absorbing or filtering them out.
  - ✓ Actively breaks down NO_2 to purify the air by reducing pollution and toxins.
  - ✓ Contains no VOCs (respirable irritants).
  - ✓ Prohibits mould growth, thereby reducing airborne spores and allergens.
  - ✓ The paint lasts about 10 years.

Source: https://www.bouygues-es.co.uk/buildings/airlite-paint-purifies-air ; Image: https://www.republicworld.com

2. London city

BioSolar Leaf

- Scientists at Imperial College, London are collaborating with start-up Arborea on the world's first BioSolar Leaf—large panels covered with tiny plants that wash up carbon dioxide and release oxygen at a rate equivalent to 100 trees from the surface area of a single tree.

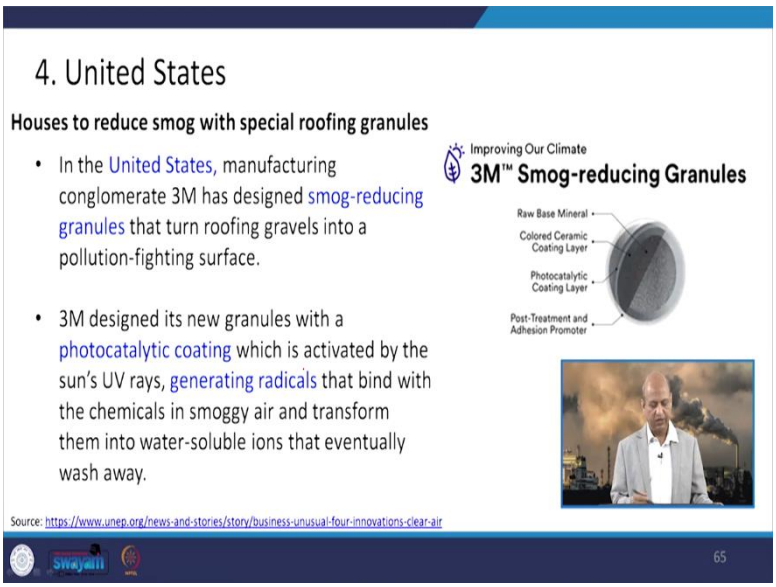


BioSolar leaf. Photo by Arborea

Source: https://www.unep.org/news-and-stories/story/business-unusual-four-innovations-clear-air

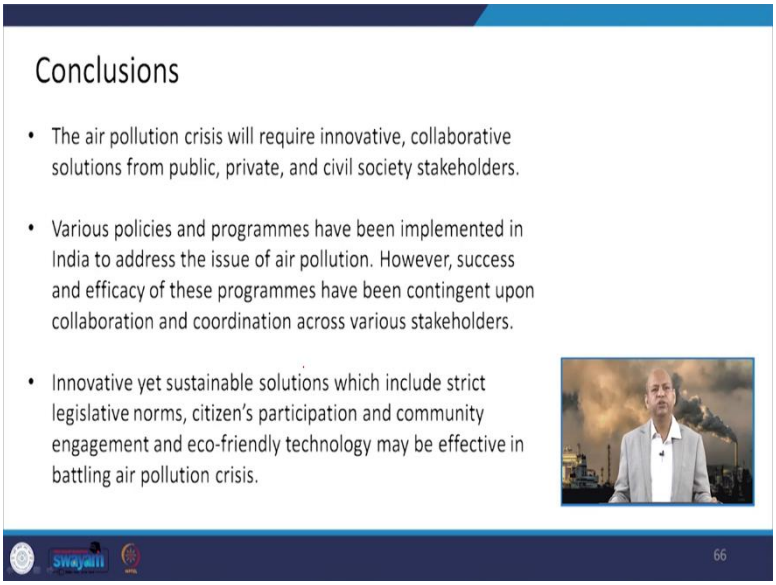
Then new innovative technologies are also coming to curb their pollution around the world. Like in Mexico City special mural painting has been promoted which absorbs pollution, Biosolar leaf, City tree or special roofing granules you can see these murals which are using certain paint which can absorb the air pollutants. So, antipollution, gravity's popular nowadays in Mexico City. Biosolar leaf is also one technology large panels which are like they are producing energy with this new kind of solar panels.

(Refer Slide Time: 36:56)



Then in Germany City tree is one technology, where they are using these kind of moss cultures, which can absorb a lot of particulate matter and nitrogen oxides basically. So, that way improvement in air quality can be achieved. In United States again, the smog reducing granules are promoted by a company which can reduce the smog formation kind of pollutants.

(Refer Slide Time: 37:23)

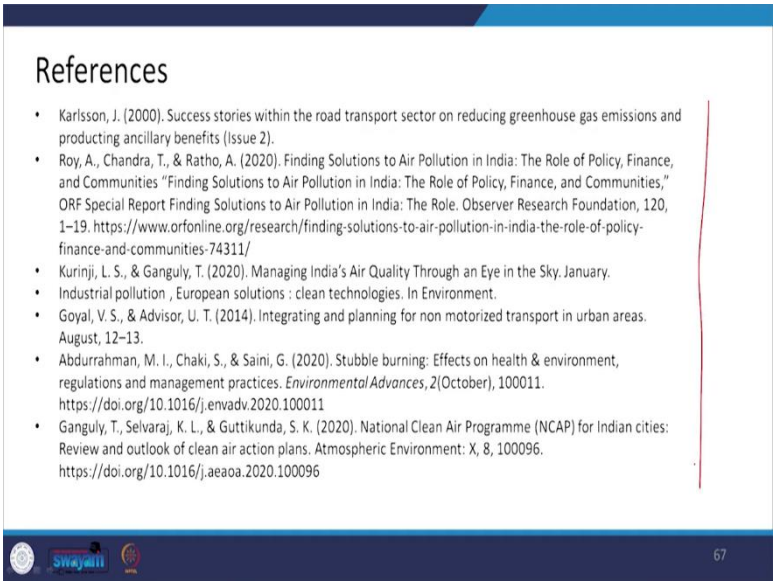


So, in conclusion, we can say that of course there are a lot of challenges still to reduce the air pollution emissions. But new innovative technologies are coming, new innovative programs are implemented by several countries. And in India, basically we are shifting from fossil fuel based economy to renewable energy based economy that is a big program and like E mobility and there are other ways which are coming up in a big way to reduce the air pollution emissions.

So, that way we can say that awareness of public is also needed. So, that they can shift from quickly from those polluting kind of technologies to non-polluting kind of technologies and also like sifting from fossil fuel based transportation to non-motorized transportation (NMT). All these need infrastructure facilities as well as public awareness. So, so many innovations are coming and that way we can deal with the challenges.

So, in conclusion, we can say that challenges are there but innovative solutions are also there. And you can also think means everybody has a creativity and innovative attitude if they can apply they can come up with new solutions. So, this is all for today. So, to deal with the challenges let us come with the innovative solutions to put forward the new ways of dealing with the air pollution emissions and to improve the air quality.

(Refer Slide Time: 38:56)



So, this is all for today, these are the references where we have taken information you can go through at leisure to these references to have more information on a particular topic. So, thank you for your kind attention. See you in the next lecture. Thanks again.