AIR POLLUTION IN INDIA:

POLICY PROPOSALS FOR A CLEANER COUNTRY

Baijayant "Jay" Panda
Member of Parliament (Lok Sabha)
Kendrapara, Odisha

CLEAN AIR POLICY CHALLENGE

Baijayant "Jay" Panda calls young Indians to share their ideas and solutions to address the pressing issue of air pollution. Work in teams to devise technical and policy solutions to improve air quality in Indian cities.

Winning entries will be shared with the Ministry of Environment.

Eligibility: 18-28 years of age

New Deadline for submission of abstract: 28th January , 2018

Prizes: Top Prize (Rs.10,000); Runners Up (Rs.5,000 each to two teams)

Visit: http://jaypanda.in/national.initiatives/clean-air-policy-challenge/

PREFACE

Tackling air pollution in India is critical for its young people. Overexposure to toxic PM2.5 particles can have a deleterious impact on long-term health out-comes and is a leading cause of premature death (3).

As India's population and economy has grown, so has air pollution in its cities. Without urgent action this is likely to grow further as urbanisation increases.

In order to increase awareness and garner innovative solutions to deal with this situation, Shri Baijayant 'Jay' Panda, Member of Parliament (Lok Sabha) for Kendrapara, launched his Clean Air Policy Challenge.

This initiative prompted dozens of responses from young people across India, who identified a range of polluting sources and considered potential policy solutions to address these.

This report aims to provide an overview of the present state of air pollution in India, and the likely consequences of this. It will then distil the best ideas shortlisted from the Clean Air Policy Challenge and seeks to propose these to the Ministry of Environment, Forest and Climate Change.

It is hoped that a fresh injection of ideas from young Indians will provide a different perspective from the traditional policy making process.

CONTEXT

Air quality significantly affects the lives of people, severely impacting their ability to function freely and lead a healthy life free from physical and psychological diseases. According to World Bank's *The Cost of Air Pollution* report (1), which evaluates impact on mortality as well as economic costs associated with air pollution, every one in ten deaths is attributed to exposure to air pollution . The study ranks air pollution as the fourth leading risk factor for premature deaths worldwide after blood pressure, dietary risks, and smoking. Further, the report estimates the economic burden of pollution associated with such premature mortality and morbidity to approximately range between 5-14 per cent of the world's gross domestic product (GDP)(1).

Considering that 92 per cent of the world's population lives in areas where air pollution exceeds World Health Organisation's (WHO) prescribed safety limits, the challenge of air pollution is a global one (1). The adverse impact however, is felt more in developing countries than in developed countries. About 95 per cent of adults and children affected by pollution-related illnesses live in low and middle-income countries (1). Studies done in South America and South Asia, at both national and sub national levels suggest that the costs of pollution related disease are mainly attributed to outdoor and household air pollution, lead exposure, inadequate water supply, sanitation and hygiene (2).

Susceptibility to pollution related deaths are most common among young children and the elderly, often also causing irreversible physiological harm. The loss of a healthy life in addition to financial costs incurred is monumental.

Indian Scenario

In India, air pollution is a present and growing threat to both health and environment. Set in a diverse socio-cultural context, air pollution in India, is a complex issue, with diverse sources contributing to pollution across the country. This situation

is worsened due to the stark differences in regional climatic conditions. Since 2010, air pollution levels have risen by 13 per cent, majorly disrupting life in both urban and rural areas (3). The main sources contributing to this are common across Indian cities and mostly stem from a range of human activities such as - power generation, open waste burning, combustion of fuel for household activities like cooking, heating and lighting and emissions due to vehicles and brick kilns. Weather conditions of dust storms and low temperatures further aggravate these conditions.

In addition to the Greenhouse Gases, particulate matters such as fly ash, dust and other Suspended Particulate Matter (SPM), generated due to the burning of coal, diesel, petrol and stubble from crops, and from mineral dust are considered highly hazardous as they are small enough to enter deep into the human body (4). Particulate matter includes PM2.5 and PM10 particles: those which are smaller than 2.5 and 10
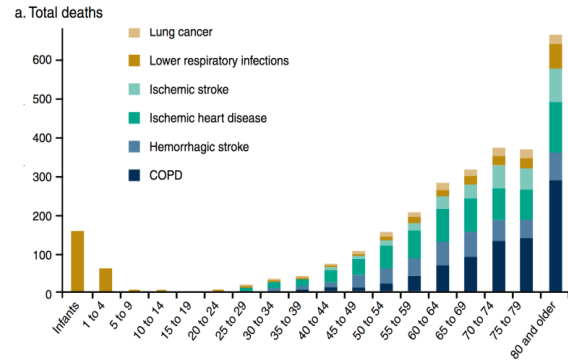

Figure 1: Global deaths from ambient PM2.5 pollution by Age Group, 2013 (1)

micrometres (μm) respectively (4). Of these, PM2.5 has been linked to severe health impacts (1).

Environmental standards and regulations are relatively harder to enforce in developing countries. Combined with lower access to high quality medical facilities results in higher per capita deaths attributable to PM2.5 particles in developing countries.

Figure 2 : Map of annual average PM2.5 concentrations (μg/m3) as they meet or exceed World Health Organization guidelines for air quality, 2013 CITATION Wor16 \l 3081 (1).

AIR POLLUTION IN INDIA | POLICY PROPOSALS FOR A CLEANER COUNTRY
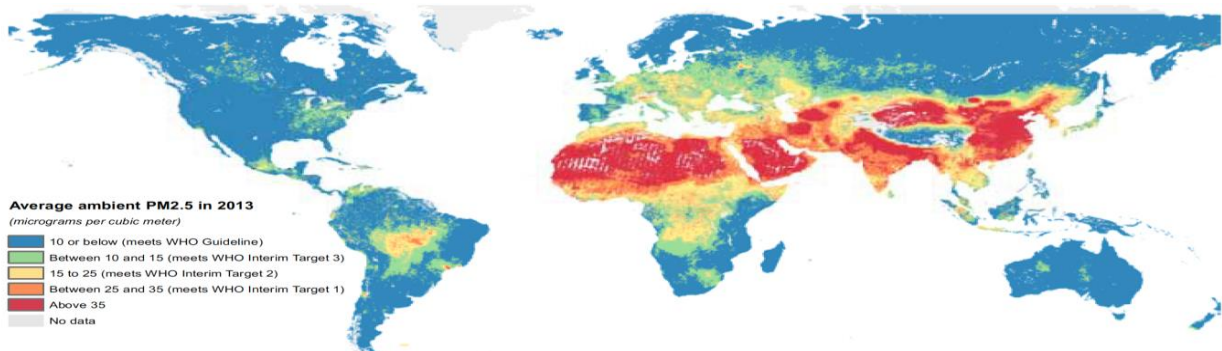
Not dissimilar to countries in Asia and North Africa, India also suffers from high levels of PM 2.5 per cubic metre, as shown in figure above.

WHO recommends that PM2.5 should not exceed an annual average of 10 μg/m3 (5), but in India, it is estimated that 99.9% of Indian population exceeds this level of exposure (6). The levels vary across regions. Population - weighted PM2.5 concentrations in 2015 showed concentration in northern states of NCR, Uttar Pradesh, and Bihar to be the highest, followed by West Bengal, Haryana and the Punjab (6).

Over the past few years, reducing levels of PM10 and PM2.5 over other pollutants has become the main priority. Particulate Matter being chemically charged combines with greenhouse gases to form noxious compounds. Thus, policies targeting lower levels of particulate matter emissions inevitably end up controlling other pollutants except for re-suspended dust.

To tackle this growing concern, the Union and State Governments have experimented with multiple programs. These include introduction of an even-odd driving scheme in Delhi to reduce vehicle exhaust (5), the provision of free LPG to encourage people

to shift to cleaner cooking fuels (7), and bans on stubble burning in some states (1) (8). While these policies are a welcome step in the direction of reducing pollution, they have proven to be insufficient. Air pollution has worsened and deaths resulting from it remain high. In 2015, air pollution was responsible for approximately 1.1 million deaths, 10.6 per cent of total deaths, as per the Health Effects Institute report (6).The same report predicts that if no action is taken, population exposures to PM2.5 are likely to increase by more than 40 per cent by 2050 (6).

Concentration in Northern Regions

According to the UN Greenpeace report titled "*Airpocalypse*" (9), one of the most comprehensive reports on air pollution in India, air quality in many Indian cities including Mumbai, Pune and Kolkata is steadily becoming worse. In 2016, ten cities of India were placed on WHO's list of the world's most polluted cities. The north Indian cities on the Gangetic plains, including Agra and Allahabad, are also affected by particulate matter pollution during winters. Why is this problem more endemic to Northern India? The scientific reasons suggest that winters in North India

lead to a drop in wind speeds and high moisture levels from retreating monsoons - both trapping the dust and particulate matter in the atmosphere.

#	COUNTRY	CITY
1	Iran	Zabol
2	India	Gwalior
3	India	Allahabad
4	Saudi Arabia	Riyadh
5	Saudi Arabia	Al Jubail
6	India	Patna
7	India	Raipur
8	Cameroon	Bamenda
9	China	Xingtai
10	China	Baoding
11	India	Delhi
12	India	Ludhiana
13	Saudi Arabia	Dammam
14	China	Shijiazhuang
15	India	Kanpur
16	India	Khanna
17	India	Firozabad
18	India	Lucknow
19	China	Handan
20	Pakistan	Peshawar

Table 1: Top 20 most polluted cities globally, 2016

Crisis in New Delhi:

New Delhi has been the face of this air pollution crisis that mars Indian cities. The UN-Greenpeace report (9) ranks Delhi as one of the most polluted cities in India and across the world. The media narrative on this issue has predominantly focused on stubble burning in Punjab and Haryana as the main reason for Delhi's air pollution. However, in reality the situation is quite complex as Delhi witnesses high amounts of sulphur dioxide (SO_2) and nitrogen dioxide (NO_2) gases and other pollutants at various times of the year. According to an IIT Kanpur 2016 study (10), sponsored by Central Pollution Control Board (CPCB) and Delhi Pollution Control Board (DPCB) the main pollutant in Delhi is particulate matter (PM 2.5 and PM 10). Particulate matter (as discussed above) itself being harmful also combines with other pollutants forming carcinogenic compounds and is thus a bigger threat. Depending on the time of the year, particulate matters are added to the atmosphere from different sources and in varying quantities. Vehicular pollution accounts for 9 per cent of particulate matter emissions in summer months and a whopping 25 per cent during winter months (10). Out of this two wheelers

account for nearly 33 per cent of the total vehicular particulate emissions (10). During winters, the level of particulate matter in Delhi increases abruptly, owing to stubble burning that occurs in all its neighbouring states including Haryana, Punjab, Uttar Pradesh and Rajasthan.

Air pollution levels in Delhi in 2015 highlighted that PM10 concentration was 4.5 times than the annual limit set by the CPCB and 13 times the annual limit set by WHO (9). Last year in November, pollution surged so high that some monitoring stations maxed out their readings, reporting an Air Quality Index of 999, way above the upper limit of the worst category, Hazardous (300).

The despicable condition of air quality in Delhi and other metropolitan cities has been in national and international media for quite long However, what is often overlooked is that pollution in India is not only endemic to main metropolitan cities but is in fact a pan India epidemic. As per the Airpocalypse report (9), out of the 280 Indian cities surveyed, 228 didn't meet the criteria set by National Ambient Air Quality Standards (NAAQS) even though the permissible limit for particulate matter under NAAQS is way higher than the limit set by WHO.

In this light it becomes even more pertinent to recognize that air pollution in India is a much more complex problem than it is considered to be. It has multiple causes and thus effective tackling of this issue requires working on different policy as well as governance based solutions.
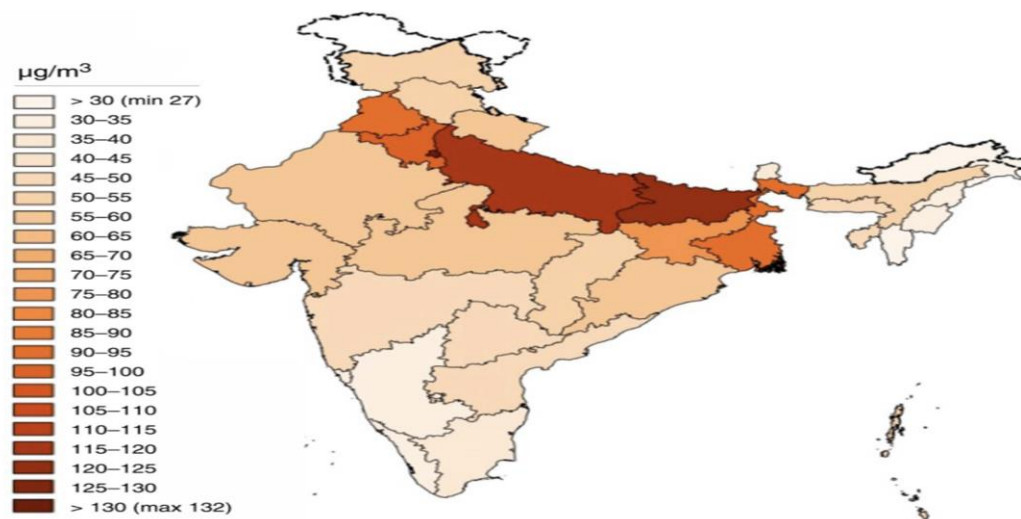

Figure 3: Average PM2.5 µg/m3 in Indian states in 2015, weighted for population (3).

LEGISLATIVE LANDSCAPE AND ITS SUFFICIENCY

India has an impressive number of environmental legislations. There are around 16 laws governing and managing air, water and noise pollution including environment protection and waste management. For achieving the socially optimal outcome of a healthier and cleaner environment, these legislations impose costs on households and businesses. However the fact is that although we were able to push through such legislations and principles of sustainability, the loophole continues to exist at the implementation end. **Anumita Roy Chowdhury** reiterates this point when she says **"***Environmental laws are pretty strong but it necessarily doesn't lead to enforcement and implementation. Institutions and mechanisms for implementation are weak and have not matured* (11)*.***"** Many environmental legislations end up creating weak institutions like the State Pollution Control Boards (SPCBs). **Mr. Shubho Roy** from National Institute of Public Finance and Policy (NIPFP) points out this lacuna of PCBs not having any feature of modern regulator when he says PCBs not having any feature of modern regulator when he says *"The PCBs in India are designed to be toothless… they don't have adequate legal authority to do much about pollution, nor have financial and administrative capacity."*(11) Apart from lack of mechanisms and weak institutions, the menace of corruption in public bodies, non-imposition of regulations, lax penalties on the non-compliant companies, no time-bound imposition intensifies these implementation challenges.

Lack of Federal Cooperativism: Another challenge to implementation of pollution related legislations is their federal nature, requiring state governments and the Union Government to act in tandem for its success. This is best demonstrated by the crop residue burning issue in Punjab, Haryana and Uttar Pradesh.

Banning of Crop Residue by National Green Tribunal (NGT):

In 2015, NGT ordered Governments of Haryana, Punjab, Rajasthan and Uttar Pradesh to enforce a ban on crop stubble burning through imposition of steep fines of INR 2500 for less than 2 acres and INR 15000 for more than 5 acres, for every incidence of crop burning (12). Such a blanket ban proved to be impractical as farmers are faced with a lack of alternatives for doing away with crop residues. In this context, it is important to note that the practice of crop stubble removal and management is costly and time intensive, requiring costs above the financial capacity of marginal farmers. Additionally, it also leads to longer inter cropping cycle gaps. The policy was also unfair for farmers in four states given that stubble burning is practised across the country. It would have been more prudent to gather evidence and understand why farmers who prefer wheat as fodder, despite a 22 per cent shortage, prefer to burn wheat crop stubble instead of saving for future use (13).

There are also various reports that suggest that mechanization of harvesting is not the solution as it leaves behind stubble that is too sharp to be used as fodder. Among other causes of crop stubble burning, accidental spreading of fire to adjacent farms and threshing machines which are used to convert stubble into fodder, sparking and causing fires across farms. This failure makes it abundantly clear that any solutions to reducing air pollution must first identify and address its stakeholders' concerns, create cooperation mechanisms across states and follow a data driven approach to policy formulation and implementation.

Ad-Hoc Measures: In addition to poor implementation, the state governments have resorted to ad-hoc measures like odd-even schemes, Supreme Court ban on firecrackers and distribution of masks to personnel.

New Delhi - the face of India's air pollution crisis has been ground for such experiments. Year after year, the state government has rolled out different schemes to reduce the impact and lower the levels of particulate matter that reach alarming levels, especially in the winter months. The several measures adopted such as Supreme Court's decision to ban sale of fire crackers in National Capital Region (NCR), Delhi's Odd-Even Scheme and others have proved to be insufficient to achieve sustainable clean air. These measures, mostly ad-hoc are worthwhile to study the reasons for the failure of such rationale policies.

Delhi's Government Odd-Even Rule:

The Odd-Even rule, Delhi Government's pet scheme to reduce air pollution launched in 2015, wherein cars with license plates ending in odd numbers and even numbers were allowed to ply on roads on alternate days. In addition to this, special arrangements like extra buses, a bike taxi service and increase in metro frequency were made to increase the possibility of making this plan successful. The Central Pollution Control Board (CPCB) in a report to NGT stated prima facie, that there was no data to suggest that odd-even scheme had any impact on the decrease in the vehicular pollution. This observation was later accepted by Delhi Government.

When looking at the scheme's failure in hindsight, one can point out a number of issues that plagued the scheme. First and foremost is the exemption of two wheelers from the scheme when there are about 63.4 lakhs two wheelers operating in Delhi accounting for nearly 33 per cent of the total vehicular particulate matter emissions (both PM 2.5 and PM 10) in summer as well as winter months (10). With these numbers, two wheelers are only second to trucks in terms of contribution to the particulate matter pollution among all categories of vehicles.

Further the scheme also faced criticism from the public for its discriminatory approach in exempting VIPs, politicians, Supreme Court judges, defence vehicles and single women drivers. This was the only difference between the Odd Even scheme in Delhi and Beijing from where it has been borrowed. These measures which may have been successful in Beijing's context did not translate to India owing to bad governance and incomplete -adoption to suit ourselves. As a result, these exemptions not only resulted in bad publicity for the government but also added increased complexities in the implementation of the scheme.

Judicial Interventions:

As argued by many over the years that legislative and executive actions and not judicial interventions are the only way forward to the tackle the menace of air pollution, Mr. Shubho Roy of NIPFP argues the same when he says *"Judicial interventions through NGT and Supreme Court seems to be the only ways we are intervening to protect the environment. I feel it is counter-productive and will harm the environment and the Judiciary* (11)*."* The most recent example of the same was seen in

the Supreme Court's ban on the sale of firecrackers in Delhi-NCR region.

Supreme Court's an on the Sale of Firecrackers:

In anticipation of worsening air quality and dense smog, the Supreme Court imposed a region wide ban on sale of firecrackers in Delhi-NCR during the month of October and November. The idea was to test whether decreased use of firecrackers use could alleviate the pollution in Delhi during winters. A study done by SAFAR (System of Air Quality and Weather Forecasting And Research) during the period of Diwali showed that pollution levels recorded in the NCR matched the forecasts that assumed that 100% stock of unsold firecrackers were used (14). This data highlights the failure of the ban. The reasons for its ineffectiveness were mainly its untimely and unplanned implementation wherein being imposed quite late and without accounting for resource constraints. As was pointed by Amit Bhatt from World Resources Institute, Delhi, episodic events like Diwali account only for 4-5 days of bad air, while other pollution sources such as vehicular pollution which account for most of the air pollution across the year need to be tackled in a phased out manner (14).

Even though these ad-hoc measures and ill-planned policies built a success narrative, they were unable to do much to tackle Delhi' air pollution because of their flawed non-data driven and discriminatory approach. This is a lesson to our policy-makers to focus on evidence-based policy making through better data collection and research.

GLOBAL EXPERIENCES AND LEARNING

In the light of the issues with local governance and policy based solutions, it's time that we explore global successful models and interventions and also learn from their failures.

Carbon Tax/Trading in United States

Economists across the world have time and again argued for the need to better utilize the "invisible hand of the market" with correct incentives for tackling industrial pollution. They say that such a solution not only provides for a long term impact but also results in a behavioural change for businesses and households.

In the recent years, emission's trading has become an important component of programs to control air pollution. US experience in this regard indicates that an emissions trading program, if designed and implemented effectively, can achieve environmental goals faster and at lower costs than traditional command-and-control alternatives. Control and command mechanisms don't work as they seem over-regulatory and don't provide for any

incentives to the private institutions to adopt sustainable and green alternatives. A cap and trade mechanism as is practised in US is more attractive for controlling global pollutants like greenhouse gases (15). In such a system, the emissions for different pollutants are capped nationally and based on that each private player is given a cap (either through allocations or biddings) which is not expected to be breached. In case the cap limit is surpassed, a company has the option of trading emissions with another which has unused emission allowances.

Such a mechanism to control industrial pollution is being considered successful because it creates a free market system around emission control with inherent competition among private players to minimise their emission. It not only facilitates in meeting the major objective of lowering the costs of achieving emissions goals of the country but also has the potential to be implemented in the very near

future, without the need for a gradual transition.

Phased out Policy Adoption – China's Success Story

China, a leading economic superpower, had for decades ignored environmental policies as a trade-off for faster economic growth. In the last decade the rising air pollution in Beijing was an alarming call for the government of China. Due to the urgency of the situation, China formulated various national and state policies to tackle the situation. The difference between China and other emerging economies was the phasing out of these policies over time and implementing them in groups. The targets were also updated and adjusted to balance economic growth targets with changing environmental needs. Although due to this controlled growth strategy, Chinese cities' growth rates suffered, yet this Chinese culture of introducing adaptive policies in a phased out manner provides a precedent to many emerging countries including India on ways to control emissions along with sustained economic growth while being in the pursuit of a stable economy (16).

Ukraine's Policy level failure

Ukraine provides another precedent in sphere of policy formulation, albeit a negative one. Despite having well-intentioned legislations in place, Ukraine failed to conceptualise and implement steps to control air pollution in the country (17). This failure was mainly attributed to the continuous political instability within the country, war conditions, financial slowdown and lack of proper data on present and past conditions of air pollution in the country - all of which can cause setback to best formulated policies, in any part of the world. Contrary to this, Europe's experience with policies and regulations has been a positive one. Political stability and sound financial atmosphere in most of the European Union (EU) member countries(except a few) in the last decade, gave EU an opportunity to formulate policies and sign binding conventions among its member nations to keep its emissions below the targeted goals. Further these policies were backed with extensive research and innovative technologies which identify short-lived and long lived GHGs with a goal to reduce global warming by 0.5 degrees by 2030. Both these precedents display that the success and failure of any policy or intervention is not only contingent upon the intention and rigour with which it has been worked out but also upon the internal conditions and external factors that affects

the implementation of such policies or schemes within the country.

The Lancet Commission on pollution and health reported 9 million premature deaths stemming from air pollution in 2015. More than 2.5 million of these deaths were in India, the most in any single country. Such huge statistics for deaths in India shows that air pollution menace is not insignificant issue but a nation-wide concern which needs to dealt at the policy level. One way would be to involve and leverage the talent of young dynamic minds of the country in policy making process to innovate and come up with new out of the box solutions. One such initiative to involve the youth in the process of policy formulation and design has been discussed in the next section.

POLICY PROPOSALS FROM YOUNG ACTIVE CITIZENS

Last year in December, Office of Mr. Baijayant 'Jay' Panda, Member of Parliament, Lok Sabha launched "Clean Air Policy Challenge", an event calling out young Indians to share their pressing concerns and solutions for addressing the grave problem of air pollution. The event received an overwhelming response in form of innovative ideas and suggestions to tackle the air pollution menace in India. The policy proposals ranged from immediate reform measures to tackle crop residue burning to long term policy measures to encourage industries to reduce their emissions. The proposals highlighted the lack of innovative technologies and their use in India and also commented on the data availability and research scenario surrounding this issue in India. Of these innumerable solutions by the youth, we selected three proposals based on the practicality and inclusiveness of the solutions. These proposals are to be forwarded to the Ministry of Environment and Forest in form of this consolidated report. This chapter summarizes the main ideas contained in these proposals.

A. Crop Residue Burning

A.1 Short term/immediate steps:

1) Subsidising Happy Seeders /technology:

Many technological solutions/alternatives to stubble burning are now available in the market. Agricultural innovations such as Turbo Happy Seeders, a machine that fits onto a tractor and is capable of planting wheat without getting jammed by residue leftover after the rice harvest and the Super Straw Management System (S-SMS), another machine that fits onto the combine harvesters for rice in order to spread residue evenly over the field, making the Happy Seeders more effective, are creating new ways to reduce and reuse wheat stubble and thus reducing the stubble burning menace in India. The cost of adopting such technology would be between INR 1.2 lakh to INR 18 lakhs for the farmers which in the present age and time seems far-fetched (18). Experience and evidence from within and outside the country shows that subsidizing such technologies improves the adoption

rates and more-so-ever if it is backed by the right kind of political will and awareness drives to promote such technologies. In November 2017, a version of a plan outlining the same was proposed in the Supreme Court and was estimated to cost approximately INR 2000 crores (19). This plan or a customized version of the same plan being taken up by Union and State governments would provide for a sustainable, long term solution to the menace of crop residue burning. Although there is a concern with regard to the availability of financial resources. This concern can meted out in various ways as listed:

a) Tapping into Green Climate Fund

A task force constituted by Niti Aayog to study the ways to tackle the crop residue burning issue, effectively and efficiently, estimated a total cost of INR 11,477 crores to control and prevent the crop residue burning in the states of Haryana, Punjab and Uttar Pradesh (20). This amount comprises of the subsidies needed for technology like Happy Seeders, for aiding farmers to avail cheaper labour and for providing transportation infrastructure and creating trade mechanisms to facilitate and incentivize the sale of stubble to industries as a raw material for various purposes. With

the Union Government already having budget constrains for social security schemes and state governments' finances being crunched due to farm loan waivers, it becomes imperative to look for other funding sources to fund our mission to curb this air pollution menace.

The Green Climate Fund (GCF) constituted under the Paris Climate Accord provides one such avenue for funding. GCF is financial mechanism that establishes a direct access modality for national and sub-national organisations to receive financial help ($200 million direct access as of 2016) for viable climate protection proposals. This is where the state governments can use the opportunity to get approved proposals to fund subsidized technology and to provide alternatives to stubble burning through an intermediary like the NABARD which would later help in the implementation of these projects.

The State governments also need to come up with innovative project proposals which have higher chances of being approved by fulfilling the four criterions as required by GCF mechanism (21). These are namely:

Criterion I: Indicate the results areas of the project - Mitigation and Adaptation

Criterion II: To mention the direct and indirect beneficiaries of the mitigation and the adaptation impact.

Criterion III: To provide sufficient evidence to prove the requirement of external funding and the provision for creation of a direct access channel to maximize efficiency per dollar spent.

Criterion IV: Providing Indicative Total Project Cost

b) Rent the equipment:

As is practised in many other countries and also in many parts of India, with agricultural machines and equipment's, renting the new innovative technologies available to control stubble burning is a possible option. This makes more sense as the high cost of the technologies and delays in subsidies might lead to their slow-paced adoption. Renting at custom hiring basis to be provided by state governments seems as a viable way out.

Figure 4: Happy Seeder

A.2 Long term policies

2) Biomass Energy Production:

Crop residue management opens up new doors for climate protection and renewable energy generation for India's stubble burning menace when seen in the context of India's renewable energy targets for the year 2022 as per its Intended Nationally Determined Contributions (INDCs) (22) under the Paris Climate Agreement on Climate Change. According to a report by Ministry of New and Renewable Energy (MNRE), Biomass energy's total capacity has met 80 per cent of its target of 10 GW from Biomass for 2022 (23).This shows that biomass capacity can be met to its fullest, with proper planning and implementation.

In 2004, MNRE implemented the Village Energy Security Programme (VESP) project to meet energy requirements in rural areas where grid connections are often difficult. The idea was to set up village level decentralized biomass powered grid systems to electrify the villages. However this programme was dropped in 2009 under 12th Five Year Plan, due to the implementation challenges it posed. Of the 79 VESP projects commissioned initially, more than half did not remain operational due to the support withdrawal. A study (24) conducted to

identify the reasons for its failure listed out the following:

- Lack of monetary incentives to the farmers - leading to supply shortage of biomass fuel.
- Lack of revenue management for collection of tariffs in lieu of electricity services.
- Inadequate capacity building of the community to handle operations and maintenance.

Clearly, a policy like VESP had the capability of making villages self-reliant for their energy needs as it rested on community ownership and usage of locally available resources. Although the lack for a proper foundation in terms of technology, training and incentives lead to its failure.

Here is a proposed few steps (25) which if implemented in their true sense have the potential to tackle the problem of crop residue burning in wholesome and sustainable manner.

a) Use of Geographic Information System (GIS):

GIS software is used to store, retrieve, manage, display and analyse all types of geographical and spatial data. The crop residue waste management process as was proposed in VESP requires proper data collection for better planning and implementation. GIS as a technology tool can help us do this is easier and more efficient way. Furthermore GIS can also be used in monitoring and evaluation process.

b) Waste Management Certificate:

On the lines of an energy certificate, a tradable waste management certificate system can be devised to encourage farmers by providing proper incentives in lieu of their waste management efforts or activities. An energy certificate is a transferable certificate issued in relation to the amount of a specific type of energy or material goods consumed by an energy conversion device in production of energy or material goods.

This policy of waste management certificate (or its variant) is tried and tested which several European and North American countries are already implementing it. It has also got huge industrial support in India as industries see this as an opportunity to procure cheaper raw material from within the country. It has the potential to bring in intermediate technological revolution at the village level which was once envisioned by the father of the Nation, Mahatma Gandhi.

c) Fire Detection Systems

Remote sensing data from various Earth observation satellites can be used to quantifiably measure the amount of burned areas in different states. Similarly multi-

temporal image difference technique (a remote sensing technique) can be used to estimate the burned area affected due to fire. Depending upon our need for fine resolution or coarse resolution, sensors or a multi sensor approach can be used for this estimation. Visible Infrared Imaging Radiometer and its data available on NASA website can be also used to detect daily active fire locations. The main advantage of these technologies is that their thermal sensors can detect anomalies even at night.

Such technologies can be used to develop a "Crop Fire Alert" system where information regarding daily crop fire locations (including the latitude and longitudes) can be sent to the state and district level officials through SMS alert, ensuring immediate action against the culprits.

d) Storage facilities for Stubble:

Since harvest and stubble collection is a seasonal affair and occurs few times around year, the quantity of agricultural waste increases drastically at particular times in year, producing bulk waste at once with no infrastructural or management support to deal with it. This calls for better infrastructure and management practices to be in place for the proper storage of stubble and other agricultural wastes. Some infrastructural suggestions could be creating a hoop framework or other strong steel structures to accommodate the bulk agricultural waste. Management practices could involve management of manure which includes activities such as cleaning out stalls, pens and holding areas for animals in barns. A similar mix of policy and technological fix has been adopted by Government of British Columbia with much success.

e) Personnel Training:

Capacity building of the stakeholders involved in any policy or scheme forms the backbone of its implementation process and thus determines its success or failure at large. Further, without trained personnel with regular capacity building support framework, any policy is ought to fail. Keeping this in mind, it becomes necessary that we have a comprehensive training program for various stakeholders involved. This must include:

1) Training of localities in the production of the necessary parts required for running a biogas plant. This ensures supply of replacement parts as and when needed, thus ensuring the sustainability of the project.

2) Training the local people in maintenance and operations capabilities of a biogas plants.

3) Creating mass awareness about the usage of biogas power to maintain a continuous flow of demand for biomass energy.

These capacity building exercises can be done with the support of or in partnership with private entities, utilising their CSR funds. Further to ensure gender parity, a women centric module should also be developed and Anganwadi Kendras can be used to reach out to women and for training purposes.

f) Decentralization of Biogas plants:

Decentralisation helps in creating energy self-sufficiency in villages with the help of an off-grid energy generation and distribution plant within the villages. Such models have been very successful in neighbouring country of Bangladesh. The financial feasibility of such systems has been validated in Austria through the mechanism of SWOT analysis.

A.3 Coordination between different governments and stakeholders

As seen in the case of NGT's ban on crop stubble burning, any policy intervention or programme will be unsuccessful in absence of coordination across different governments, agencies and stakeholders. In this case too, the coordination was lacking between the state governments of Punjab, Haryana and Uttar Pradesh, leading to its

failure. Moreover in case of pollution and environmental protection, this becomes more of a necessity as this domain lies with both the Union and the State Governments to legislate and implement on. The solutions suggested above too would be successful only with the cooperation among government stakeholders such as State Pollution Control Boards, Ministry of Environment and Forest, Union Government's planning agency – the NITI Aayog and any other ministry involved.

B. Industrial Pollution

Industrial Pollution is another area of concern that contributes majorly to the air pollution in India. Control of Industrial Pollution has become a governance problem within India and is marred by lack of transparency and law enforcement issues. Although we have high standards of environmental protection laws in India, effective enforcement of these laws is a pertinent issue. Lack of accurate, independent and easily accessible data on emissions creates hurdles in ensuring compliance to standards and law enforcement.

Experiments conducted in Gujarat and Maharashtra in conjunction with the State

Pollution Control Boards (SPCBs) and research institutions from University of Chicago and MIT show quite promising results which can also be applied to regions like Delhi-NCR.

B.1 Immediate steps:

1) Shutting down non-essential red category industries and brick kilns (26) :

Taking the example from Chinese city of Tangshan, one of China's busiest steel centres, where 267 businesses were ordered to suspend operations in advance of the 2008 Olympics, the Delhi-NCR region can also try something similar to provide temporary relief to its residents while it mulls upon more sustainable solutions to this problem.

B.2 Long Term Steps:

Any long term solution requires a mix of policy approach and implementation approach with an aim to improve the governance structure.

The flowchart below points out the basic elements required for ensuring accountability:

Based on the above elements, we here propose a few steps which can lead to transparency followed by accountability and also help in enforcing the compliance standards upon the private companies:

1) Third Party Pollution Compliance Audits:

The experiments conducted in Gujarat through randomized evaluation (which we referred to earlier) found that random assignment of auditors to industrial plants, payment from a common pool, their monitoring for accuracy and providing them with financial incentives for better reports for compliance auditing, led to 80 per cent less likeliness of submission of false pollution readings.
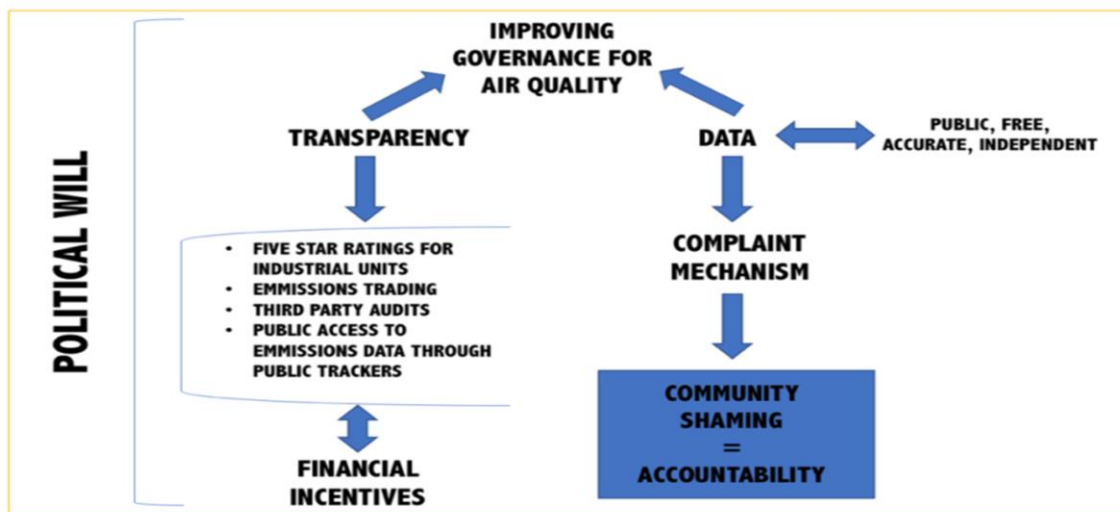

Figure 5: Flowchart with basic elements for ensuring accountability

In addition to this, according to a J-PAL study, industrial plants too reduced their air and water polluting emissions by 28 per cent (27). Such evidence from Gujarat makes for a compelling case for states of Uttar Pradesh, Haryana and Punjab to adopt third party audits for polluting industries.

2) STAR Ratings Programs:

United States provides us with the best example of successful implementation of the STAR rating program, though it practised all around the world. The program is named "Energy Star" and has been widely adopted by households for assessing the efficiency of home appliances.

EPIC at University of Chicago where a project is being implemented in collaboration with Maharashtra Pollution Control Board (MPCB) with an aim to enhance the environmental performance of the industry and inform market based regulations (28). The project helps in improving factory's access to emission data, inform them about missed abatement opportunities and rates them based on their track record. Such steps can help in increase in adoption of technology due to better data availability on pollution emissions.

New Delhi is also planning to collaborate with them on such a project and it would help complement New Delhi's effort if the other states of Punjab, Haryana and Uttar Pradesh do the same.

3) Private Sector Engagement through Financial Incentives

A policy with a provision of tax rebates for private sector companies which comply with the pollution standards and use renewable energy to cut down pollution emissions can be thought of.

Such a pioneering effort was made in the City of Somerville (Massachusetts, USA). Here innovative initiative "Greentown Labs" - a start-up incubator- was given substantial rental cuts to promote relocation of their clean energy research and start-up space in Somerville (29). Further the initiative was helped by providing financial support , fundraising support and infrastructural support. This was city's long term strategy where it wanted Somerville to become a laboratory for testing new energy efficiency and clean energy technologies so as become a net zero energy emissions city by 2050.

Such support by public sector in de-risking of sustainable and environmentally friendly technology start-ups can be useful to boost several technological innovations that are aiming at reducing pollution. New Delhi, with all its available resources can create

innovation friendly spaces for start-ups with innovative technological solutions to the problem of air pollution and thus become the Somerville of India.

C. Data, Innovation and Research

In today's era public sector support is an essential component in making most advanced scientific discoveries and in promoting newer technological innovations. DARPA project in USA is the best example where the government and the internet helped in funding new technologies with no immediate commercial potential or returns but having long term gains. We can infer that such public support can help take technologies in R&D stage to their demonstration step making it available to the consumers and the market. The ways to do so are:

1) Partnerships with Technological and Scientific Institutions:

The state governments should collaborate with research institutions like Indian Institute of Technology (IITs), Indian Institute of Management (IIMs), BITS-Pilani, Tata Institute of Social Sciences (TISS) etc. to research improved technologies.

2) Research Grants for "Green" stubble waste - Reuse and Disposal:

The Happy Seeders and the Super Straw Management System(S-SMS) technologies have also been developed indigenously by Punjab Agricultural University. More research grants given to national institutions to collect data and generate evidence on environment and find cost-effective alternatives to stubble burning. Some of these areas have already being worked upon with innovations such as crop residue usage for mushroom cultivation, paper and pulp board production.

3) Data on crop cycles and stubble burning patterns:

With crop residue burning not only being endemic to few states but a pan-India problem, non-availability of data on causes, duration, timing and patterns of crop residue burning nationwide makes the issue more hard to handle. Crop cycles data and stubble burning patterns data can be collected through the use of innovative and scientific research methods such as GIS mapping and thermal sensors. Such data can be used not only to implement effective strategies but also to triangulate with health and economic data to assess the consequences of crop residue burning on health and wellbeing of farmers as well as the affected localities.

CONCLUSION

The Clean Air Policy Challenge was an endeavour to push young citizens to actively engage with the issues they see around them and innovate on solutions together. All the ideas received were novel and although there are constraints to realise each of them fully, they are a great beginning to initiate conversations amongst the young citizens towards policy solutions to pressing problems perhaps older than them. The policy proposals mentioned in the paper would be shared with the Ministry of Environment and Forest to take them forward to whatever extent possible. The problems the world faces today are too complex to be tackled effectively by the government single-handedly. With further such deliberations, the aim is to pool in the young talent, immerse and sensitise them to the pressing issues and together collaborate and innovate to come up with local community based solutions.

Baijayant Panda meets the winners

Winner Namrata Rao

1st Runners up : Debolina Das, Suman S Chukki, Runal Shrivasta

2nd Runners up : Shashank Mattoo and Niharika Yadav

ACKNOWLEDGEMENTS

Credit for the above policy solutions is owed to all those who made submissions to the Baijayant 'Jay' Panda's Clean Air Policy Challenge.

In particular, the following submissions were awarded prizes:

1st Prize: Vasundhara Jolly and Namratha Rao

1st Runners up: Debolina Chakrabarty, Runal Shrivastava and Suman Chukki

2nd Runners up: 1) Niharika Yadav , Shashank Mattoo, Pranav Valmeekanathan

Other finalists included:

Kushagra Srivastava, Arpit Dhupar, Bharti Singhla, Tushar Batham, Alok Goyal, Shivani Singh, Rahul Unnithan, Amit Dalmia, Neethi Sarah John, Madhav Sharma, Ishani Palandurkar, Ishita Misra, Indrani Misra, Akash Narendra, Shivali Malhotra, Anisha Malhotra, Anirudh Gupta, Steven Connolly, Anshul Maudar, Sourabh Tuwani, Vivek Kumar Lohia, Suman, Christie Deepa, Ankita Kundra, Sanya Sardana, Anchal Wadhwa, Vikrant Kadian, Vishal Ajjampur, Jayjit Das, Vishal Mehndiratta, Yash Raj, Ayush Pratap, Ayush Pratap, Rahul Roshan, Titikshya Tushar Kanti, Ipsita Dalei.

Concept and organisation by:

Nayantara Narayan, Sanya Dhillon and Shagun Kashyap

BIBLIOGRAPHY

1. **World Bank,** *The Cost of Air Pollution: Strengthening the Economic Case for Action.* Seattle: World Bank Group, 2016.

2. **World Bank,** *Individual Country Analysis- Argentina, Colombia, Pakistan, Peru*. Seattle: World Bank Group, 2016

3. **World Health Organisation,** *Ambient air pollution: A global assessment of exposure and burden of disease.* Geneva: World Health Organisation, 2016.

4. **UK Department for Environment, Food and Rural Affairs,** *Fine Particulate Matter (PM2.5) in the United Kingdom.* London: UK Government, 2012.

5. **World Health Organisation.** *WHO Air quality guidelines for particulate matter, ozone, nitrogen dioxide and sulphur dioxide.* Geneva: World Health Organisation, 2005.

6. **Health Effects Institute.** *Burden of Disease Attributable to Major Air Pollution Sources in India.* Boston: Health Effects Institute, 2018.

7. **World Health Organisation.** Global Urban Ambient Air Pollution Database.[Online] . Geneva: World Health Organisation (April 4, 2017)

8. **Aaron J Cohen et al.,** *Estimates and 25-year trends of the global burden of disease attributable to ambient air pollution: an analysis of data from the Global Burden of Diseases Study 2015***.** 1, Massachusetts: s.n., 2017, The Lancet, Vol. 389, pp. 1907-18.

9. **Greenpeace.** *Airpocalypse: Assessment of Air Pollution in Indian Cities.* Amsterdam: Greenpeace 2017

10. **Mukesh Sharma; PhD and Onkar Dikshit ;PhD, Indian Institute of Technology Kanpur,** *Comprehensive Study on Air Pollution and Green House Gases (GHGs) in Delhi.* **Department of Environment, Government of National Capital Territory of Delhi and DPCB, 2016**

11. **Samarth Bansal**, *Pollution problem: rules tough but implementation weak,* The Hindu, January 5, 2017.

12**. Mukta Patil,** *Delhi's air quality could improve 90% if stubble-burn in fields is stopped*, Business Standard, October 23, 2017.

13. **Kundan Pandey**, *India's burning issue of crop burning takes a new turn,* Down To Earth, May 31, 2017.

14. **Priyanka Pulla**, *Delhi firecracker ban had no impact, say studies*, The Hindu, October 25, 2017.

BIBLIOGRAPHY (Contd.)

15. **A. Denny Ellerman et al**., *Emission Trading in the US: Experiences, Lessons and Considerations for Greenhouse Gases,* **Centre for Climate and Energy Solutions, (**May 2003)**.**

16. **Yujuan ZHANG et al** 2017 IOP Conf. Ser.: Earth Environ. Sci. 61 012156

17. **Nathaniel Copsey and Natalya Shapovalova**, *Ukrainian Environment Policy and Future SIDA Assistance in the Sector,* Swedish International Development Agency (SIDA) (January 23, 2008).

18. **Gupta, Ridhima , and E Somanathan**, *Happy Seeder: A solution to agricultural fires in north India*, Ideas for India, November 12, 2016.

19. **Press Trust of India,** *Rs 2000 crore roadmap to end stubble burning submitted in SC*, Press Trust of India, November 30, 2017.

20. **Ranjan Mukesh**, *Stubble-Burning solution to cost Rs 11,477 crore: Aayog*, Tribune India News Service, October 29, 2017.

21. **Green Climate Fund**, *Concept Note User's Guide,* Green Climate Fund.

22*.* **Ministry of Environment, Forest and Climate Change***, India's Intended Nationally Determined Contributions – Towards Climate Justice,* **Ministry of Environment, Forest and Climate Change,** September, 2015**.**

23**. Press Information Bureau,** *Year End Review 2017-Ministry of Renewable Energy,* **Press Information Bureau, December 27, 2017.**

24. **Muhammad Pervaz and Md. Lutfar Rahman**, *Review and Evaluation of Successful and Unsuccessful Renewable Energy Projects in South Asia*, **SAARC Energy Centre**, 2012.

25. **World Bank**, *India: Biomass for Sustainable Development Lessons for Decentralized Energy Delivery Village Energy Security Programme*, **World Bank**, July 2011.

26. **Jim Yardley**, *Cities near Beijing Close Factories to Improve Air for Olympics*, **New York Times**, July 7, 2008.

27. **Esther Duflo et al**., *Improving Third-Party Pollution Audits in Gujarat: Evidence informs scale-up of pollution audit policy scaled up in Gujarat, India***, MIT J-PAL**, 2015.

28. **EPIC India**, *Improving Monitoring to Enhance Environmental Performance and Regulations*, **University of Chicago**, 2014.

29. **Jeff Engel***, Greentown Labs Grows, Wants to Make Somerville a Global Cleantech Hub*, **Xconomy**, October 30, 2015.