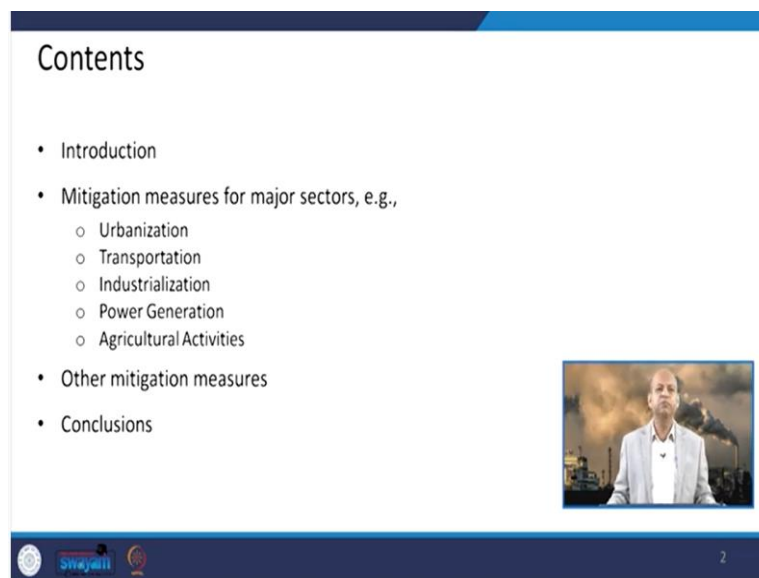


**Air Pollution and Control**  
**Professor Bhola Ram Gurjar**  
**Department of Civil Engineering**  
**Indian Institute of Technology Roorkee**  
**Lecture 53**

**Sector Wise Mitigation Measures to Control Air Pollution**

Hello, friends. So, you may recall so far we have discussed so many issues about air pollution and its control like policies then specific control to sources. Today we will discuss the sector wise mitigation measures to control air pollution means, broadly speaking, what are the mitigation measures which can be implemented to a specific sector.

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For example, urbanization sector or transportation sector those kinds of things we will today discuss. So, the mitigation measures for major sectors which have been included in this particular lecture are like urban centers or in urbanization what kind of things we should take care so, that emissions are less and air quality is better, than transportation sector related emissions, how to control or how to deal with it, then industrialization, power generation, agricultural activities, then some other mitigation measures and then we will conclude.

So, basically, like in power generation, we have seen the ESPs etc. or baghouse filters, but today we will see the complete sectors related policies and mitigation measures basically, policies, programs and mitigation measures. So, what are those mitigation measures or the strategies which can be implemented in an overall sector?

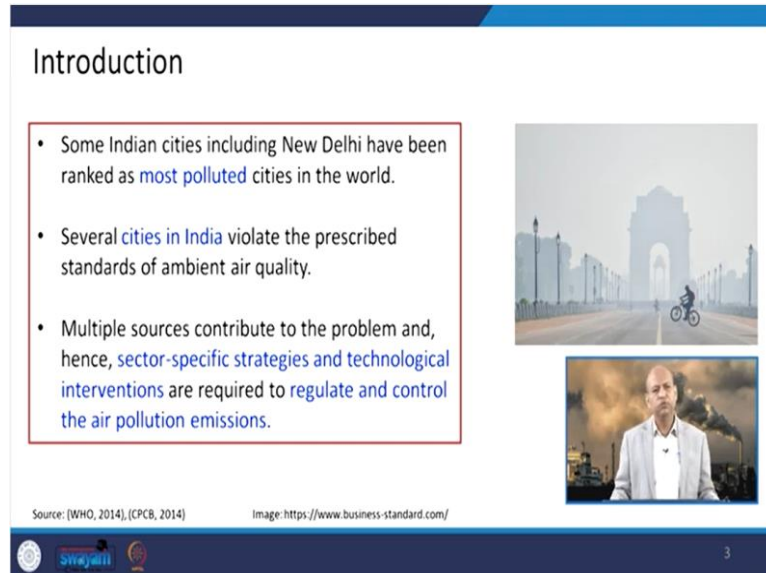
So, that is today's focus means, you should not get confusion, like we have discussed several other control mechanisms already, but today we will see the sector specific broadly mitigation

measures. So, that way you will have a holistic viewpoint about these sectors and their mitigation measures.

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### Introduction

- Some Indian cities including New Delhi have been ranked as **most polluted** cities in the world.
- Several **cities in India** violate the prescribed standards of ambient air quality.
- Multiple sources contribute to the problem and, hence, **sector-specific strategies and technological interventions** are required to **regulate and control the air pollution emissions**.




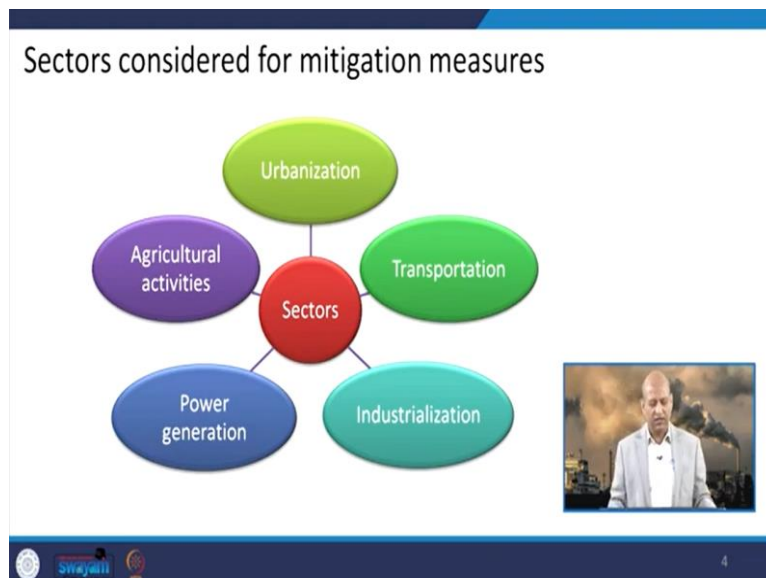
Source: [WHO, 2014], [CPCB, 2014]      Image: <https://www.business-standard.com/>

3

So, when we talk about like Indian cities, in recent reports and even for several years, we have been seeing that some of the Indian cities are figured out as most polluted cities in the world and several Indian cities violate those standards of ambient air quality which are prescribed by CPCB or MoEF and the multiple sources contribute to the problem of air pollution.

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### Sectors considered for mitigation measures



4

Therefore, the sector specific strategies and technological interventions are required to regulate and control the air pollution emissions in overall sense basically. So, the sector's which have



been considered in today's lecture for mitigation measures, are like urbanization, transportation, industrialization, power generation and agricultural activities.

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Sector-wise mitigation measures: Urbanization (1/8)

❖ City planning and management

- Adopting a balanced sub-regional approach for regional and metropolitan development with integration of mass transit is found to be helpful in reducing trip lengths, motorized travel, and urban sprawl.
- Landuse planning with plans of reduced population density around industrial zones or in downwind direction can help in reducing exposure to the pollutants released from industries.



Source: TERI Report, 2018  
Image: <https://www.eltis.org/>

5

So, let us start with urbanization. So, when we talk about city planning and management focusing on city planning. So, when we adopt a balanced sub regional approach for regional and metropolitan development with integrated mass transit, you might have heard TOD, this term is Transit Oriented Development. So, when we have these kind of integrated mass transit systems, then it has been observed there these are the systems which are helpful in reducing the trip lengths as well as motorized travel and urban sprawl is reduced basically. So, that emissions are also reduced ultimately.


Well, land use planning with plans of reduced population density around industrial areas or industrial zones or in downwind direction of those industrial zones can help in reducing exposure to the pollution released by industries. So, we have to be careful that the population should not be in and around the industrial zones or in the downwind direction, because the pollution emissions will travel to the downwind directions.

So, when we talk about like supply of cleaner fuels, in the stoves, which are used in rural areas and urban slums, I am sure you might be knowing that in the rural areas, a lot of dung and woods etc are used for cooking purposes and they emit lot of smoke, lot of air pollution.

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### Sector-wise mitigation measures: Urbanization (2/8)

- ❖ Supply of cleaner fuels, stoves to rural areas and urban slums
- Government schemes (Pradhan Mantri Ujjwala Yojana) designed to increase LPG access across India have successfully enhanced the use of clean fuel in rural and urban areas.
- There is a need for more efficient use of biomass as a cooking fuel (higher calorific value and less smoke) through the improved stoves with efficiencies ranging between 30 and 40 % as compared to 8 and 10 % of traditional cook stoves.



Source: [www.teriin.org/article/air-pollution-india-major-issues-and-challenges](http://www.teriin.org/article/air-pollution-india-major-issues-and-challenges), TERI Report, 2018

Image: <https://csrbox.org/>

6



So, the government schemes like Pradhan Mantri Ujjwala Yojana these schemes have been designed to increase the LPG access across India to the poor people also and this has successfully enhanced the use of clean fuel in rural as well as urban areas in urban slums especially those are the poor segment of the population. So, it has resulted in very less of air pollution emissions, that way the indoor air quality has been improved.

Also, the energy has this, the total energy utilization has increased and when we go for usage of biomass, or biofuels or biomass as a fuel, then we have to see what kind of cooking stoves we are using. Basically, the traditional way of cooking they are using only to 8 to 10 percent of that, this energy which is available in the biomass. So, to enhance that efficiency, we have to have better efficient stoves and Nirdhum Chulha those kinds of terminology you might have heard, so, that we can have less smoke or less pollution in the household activities.

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### Sector-wise mitigation measures: Urbanization (3/8)

- ❖ **Solar lighting options to rural areas and urban slums**
  - For lighting, 7 per cent urban households still use kerosene in India.
  - Solar lanterns need to be promoted to households in urban slums and rural un-electrified regions that use kerosene (for lighting).
  - More programmes to generate awareness are needed to increase adoption of simple household level measures such as improved ventilation and selection of cleaner traditional fuels.



Source: (Census 2011), TERI Report, 2018  
Image: <https://www.indiamart.com/>

7



Well, when we talk about solar lighting options to rural areas and urban slums, then for lighting purposes around still 7 percent of the urban households using kerosene in India for lighting purposes. I recall that in my childhood in whole village, we did not have the electricity. So, these kerosene lamps used to be used for lighting purposes, but slowly this development phenomena has gone to the rural areas also. So, a lot of change has been there.

Now, solar lanterns or they are needed for promoting the households in urban slums, in urban and unelectrified regions. So, these solar lanterns are becoming very popular, because you can charge during the daytime and in the nighttime you can use and these kind of solar lanterns are there.

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### Sector-wise mitigation measures: Urbanization (5/8)

- ❖ **Enforcement of complete ban on refuse burning**
  - Ban on refuse burning needs to be strictly enforced with substantial penalties on non-adherence.
  - State pollution control boards in collaboration with City Corporations can develop a mobile application for bringing any major refuse burning event to notice in a region.
  - State governments need to set up winter shelters with heating arrangements for homeless people.



Source: TERI Report, 2018  
Image: <https://www.istockphoto.com/>

9

So, the next is like in urbanization, in urban areas, if we can enforce strictly the complete ban on refuse burning, then also we can improve air quality because this is a very bad habit, many people just collect the refuse or the waste material and they just burn it rather than disposing at the proper place. So, the burning the refuse, this refuse burning needs to be strictly enforced with the substantial like penalties or non-adherence. So, the implementation is very important.

Then, for that purpose like State Pollution Control Boards, in collaboration with city corporations can develop some mobile apps nowadays, this digital age, mobile apps are quite popular, and so that people can bring in these major refuse burning events to notice for particular people in a particular region. And that community can be sensitized about these kinds of activities.


And these state governments, they need to set up winter shelters with the heating arrangements for homeless people otherwise, the people who are roaming around or they do not have proper homes, they have to warm up themselves by burning these waste materials here and there and a lot of air quality deterioration occurs because of that. So, it is our responsibility that we should as this urban local bodies or government, they should provide them some shelters.

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Sector-wise mitigation measures: **Urbanization** (6/8)

❖ **Waste to energy options**

- With proper segregation of high calorific value non-recyclable and non-biodegradable waste, waste-to-energy options with proper pollution control measures need to be explored on public private partnership mode; initially, on pilot basis and then at larger scales in the cities.



The diagram illustrates the waste-to-energy process. It starts with 'WASTE' (represented by a green bag and a blue bin) which undergoes 'RECOVERY' (indicated by a green arrow). This leads to 'HEAT' (represented by a person sitting by a radiator) and 'FUEL' (represented by a blue diamond). The 'FUEL' is then used to generate 'POWER' (represented by a power plant icon).



A small video inset shows a man in a white shirt speaking, likely presenting the content of the slide.

Source: TERI Report, 2018  
Image: <https://www.ecomena.org/wte-pathways/>

10

Then we talk about like waste to energy options. So, you might have heard like waste to wealth or waste to energy. So, the proper segregation of high calorific value materials and non-recyclable and non-biodegradable waste can be burnt basically, which have high calorific value, but that is the condition. So, waste to energy option can be utilized in that sense.

And it needs to be explored on public private partnership mode, initially on pilot basis and then it can be applied at the larger scale at the city levels. So, that means, the segregation is very important and like I recall, in Germany when I was doing postdoc, there is lot of segregation of the waste like these papers, newspapers will go in a different bin and this kitchen waste will go differently and bottles or toxic waste will go differently, though all those kinds of things are there, plastic will go in different bin so, that segregation at the source itself happens.

So, that way we can take the things like recyclable things can go to recycle flowchart or those are like for composting purpose, biodegradable things can go to those places where this anaerobic digestion occurs and like papers or some waste material, which has high calorific value, but they are not recyclable in a proper way, then they can be burned and you can have this steam, you can generate the steam and through steam you can generate the electricity, there are such plants in developed countries and they are using their cities waste for generating lots of energy.



Like in Sweden there is a Linköping city, the whole city this public transport system is running through this biogas they are generating from slaughterhouse, related waste and other biodegradable waste. And those waste which has high calorific value, which is not biodegradable then they take it and they burn and then they generate steam. So, steam is used for running turbines, electricity is produced and then the hot water is circulated in entire city for warming up their houses because in Sweden a lot of cold seasons are very long and that way they use this hidden energy.

And our country which are energy deficit and we have so much waste, but because we do not have proper segregation and that is the reason we are not segregating the calorific value related waste from biodegradable waste and other recyclable waste and all things are mixed and then it becomes very difficult to recycle them or to go for converge into energy.

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### Sector-wise mitigation measures: Urbanization (7/8)

- ❖ **Maintaining quality and cleanliness of roads**
  - Maintenance of roads can be ensured with the use of mobile applications to spot and inform irregularities.
  - Vacuum cleaning devices can be used for regular and efficient road sweeping.
  - Unpaved roads need to be paved and, if not possible, they can be covered with gravel and maintained on annual basis.



Source: TERI Report, 2018  
Image: <https://www.dailyioneer.com/>




11

Well, then we come to this maintaining quality and cleanliness of roads. So, we can have better mechanism like this, nowadays vacuum cleaning devices are there which can be used and several cities are using these kinds of devices nowadays, unpaved roads need to be paved because otherwise resuspension of dust occurs, and then we can cover them with gravel or maintain, we can maintain them on annual basis so, that this dust pollution is significantly reduced.

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### Sector-wise mitigation measures: Urbanization (8/8)

- ❖ **Dust control at construction sites**
  - Usage of trees and shrubs as wind barriers to control dust emissions.
  - Enhancing moisture content at the construction site.
  - Fogging systems could also be used to trap dust particles.
  - Pre-fabricated material can be used at construction site to minimize activities such as cutting, grinding, and drilling in an open area.



Source: TERI Report, 2018  
Image: <https://www.vectorstock.com/>, <https://www.brumstyi.com/>

12

Then another way of controlling the dust from these construction sites could be like using trees or shrubs or wind barriers to control the dust emissions here and there and fogging system is also sometimes used for trapping the dust particles. Then there is also one possibility that if we



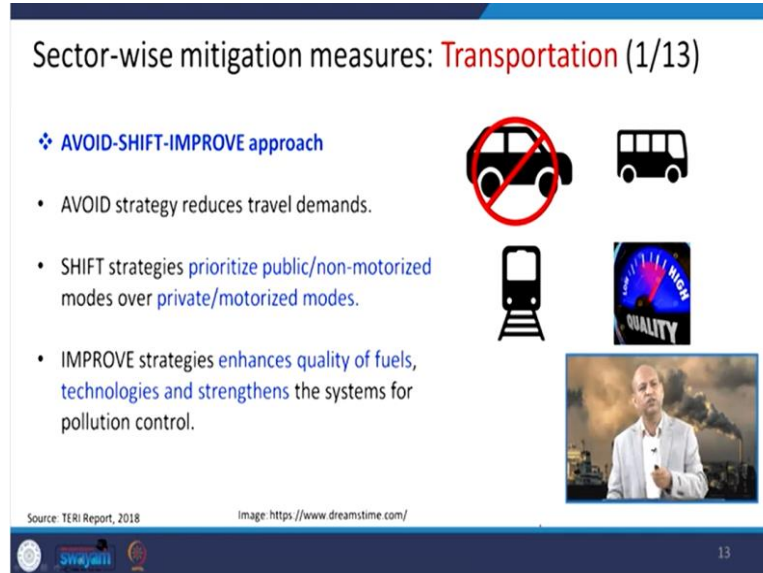
use prefabricated material rather than constructing in-situ then also we can avoid lot of dust emissions basically.

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Sector-wise mitigation measures: **Transportation** (1/13)

❖ **AVOID-SHIFT-IMPROVE** approach

- AVOID strategy reduces travel demands.
- SHIFT strategies prioritize public/non-motorized modes over private/motorized modes.
- IMPROVE strategies enhances quality of fuels, technologies and strengthens the systems for pollution control.



Source: TERI Report, 2018  
Image: <https://www.dreamstime.com/>

13

Then, there is another way of for transportation if we talk like we have discussed all those measures, mitigation measures, which are city focused or urban areas focused, if we focus on the transportation sector, then the first thing comes like AVOID, SHIFT and IMPROVE. So, this very thumb rule of AVOID, SHIFT, IMPROVE is like we should not unnecessarily travel, whatever things we can do through telephone or other ways of communication rather than going somewhere that should be done like that only.


So, we can reduce the travel demands basically, then we can also shift from private or motorized modes to public transportation or non-motorized modes of transportation so, that we also gain per capita emissions reduce very much. Then we can improve the strategies to enhance the quality of fuels or technologies and like we will discuss like BS-IV, BS-VI those kinds of quality of fuels and technologies like two stroke to four stroke engine those kinds of things, we can always go for innovation and improvement in the technology.

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### Sector-wise mitigation measures: **Transportation** (2/13)

❖ **Travel Demand Management (TDM)**

- Ministry of Urban Development has suggested planning and implementing travel demand management (TDM) measures as part of Comprehensive Mobility Plans in India.
- Vehicle ownership controls can be implemented through vehicle quota systems and taxes and insurances.
- Vehicle usage controls in the form of road space rationing (alternate-day travel or driving restriction or no-drive days), congestion pricing, parking management etc.



Source: TERI Report, 2018  
Image: <https://www.deccanherald.com/>, <https://www.indiamart.com/>

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When we talk about Travel Demand Management, TDM then basically this ministry of urban development has suggested planning and implementing travel demand management system. These measures as part of the comprehensive mobility plans in India. And the vehicle ownership, control can be implemented through vehicle quota system and taxes and insurances. Like if you are having vehicle and if you want to buy more vehicle, more number of vehicles, then there should be some sort of policy so that ownership of vehicle does not go just without any control. So, there are other ways also like vehicle use control can also be in the form of road space rationing, you can have congestion pricing or parking management or high price for parking at the those critical zones, where there are chances that more traffic may rush to that particular location. So, that way a smooth movement of traffic can be management.

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Sector-wise mitigation measures: **Transportation** (3/13)

❖ **Public Transportation**

- Use of public transportation can lead to 90-95% reduction in emissions of CO, VOCs and 50% reduction in CO<sub>2</sub> and NO<sub>x</sub> emissions.
- Need to enhance the public transportation system to shift people from private modes.



Source: TERI Report, 2018      Image: <https://www.trafficechnologytoday.com>

15



Then the public transportation, the use of public transportation can lead to 90 to 95 percent reduction of emissions of carbon monoxide and VOCs it has been studied and 50 percent reduction in CO<sub>2</sub> and NO<sub>x</sub> emissions. So, that way great benefits are there, if we can shift to the public transportation system, but people can have incentive to shift towards public transportation system, when it is reliable in time we can have it and then comfort level is also there or wherever we want to go there some connectivity is there. If there is no connectivity, then people will not feel encouraged to use the public transportation system.

Well, we also need to enhance the public transportation system to shift people from their private modes, but that is just when only when this public transportation system will provide the comfort, high comfort level journey and reliability and punctuality all those kinds of things are there.

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### Sector-wise mitigation measures: **Transportation** (4/13)

- ❖ **Non-Motorized Transport (NMT)**
  - Non-motorized modes of transport are **non-polluting modes of transport**.
  - NMT exclusive lanes should be complemented by **good shade, bike parking facilities, road crossing priorities, etc.**
  - **Cycling in Indian cities need to be encouraged**, as available in cities such as Paris, Copenhagen, Amsterdam, London, etc.



Source: TERI Report, 2018      Image: <https://indianexpress.com/>

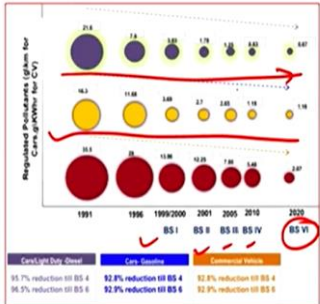
16

Well, the non-motorized transport system promotion can also be there basically, because it is not emitting any kind of emissions. So, for shorter distances also, when, if we have good infrastructure dedicated lanes for cyclists or pedestrians then people feel motivated otherwise it is difficult to walk on the road where all kinds of traffic is there.

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### Sector-wise mitigation measures: **Transportation** (5/13)

- ❖ **Fuel quality and Vehicle emission norms (1/2)**
  - Auto Fuel Policy in 2003 by GOI laid the roadmap for introduction of **cleaner fuels and vehicles**.
  - By 2010, 13 cities moved to **BS-IV norms**.
  - Auto Fuel Vision committee set up in 2013 to recommend future roadmap for advancement on **BS-IV standards**.



Vehicle Category	BS-I	BS-II	BS-III	BS-IV	BS-VI
Cars Light Duty Diesel (g/km)	20.4	18.0	15.0	12.0	8.0
Cars Gasoline (g/km)	14.3	11.8	9.8	7.8	5.8
Commercial Vehicles (g/kWh)	10.0	8.0	6.0	4.0	2.0

Concentration of regulated pollutants for Cars Light Duty Diesel vehicles (g/km)

Concentration of regulated pollutants for Cars Gasoline vehicles (g/km)

Concentration of regulated pollutants for Commercial vehicles (g/kWh)

Source: B. Sen Gupta, 2018, TERI Report, 2018

17

Then if we talk about like fuel quality and vehicle emission norms, then over the years this like BS-I, BS-II, BS-III, BS-IV and now BS-VI we have jumped from BS-IV to BS-VI. So, that way these concentration of regulated pollutants from commercial vehicles it has decreased so significantly and from regulated pollutants, from cars and gasoline vehicles, it has also reduced and cars light duty diesel vehicles, it has also reduced.


So, over the years basically emission norms have been better in terms of BS-I to BS-IV and now BS-VI. So, that way, emissions are decreasing, but the number of vehicles are increasing that is the problem. So, the total emission grow day by day when population also grow in the city centers.

And if you look into perspective of the policy related timeline, then the auto policy in 2003 by Government of India laid the roadmap for introduction of cleaner fuels, and by 2010, 13 cities moved to BS-IV norms, that was within 7 years it was achieved. An auto fuel vision committee set up 2030 to recommend future roadmap for advancement on BS-IV standards.

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**Sector-wise mitigation measures: Transportation (6/13)**

- ❖ **Fuel quality and Vehicle emission norms (2/2)**
  - Ministry of Road Transport and Highways (MoRTH) decided to move directly from BS-IV to BS-VI emission standards by 2020.
  - This is an important move as it can reduce vehicular PM emissions to lowest possible levels i.e. reduction of 55 % in 2030 with respect to BAU (business as usual) scenario.
  - Use of bioethanol and compressed natural gas (CNG) as alternative fuel.



Bioethanol is a renewable fuel because it is produced from biomass. Ethanol also burns more cleanly and completely than gasoline or diesel fuel. Ethanol reduces greenhouse gas (GHG) emissions because the grain or other biomass used to make the ethanol absorbs carbon dioxide as it grows.

Source: Sharma et al 2014, ERI Report, 2018  
Image: www.javatpoint.com, www.shutterstock.com

18

And now, like this Ministry of Road Transport and Highways has decided to move directly from BS-IV to BS-VI and it is already implemented in 2020. So, this is a great leapfrog or achievement in that sense. And we can say that because of this lot of reduction of emissions will occur.

Basically, this is an important move because it is estimated that it will be able to reduce vehicle this particulate emissions from vehicle segment to the lowest possible levels like 55 percent in 2030 with respect to this business-as-usual scenario. And if technology grows, then more emissions will be reduced.

The use of bio-ethanol and this compressed natural gas promotion is also in the plate of our government policies as alternate fuels and this bioethanol is a renewable fuel because it is produced from the biomass and ethanol also burns more cleanly and completely then gasoline or diesel that means, complete combustion process occurs in this bio-ethanol more quickly



basically. And this is also possible to reduce greenhouse gas emissions, if you blend it with the conventional fuels.

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Sector-wise mitigation measures: **Transportation** (7/13)

❖ **Inspection and Maintenance programme (I&M)**

- Current I&M mechanism in India is not fool-proof and allows pass-through without proper testing.
- The purpose of the in-use vehicle compliance programme (IVCP) is to test in-use vehicles to see if they meet the original emission standards.
- Essential to **strengthen the inspection** procedure to address the risk of high emitters due to lack of **proper maintenance**.



Source: TERI Report, 2018

19



Well, then, we talk about inspection and maintenance programs, which is, if we do not maintain our vehicle, then they emit lot of emissions. If we keep on doing regular maintenance, and that way we can keep the vehicle fit and it emits less.

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Sector-wise mitigation measures: **Transportation** (8/13)

❖ **Congestion (1/2)**

- **Odd-Even schemes** may be considered.
- **Traffic signal improvements** can be made through equipment upgradation, timing plan improvements, signal coordination and interconnection, and, in some cases, by signal removal, depending on intersection characteristics.
- Converting **two-way traffic to one-way traffic** and imposing **left/right turn restrictions** on two-way streets.



Source: TERI Report, 2018  
Image: <https://urbanemissions.blogspot.com>

20

Then there are other ways like we can go for odd-even scheme so, that traffic is less in number on the roads, but it also has some other issues linked with it, because sometimes people need and then they use their old vehicle with the other number plate which is even or odd as per the

need and rather than reducing the emission it can increase. So, it can backfire also, so, we have to implement these kinds of schemes very smartly or with the proper care.




Well, then there are other ways like converting two-way traffic to one way traffic and imposing left right related turn restrictions on two-way streets so that this traffic movement is very smooth and when traffic movement is smooth and at higher speed then emissions are lower, when we apply a lot of brakes and the speed is slow, then lot of emissions occur and that deteriorate the air quality.

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Sector-wise mitigation measures: **Transportation** (9/13)

❖ **Congestion (2/2)**

- Incident management systems should also be implemented to manage traffic during any incident such as accidents, traffic jams, etc.
- IT-based applications and other means of car-pooling or work from home strategies should be adopted.
- Purchase of new vehicles could be made conditional on an older car being scrapped.



Source: TERI Report, 2018  
Image: www.nextva.com, www.chandigarh.com



21

Then congestion, similarly, if congestion occurs then basically in idle conditions, lot of fumes come out of the engine, basically carbon monoxide and other. And so, it can be, it can also result in traffic jams or accidents etc. So, to avoid that, we can use this IT-based applications or other means for like carpooling or work for, work from the home those kinds of things can be there to reduce the traffic and to reduce the chances of congestion. Then purchase of new vehicles could be made conditional on an older car being scrapped. So, nowadays, even this scrapping policies also is in force.

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### Sector-wise mitigation measures: **Transportation** (10/13)

- ❖ **Transit bypasses**
  - Construction of bypass allows the vehicles to smoothly bypass the city without entering it.
  - It reduces the air pollution loads within the city, and also helps the transit vehicles to avoid city congestion.



Source: TERI Report, 2018  
Image: <https://www.guwahatipius.com>



22

If we talk about like transit bypasses so that vehicles do not enter these trucks or those are people who are going on long distances so, they do not need to enter in every kind of city, if there are bypasses for those particular cities. So, they go with the same speed, they bypass the city, they do not enter into the city and if a lot of vehicles enter into the city then of course, they will emit lot of emissions. So, that way those emissions can be avoided in the city.

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### Sector-wise mitigation measures: **Transportation** (11/13)

- ❖ **Road to rail freight improvements**
  - Sharp increase in energy demand from heavy duty vehicle sector in India due to increased freight movement.
  - Share of railways in freight movement need to be improved considerably.
  - Initiatives from railways to provide door-to-door services in collaboration with local transporters.



Source: TERI Report, 2018  
Image: <https://www.trukky.com>

23

Then this road to rail freight improvement is also needed, because over the years it has been observed that a lot of freight has gone to on through the trucks basically. So, we need to shift this load to the railways, that way we can reduce lots of emissions, otherwise, these trucks are responsible for huge emissions of greenhouse gases as well as air pollutants.





And even this inland waterways also has a lot of scope to increase the freight transportation through inland waterways, that is also very environment friendly and very cost effective way in fact, and government of India is investing a lot of money to develop infrastructure related to inland waterways.

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Sector-wise mitigation measures: **Transportation** (12/13)

❖ **Electric mobility (1/2)**

- Electric vehicles have no tailpipe emissions, making them ideal for lowering pollution levels.
- India adopted the National Electric Mobility Mission Plan (NEMMP), 2020 that aims to promote electric mobility in the country.
- Public transport systems also need to be planned on hybrid/electric modes.



Source: TERI Report, 2018  
Image: <https://www.thehindubusinessline.com>

24

Well, then this electric mobility related policies also has been in our government has implemented or adopted this National Electric Mobility Mission Plan (NEMMP) in 2020, and the aim is to promote electric mobility, battery-based mobility. So, the public transport system also need to be planned on hybrid or electric modes so, that these vehicular emissions can be get rid of from the cities basically.

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Sector-wise mitigation measures: **Transportation** (13/13)

❖ **Electric mobility (2/2)**

- To tackle the high cost of electric vehicles, faster adoption and manufacturing of (hybrid and) electric vehicles scheme has been launched under NEMMP with plans to incentivize buyers for purchasing these hybrid and electric vehicles.

❖ **Environment taxes/fees**

- Higher registration taxes/fees can be used by the government to promote low carbon, fuel-efficient vehicles and penalize inefficient and polluting vehicles.



Source: TERI Report, 2018  
Image: <https://medium.com>

25

Then, but it needs a lot of incentives, some subsidies, so that the production and marketing and selling of these electric vehicles becomes good and mass production, when it will happen then the prices will also go low, right now prices are high. But as you know in case of like bulbs, we have seen these LED etc, it was expensive, initially, even mobiles were expensive initially, but when the utilization became very large and the mass production happens, then prices got reduced, it is very simple economics of the demand and supply.

Well, then environment related taxes and fees can also be implemented, higher registration taxes can be used for promoting on those vehicles, which are more polluting in comparison to these electric vehicles. So, the differential taxation can also be there. And some policymakers argue that maybe we can make free these electric vehicles, free from the taxes basically for certain years.

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The slide is titled "Sector-wise mitigation measures: Industrialization (1/4)". It features a red-bordered box containing the following text:

❖ **Vigilance and enforcement**

- Urgent need to enforce the existing standards effectively.
- Inspection and monitoring of industries need to be randomized to reduce the scope for collusion of the inspected teams with the inspected units.
- Continuous monitoring and online reporting can be initiated for major industries for immediate actions on any violations.



Below the text box is a small video inset showing a man in a white shirt speaking in front of an industrial background. At the bottom of the slide, there is a source citation: "Source: TERI Report, 2018" and logos for TERI, Swayam, and another organization. The slide number "26" is visible in the bottom right corner.

Well, then vigilance and enforcement, it is also very important and the inspection and monitoring of industries need to be in a random manner like I have heard that in Germany, these inspectors from pollution control boards, the same inspector does not go to the same industry twice, some other inspector will go. So, those chances when people can get into agreement of shortcuts kind of things that can be avoided. Then there may be online reporting system where this personal contacts is avoided. So, those possibilities can be ruled out basically.

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### Sector-wise mitigation measures: Industrialization (2/4)

- ❖ **Cleaner gaseous fuels**
  - Cleaner (gaseous/liquid) fuels, wherever possible, should be supplied at least in and around highly polluted cities.
  - Incentives based programmes need to be developed to switch towards cleaner fuels.



Source: TERI Report, 2018  
Image: <https://www.popularmechanics.com>



27

Then if we talk about like cleaner gaseous fuels, so, we can have better fuels and we can switch over to cleaner fuels, which are available and like from solid fuels to liquid fuels, liquid fuels to gas fuels, those kinds of things are related in the industries basically. So, now, we are talking about industries, transportation has been there already. So, industrial sector is now under our focus.

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### Sector-wise mitigation measures: Industrialization (3/4)

- Online monitoring of discharges through the Online Continuous Emission Monitoring Systems (OCEMS).
- The installation of web cameras in highly polluting industries.
- There are stack emission standards in place for PM; however, they do not exist for many other pollutants measured under the National Ambient Air Quality programme.



Source: TERI Report, 2018  
Image: <https://www.indiamart.com>

28


Then we can go for online monitoring basically. So, the online continuous emission monitoring system have been there in the market, but it is expensive, and again, if we promote it with some sort of policy incentives, then it can be there and it would be very easy to monitor those kind of emission streams.

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### Sector-wise mitigation measures: Industrialization (4/4)

**New and improved stack emission standards**

- Even the PM emission standards for many **small-scale industries** seem to be quite relaxed and are to be relooked.
- Need to **revise the PM emission standards** for PM<sub>10</sub> and PM<sub>2.5</sub>.
- Also, there is need for **development of emission standards** for several other pollutants.



Source: TERI Report, 2018

29



These stack emission standards are also need to be improved, because for certain pollutants, they are not there like for PM emission standards for PM<sub>10</sub> and PM<sub>2.5</sub> they need to be revised and there are certain pollutants for them, these stack emissions standards are not there. So, they need to be developed. So that we can implement those based on those.

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### Sector-wise mitigation measures: Power generation (1/3)

**Improving Power supply**

- Need to make the **generation of power sufficient, cleaner, and sustainable**.
- In areas with poor air quality, there is a need to **supply power 24x7 to lower the usage of Diesel Generators (DG) sets**.



Source: TERI Report, 2018      image: <https://www.power-and-beyond.com/>

30

Now, we come to the power generation, power generation, we have seen those ESPs etc. Now, we go for the power sector basically we were at that time focusing on particular coal-based power plant also. So, we are now talking about the complete power generation sector. So, we need to make this generation of power sufficient, cleaner and sustainable.

This is the need of the hour. And that is why a lot of policies are there for generating power from solar, from hydro and those kinds of renewable resources and slowly going away from coal based thermal power plants, so, that these polluted ways of generating power can be replaced by nonpolluting ways of power generation.



Plus, at the same time like some places or in the towns or small cities if power supply is not continuous then people start using DG sets, diesel generator sets and sometimes they are quite polluting if they are not a very good quality and very good quality they need a lot of money. So, people go for those kinds of DG sets and they are polluting. So, it is better that if we supply 24 by 7 electricity, then there is no this possibility of using DG sets unnecessarily and that way again, this is one way of getting better air quality.

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Sector-wise mitigation measures: **Power generation (2/3)**

❖ **Tackling emissions from coal-based power (1/2)**

- To reduce ash content, coal processing should be improved and encouraged.
- Strict monitoring and maintenance of electrostatic precipitators (ESPs) should be ensured for better control of PM emissions.



Source: TERI Report, 2018  
Image: <https://www.rpmsolve.com/>


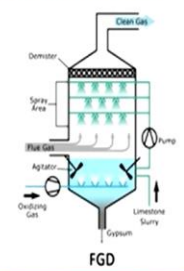
31

Then tackling emissions from coal-based power plants. So, we can go for better coal quality or processing of those coal so that ash content can be removed, there are already technologies which are in use in our country. Then a strict monitoring of maintenance and this electrostatic precipitators ESPs which we use, which is also necessary so that it is working. Otherwise sometimes if it is not working then the whole pollution goes out without controlling it through ESP.

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### Sector-wise mitigation measures: Power generation (3/3)

- ❖ **Tackling emissions from coal-based power (2/2)**
  - Introduction of **control technologies** (such as wet flue gas desulphurization (FGDs) units) should be made mandatory in all the plants to **control SO<sub>2</sub> emissions**.
  - **Stringent emission standards** need to be set to control **NO<sub>x</sub> emissions** from both coal and gas-based power plants.



Source: TERI Report, 2018  
Image: <https://savree.com/en/encyclopedia/flue-gas-desulphuriser>



32

If you talk about like, these coal-based power plant, then there are other ways also like wet this flue gas desulfurization FGDs units. So, those things we have already seen in a scrubber kind of mechanism, which we discussed about controlling of air pollutants from different sources.

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### Sector-wise mitigation measures: Agricultural activities (1/3)

- Need to set up **State/National level procurement agency** for argo-residues procurement from the farmers.
- To involve village level institutions and local entrepreneurs in **collection, storage and supply of biomass materials** and to link with **Mahatma Gandhi National Rural Employment Guarantee Act (MNREGA)** and **Prime Minister's Employment Generation Program (PMEGP)**.
- Setting up biomass depots facilities to address wild fluctuation of **biomass material prices** during season and off-season period.



Source: TERI Report, 2018

33



Well, then if we talk about like agriculture activities, so, you might have heard that lot of agricultural waste is burnt or like this paddy fields after this harvesting season, when they want to prepare it for another crop, then they burn the waste. So, rather than burning it, there can be some technologies, although people are doing research and they are giving ways to use that particular biomass for generation of fuel or converting into value added product.

So, there are many ways but that needs lot of efforts, cooperative efforts at the village level at the Panchayat level and at the government level also. So, those kinds of things are needed and that can be even linked with the MNREGA or those kinds of schemes which are already there. So, that it is very easy to implement those particular things.


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**Sector-wise mitigation measures: Agricultural activities (2/3)**

- ❖ Policy provision for financial incentives and other schemes to encourage briquettes/pellet industries in States Regulation to make mandatory use of biomass briquettes in boilers/furnaces/ brick kilns up to 30% to create demand of such fuels.
- ❖ Generation of electricity is one of the attractive options to utilize farm waste. There is a need to make mandatory use of agro-residues as blend fuel in the existing thermal power plants.



Source: TERI Report, 2018      Image: <https://www.indiamart.com/>

34


Like these agricultural waste can be converted into these briquettes and pellets, which are kind of concentrated energy source and it is, efficient burning can be ensured by these kinds of things. So, this is generation of electricity is one way of attractive options for utilizing farm waste, and there are certain plants in fact, and certain industries also need these kinds of waste for like making boards etc, but the constant supply is the issue.

If government and these cooperative societies can make this they can ensure the supply, constant supply to the industries, then they can really dependent upon these kinds of local supply. Otherwise, I have heard that many industries import these agriculture waste from Malaysia etc, it is very funny to, or strange to look into that kind of matter that we are burning our agriculture waste and people, those industries are meeting their demands by importing the waste from outside, that is not a good thing. So, better policies and their better implementation is the need of the hour basically.

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### Sector-wise mitigation measures: Agricultural activities (3/3)

- Dedicated policies to encourage crop residues based power generation and private sector to create demand of such fuels.
- Focus R&D on development of advanced process/ technologies for valorisation of crop residues into energy and material applications i.e. conversion to value-added products.



Source: TERI Report, 2018

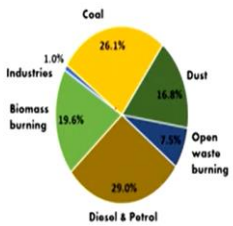
35

Then dedicated policies can be there for these crop residues, power generation as we have discussed, private sector and the government R&D and other agencies can join hands for that.


(Refer Slide Time: 29:20)

### Other mitigation strategies (1/3)

- The monitoring network needs to be improved gradually not only in terms of number of stations but also for quality of monitoring. Presently, air quality monitoring is carried out in cities only, which need to be extended to rural areas.
- Under the supervision of MoEFCC and CPCB, source apportionment studies are to be conducted by specifically identified institutions having relevant expertise.



Source	Percentage
Coal	26.1%
Dust	16.8%
Diesel & Petrol	29.0%
Biomass burning	19.6%
Open waste burning	7.5%
Industries	1.0%



Source: TERI Report, 2018  
Image: <https://urbanemissions.info/>

36


Then there may be other mitigation strategies for example, monitoring networks can be expanded, air quality improvement is dependent on several things, including monitoring, modeling etc. So, nowadays, there is impetus on expanding these monitoring network to countryside also rural areas also otherwise, only in cities, lot of monitoring stations are there. So, those kinds of issues, we can tackle.



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### Other mitigation strategies (2/3)

- The **air quality management plan (AQMP)** at city level should be drafted by the designated institutes.
- For implementation of strategies at **state or city level**, **department of environment (DoE)** in assistance with **SPCBs** should be the nodal agency.
- **Public participation begins** with informed citizens with **raised awareness** levels who can motivate the government for vigorous implementation or **adoption of mitigation strategies**.



Source: <https://www.teriin.org/article/air-pollution-india-major-issues-and-challenges>, TERI Report, 2018


37

Then Air Quality Management Plan and then state or the city level department of environment and these state pollution control boards they can be the nodal agency for implementing those strategies which are related to air quality management plans. And the public participation is very important basically. So, the urban local bodies can play a very important role in that sense. And in NCAP lecture you might have heard about all those aspects which are necessary for tackling these kinds of issues, to improve urban air quality.

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### Other mitigation strategies (3/3)

- The **CPCB ensures the monitoring and regulation** of the **NAAQS** in the cities, towns, and industrial areas with the cooperation of the respective state pollution control boards (**SPCBs**).
- To control the concentrations of **particulate matter (PM)** and dust particles, various steps, such as the **green buffer around cities**, maintenance of **33% green cover** around urban areas, installation of **water fountains** across the cities have been taken over the years.



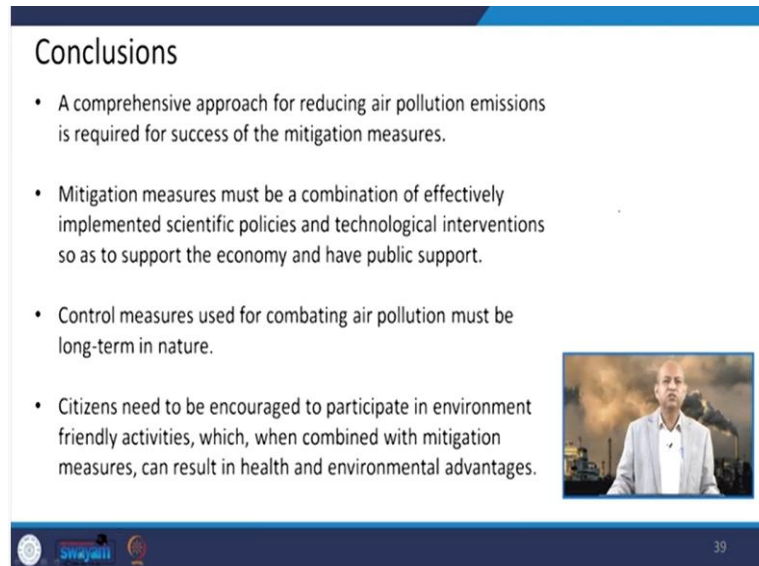
Source: <https://www.teriin.org/article/air-pollution-india-major-issues-and-challenges>

38

Then, there are other ways like to control the concentrations of particulate matter and the dust particles various types are there like a green buffer around the cities in and around the industrial zones and 33 percent green cover in urban areas, those kinds of things if we can ensure and we


can install like open fountains, water fountains across the cities but it is very difficult, it needs a lot of resources etc. So, better to go for eco-centric developments where we can use the trees and greenery as a buffer zones in between industrial zones and the residential zones.


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**Conclusions**

- A comprehensive approach for reducing air pollution emissions is required for success of the mitigation measures.
- Mitigation measures must be a combination of effectively implemented scientific policies and technological interventions so as to support the economy and have public support.
- Control measures used for combating air pollution must be long-term in nature.
- Citizens need to be encouraged to participate in environment friendly activities, which, when combined with mitigation measures, can result in health and environmental advantages.





39

So, in conclusion, we can say that this comprehensive approach for reducing air pollution emissions is required for success of the mitigation measures, comprehensive means integrated manner, not only one sector but all sectors with better policies. And the mitigation measures must be combination of like effectively implemented scientific policies and technological interventions.

So, as to support the economy and have public support also, because sometimes we go for stringent air quality standards or stringent emission norms, but if we do not have technology to control the emissions then industry people get frustrated, they say that you are giving us those type of targets but how to meet them.

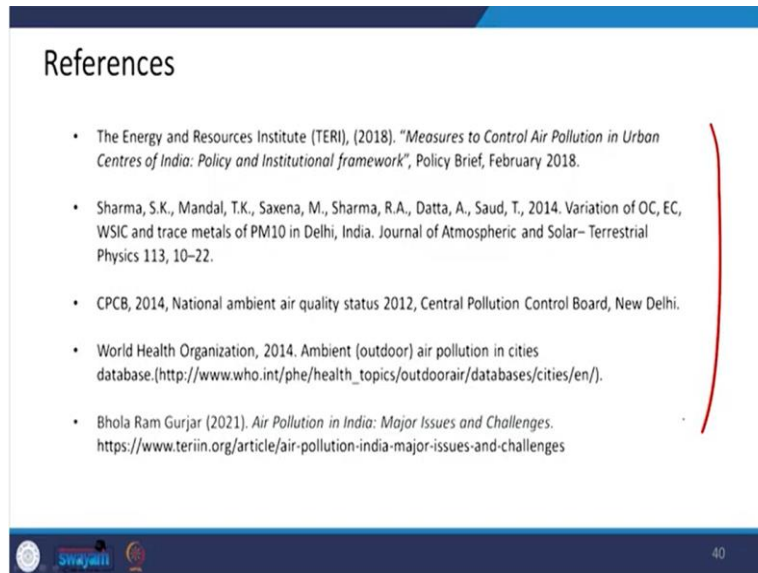
So, the public support will not be there, because economic development needs are much primary these days. So, they want the real solutions. Unless we have good solutions, it will not be effective. So, we should have this public participation according to the local needs. We should develop those technologies which can be implemented properly. Otherwise, if we import and if it is very expensive, the industry people will not like it.

Then control measures used for converting air pollution must be long term in nature, it should not be a short-term issue, it should be properly planned and implemented. And citizens need to

be encouraged to participate in environment friendly activities, which, when combined with mitigation measures can result in healthy environment.

And there are so many advantages in terms of better air quality and better health and better living conditions.

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40

So, this is all for today. And these are the references for your additional information. Thank you for your kind attention. See you in the next lecture. Thanks again.