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Detailed Project Report: Pilot Emissions Trading Schemes in Gujarat, Maharashtra and Tamil Nadu

Prepared by J-PAL South Asia in collaboration with the Gujarat Pollution Control Board, the Maharashtra Pollution Control Board and the Tamil Nadu Pollution Control Board

For the Ministry of Environment & Forests, Government of India

Ministry of Environment and Forests
GOVERNMENT OF INDIA

Maharashtra Pollution Control Board

Gujarat Pollution Control Board

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1. Executive Summary

1.1 Potential impact of an emissions trading scheme (ETS)

Emissions trading as a regulatory instrument can transform the trade-off between environmental quality and growth for the betterment of the Indian environment. India is facing challenges with pollution on both local and global scales. It must develop new regulatory instruments to meet these challenges, just as the world must agree on a new framework to address global climate change.

Introducing an emissions trading scheme, also known as "cap-and-trade," will be a leap forward from both a regulatory and economic perspective. From the perspective of polluting firms, emissions trading can reduce compliance costs and make the regulatory environment more predictable, raising investment and growth. In the longer run, the reduced costs of compliance can also make it easier to introduce new regulations that increase environmental quality.

1.2 Background on regulation of industrial pollution and project scope

Gujarat, Maharashtra and Tamil Nadu are the leading industrial states of India. Growth in industry has contributed to growth in emissions of various pollutants in air and water, including particulate matter. Throughout India, urban areas have high levels of particulate matter that are known to be harmful for health. Under the new, stricter National Ambient Air Quality Standards, many industrial regions must significantly cut particulate emissions to move towards the more stringent, uniform standards now in place.

Achieving such cuts will be easier and less costly under an emissions trading scheme than with traditional, command-and-control regulation. Even under perfect compliance, the present system of concentration norms does not impose any limit on the total emissions in industrial areas. To limit emissions, environmental regulators have had to impose blunt restrictions on new investment and industrial growth. An emissions trading system that caps total emissions is a more flexible, and therefore less costly, way to restrict total emissions from industry.

The pilot emissions trading scheme will cover 1,000 industries in close proximity to the largest metro areas in Gujarat, Maharashtra and Tamil Nadu. The industries will be selected by geographic area, sector and parameters like boiler capacity and fuel type that are indicative of capacity for pollution emissions. State Pollution Control Boards will determine the precise criteria for eligibility and mandate and enforce the emissions trading scheme as the only form of regulation for particulate matter for all industries deemed eligible. The pilot scope will include a significant fraction of large particulate emitters in each metro area covered, which are a small share of all industries in each state.

1.3 Objectives of the pilot scheme

Piloting an ETS will enable the Ministry of Environment & Forests to cap total pollution emissions in select areas and increase regulatory transparency and accountability. The pilot emissions trading scheme will be rolled out as a randomized-controlled trial to enable rigorous evaluation. Such an evaluation will provide gold-standard evidence on the environmental and economic benefits of the scheme. Pollution emissions will be measured in real time using continuous emissions monitoring, and economic adjustments will be measured with regular unit surveys. Backed by this evidence, the pilot scheme will provide a model for expansion within India and a framework for implementing global environmental policy.

1.4 Key environmental laws and regulations

The regulatory framework and technical capacity to implement emissions trading and achieve these ambitious goals already exist. The Ministry is empowered by the Environment (Protection) Act, 1986 and accompanying rules to limit net adverse environmental impact from industrial activity and is ready to apply this power to support an emissions trading scheme. The State Pollution Control Boards have the power to implement such a scheme on the ground by modifying the terms of environmental Consent. A variety of public and private organizations in India will be brought together to improve the standard of emissions monitoring and implement emissions trading.

1.5 Cost estimates

The total budget for designing an emissions trading scheme and rolling it out for 1,000 industries in three states is Rs. 360 Crores. This budget accounts for expenditure for all parties, from the Ministry of Environment & Forests to the Central Pollution Control Board and State Pollution Control Boards, J-PAL South Asia in evaluating the scheme and industry in adopting the scheme. A good part of this cost represents investment in the future of environmental regulation in India. The design of the scheme and necessary regulatory changes will establish a framework for emissions trading to be applied to a variety of pollution problems in the future.

Under reasonable cost-sharing arrangements that could be discussed with the States, the budget from the Centre may fall to Rs. 141 Crores. The largest single cost, comprising over 95 percent of the overall project budget, is for the installation and maintenance of continuous emissions monitoring systems for industry. This up-front investment in physical infrastructure for the scheme will contribute to more accurate and less costly monitoring of some of the largest polluters in participating states for many years. From the perspective of government, a significant part of this cost might be defrayed by adopting progressive cost-sharing for industry, wherein industries receive a subsidy for adoption of continuous monitoring systems that depends on their size and the timing of their adoption. For instance, if the Centre bears 50% of CEMS infrastructure cost and none of the maintenance cost, the project budget falls to Rs. 141 Crores.

1.6 Organizational framework

The project will be a collaboration between several governmental and non-governmental parties. The Ministry of Environment & Forests will introduce the required regulatory framework for an emissions trading scheme. The Central Pollution Control Board will set technical standards for continuous monitoring and review bids. The State Pollution Control Boards will revise industry Consents, implement the adoption of continuous monitoring and enforce the requirement of holding permits to emit. The evaluation of this scheme will be led by two of J-PAL's Board Members, Professor Michael Greenstone, MIT and Professor Rohini Pande, Harvard University as well as Nicholas Ryan, MIT and Anant Sudarshan, Harvard Kennedy School and J-PAL South Asia. The evaluation will be undertaken by J-PAL South Asia at the Institute for Financial Management and Research (IFMR). J-PAL South Asia will monitor the progress of the scheme and evaluate its effect on pollution emissions and industry costs.

A Governing Council will coordinate the required actions between these parties. The Governing Council will draw members from all of the organizations above, as well as outside experts. The Governing Council, in addition will supervise a task force on technical standards and engage with legal experts from time to time to develop the framework for implementing the scheme.,.

Abbreviations

CEMS	Continuous emissions monitoring system
CPCB	Central Pollution Control Board
ETS	Emissions trading scheme
GPCB	Gujarat Pollution Control Board
MPCB	Maharashtra Pollution Control Board
MoEF	Ministry of Environment & Forests
PM_{10}	Particulate matter less than 10 micrometers in diameter
SPM	Suspended particulate matter
SPCB	State Pollution Control Board
TNPCB	Tamil Nadu Pollution Control Board

2. Project Context: Moving to the Regulatory Frontier

2.1 Project Vision: Transformative potential of emissions trading

India is facing challenges from pollution on both local and global scales. At the local scale, particulate matter, especially fine particulates from combustion, is a known hazard to human health. The science behind this fact is documented in section 2.2. Many Indian cities are out of compliance with the National Ambient Air Quality Standards (CPCB, 2006; CPCB, 2010), and in the most recent year with comparable data the mean ambient level of total suspended particulates in India was about five times larger in India than in the U.S. (Greenstone and Hanna, 2010). At the global scale, India, by all accounts, is extremely vulnerable to climate change (Stern, 2006; Prime Minister of India, 2008). Climate change, in an already hot nation, is expected to lower agricultural yields, lower growth and increase mortality (Guiteras, 2010; Dell, Jones and Olken, 2008; Burgess et al., 2011).

These challenges have a common origin: the tension between environmental quality and economic growth.[1] India must not sacrifice the overall well-being of its citizens by adopting any global climate regime that unfairly limits growth. The Indian position at the negotiating table has been admirable for its flexibility, especially in acknowledging at the 16th Conference of Parties that the fundamental issue is not a cap on greenhouse gas emissions *per se* but the level of the cap and the amount of international financial and technical assistance offered to help reach it without stifling the Indian economy.[2] By the nature of the global tragedy of the commons that is climate change, all parties can gain from the right agreement.

At the local level, within India, a similar trade-off has made it difficult to enforce strict regulations. Industry is an engine of the Indian economy and a large source of employment. In the present regulatory system, the traditional command-and-control instruments of plant inspections and sanctions are blunt and inconsistent (CSE, 2009). To limit pollution in industrial areas designated as severely polluted by the CPCB, the government has imposed blanket prohibitions on new investment. There is little short-term reward for reducing pollution when the cost of regulatory action is immediate and the health and productivity benefits are by nature remote. These benefits, however, remain substantial. The Ministry of Environment and Forests (MoEF) estimated that the total annual economic loss caused by air pollution in only 36 cities of India was $2,102 million in 1995; air pollution is also estimated to have contributed to 40,351 premature deaths in the same year (MoEF, 1999). Population and emissions growth since then will have made this cost far larger.

[1] For the United States, Greenstone (2002) demonstrates that environmental regulations have restricted the growth of pollution intensive industries. There is little rigorous evidence, however, on whether environmental regulations heavily limit firm growth in emerging economies. More broadly, excessive regulation (labor regulation, industrial licensing) hurt growth in India (Besley and Burgess, 2004; Aghion et al. 2008). After the massive liberalization that took place in the 1990s, environmental regulations remain the main regulatory barrier facing Indian firms.

[2] Greenstone, M. and R. Pande (2010). Daring to be different –and right. Indian Express, 22 December, 2010. Available at http://www.indianexpress.com/news/daring-to-be-different-and-right/727957/0 (last accessed 24 January, 2011).

Emissions trading as a regulatory instrument has the potential to improve the Indian environment by transforming the trade-off between environmental quality and growth. An emissions trading scheme is a regulatory tool used to reduce pollution emissions at a low overall cost. In such a scheme, the regulator sets the overall amount of emissions but does not decide what any particular source will emit. Industrial plants and other polluters, rather than being told a fixed emissions limit or concentration standard, face a price for their emissions and choose how much to emit, within reasonable limits, taking this price into account. The price of emissions makes pollution costly and gives polluters an incentive to cut back (Duflo et al., 2010).[3]

Emissions trading has been successful in addressing a variety of pollution problems around the developed world but has not been applied in a developing economy, despite that this is where the trade-off between growth and environmental quality is most stark (Duflo, 2010; Stavins 2003).[4] The potential gains from emissions trading appear greatest where, as in India, the population is large and economic growth is reliant on industry. India, in moving forward to adopt an emissions trading scheme for local pollutants, would provide an important example for the entire world. It would move in a stroke to the frontier of environmental regulation. Regulators, with a new, more precise instrument, would be able to check pollution without crushing economic activity. The rigorous monitoring and validation procedures built in to the scheme will show in practice and at scale how verifying greenhouse gas emissions should be done. The procedures of this scheme, applied to carbon dioxide, would make India the most attractive country in the world for international investments in carbon abatement.

2.2 Nature of pollution problems

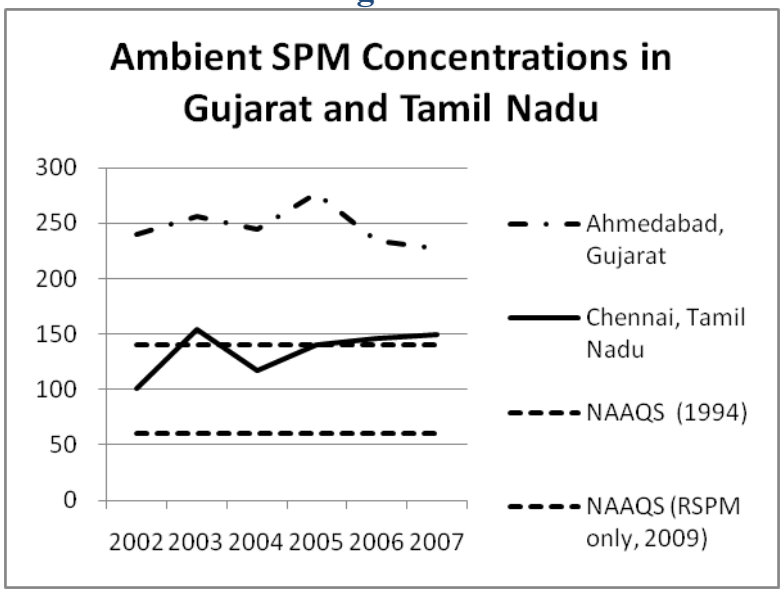
Air pollution both causes local, short-term harm in terms of increased mortality and puts the entire country at a grave, long-term risk from climate change. Pollution concentrations in India, China, and other developing countries are at levels that exceed the highest concentrations recorded in developed countries. The evidence behind the harmful effects of particulate matter is especially strong. Pollution kills people prematurely and otherwise harms health (Ransom and Pope 1995; Chay and Greenstone 2003; Almond et al. 2010). According to the World Health Organization, exposure to various forms of air pollution such as suspended particulate matters (SPM), sulfur dioxide (SO_2) and nitrogen dioxide (NO_2) significantly raises the risk of developing respiratory and cardiovascular infections, diseases and cancer (WHO, 2008). Air pollution has negative effects in spheres other than health. Air pollution undermines agriculture, accelerates deforestation and has aesthetic harm, such as reducing visibility or tarnishing the Taj Mahal.

[3] Note that the Clean Development Mechanism (CDM), in which certified emissions reductions are traded, rather than total emissions, does not meet this definition. The CDM does not measure total emissions from a sector but only from those projects that choose to participate. It also measures emissions reductions relative to a projected level of baseline emissions, rather than actual total emissions, which may not be reliable (Bushnell, 2010).

[4] The few market-based schemes that have applied, such as the Clean Development Mechanism (CDM), have introduced the idea of emissions trading but lack the comprehensive, reliable monitoring mechanism of cap-and-trade. This lack of verification has hamstrung further development; the fate of CDM after Kyoto expires in 2012 remains uncertain.

Indian standards recognize the danger of air pollution. In November 2009, the MoEF announced a new National Ambient Air Quality Standards (NAAQS) (CPCB, 2009). Compared to the previous version from 1994, the revised NAAQS brought six new pollutants under regulation, tightened the acceptable ambient concentration for other pollutants and eliminated the distinction between industrial and residential areas. As a result, many industrial regions—which may have been out of compliance even with the older norms—must significantly cut emissions to move towards the more stringent, uniform standards now in place. Particulate matter is by far the most problematic pollutant on a national scale (CPCB, 2006). India's national average of 206.7µm/m^3 is several times the current NAAQS of 60µm/m^3. Some cities dramatically exceed this high national average. By contrast, sulfur dioxide (SO_2) and nitrogen dioxide (NO_2), which are the pollutants traded most widely in the United States, are less of a problem in India. Most cities are below the NAAQS for these pollutants.

Figure 1



India also faces a long-term threat from global climate change caused by anthropogenic greenhouse gas emissions (IPCC, 2007). In poor countries from 1950–2003, a one-degree Celsius rise in temperature in a given year was associated with economic growth 1.1 percentage points lower in that year (Dell, Jones and Olken 2008). This historical relationship already suggests significant harm from climate change, but the larger temperature changes predicted in the future may have unpredictable and devastating effects (Stern, 2006). High temperatures are responsible for many premature deaths in India each year (Burgess et al., 2010). Climate change will make such hot days far more common. Higher temperatures will also reduce agricultural yields (Guiteras, 2009).

While India's historical contribution to this problem and per-capita emissions are very small, it will be an important part of any solution. For example, consumption of coal, a carbon-intensive fuel, is forecast to increase 3 percent per year from 2004 to 2030 in India and China, versus only 0.6 percent per year growth in the OECD countries (Stern, 2006). Recognizing the crucial role that low-carbon growth must play in checking future emissions, global climate policy-makers have pushed funding for carbon emissions abatement and

mitigation initiatives. The goal of transferring $30 billion from developed to developing economies, set in Copenhagen, was raised to $100 billion less than a year later in Cancun.[5] This transfer, a combination of public and private investment, can only succeed if it significantly and reliably checks emissions growth.

2.3 Purpose of emissions trading scheme

The proposed emissions trading scheme will set a new model for environmental regulation in India. The scheme will be a leap forward from both a regulatory and economic perspective. It aims to cap total pollution emissions, increase regulatory transparency and accountability and reduce compliance costs for all participants. The scheme will be rolled out in a rigorous, randomized-controlled trial in order to convincingly demonstrate these benefits and allow the scheme to serve as a model for environmental regulation across India and the world.

On the regulatory side, emissions trading, through a relatively modest extension and focusing of existing capacity, will bring about two paradigm shifts. The first shift is that regulation will target total emissions, rather than concentration norms, as under the current system. At present, engineers and scientists from the State Pollution Control Boards (SPCBs) visit polluting units at most several times each year and sometimes measure the concentration of air pollutants in the boiler and process stacks. This method makes it impossible to measure total emissions, as the concentration during a particular visit may bear little on the pattern of emissions over the whole year. Furthermore, plants may adjust their emissions during infrequent visits to appear to be polluting less. The emissions trading scheme will introduce continuous emissions monitoring systems (CEMS) to measure and report the total emissions from industry stacks continuously through the year. Targeting total emissions is essential to achieving air quality standards. It is not the concentration but the total amount of particulate emissions that matters for health.

The second shift is to a higher level of transparency and accountability. At present the level of pollution emissions is hard to ascertain and the functioning of SPCBs can be opaque. By collecting far more data and making this data available, at a lag, to the public, the Boards will commit to well-defined goals for total emissions from pilot sectors and may be held accountable for meeting them by an active public. Over time this can increase public trust and raise the respect with which industry treats regulatory standards.

The industrial units that are sources of pollution will experience even greater benefits. The most immediate benefit of emissions trading is cost savings to reach any targeted level of overall pollution. Societies usually care not about who emits pollutants but only about the total of their emissions. By fixing this total and allowing trade between different firms for the right to pollute a certain share, emissions trading schemes allow firms who can more cheaply reduce emissions to achieve more of the overall reductions. This trade therefore lowers the overall cost of meeting the pollution target. By contrast, mandating the same standard everywhere will generally miss the best opportunities for abatement.

[5] Wall Street Journal (December 11, 2010), available at http://online.wsj.com/article/SB10001424052748703518604576012922254366218.html

Aside from direct cost savings, firms will also gain from the greater predictability and transparency of regulation. The present standards for industrial pollution are very strict for some industries, and the SPCBs charged with enforcing them are under-resourced (CSE, 2009). The penalties for violations of norms can be severe, such as cutting off vital electricity or water connections or closing an industry altogether. These factors together imply that, with information from infrequent visits to units and a wide range of violations, regulators must make difficult judgment calls about what constitutes an actionable offense. This is despite that the law prescribes clear, fixed norms. Firms, in turn, find regulatory decisions to be arbitrary. By setting a continuous price of pollution permits rather than the current blunt and unpredictable penalties, emissions trading makes the cost of polluting predictable to firms, like the cost of any other input to production. The transparency of the trading scheme also instills confidence of a level regulatory playing field.

2.4 Objectives and monitoring of the pilot emissions trading scheme

The broader purpose of the emissions trading scheme, as discussed in section 2.3, leads to clear objectives for evaluating the pilot emissions trading scheme. These objectives are introduced here for reference and will be discussed more fully in the Project Activities section below.

Objective 1. Extend regulatory framework.

- *Objective.* The pilot emissions trading scheme will extend the existing regulatory framework to explicitly support emissions trading schemes.
- *Metric.* The completion of this objective will be measured by the issuance of a regulatory notification on emissions trading and the issuance of new environmental Consents to pilot units. Intermediate steps towards this goal include the design and drafting of a regulatory notification and the solicitation of public comments on the same.

Objective 2. Implement continuous monitoring.

- *Objective.* The scheme will develop instrumentation and monitoring standards and roll out continuous emissions monitoring systems (CEMS) at several hundred factories in each participating state.
- *Metric.* The completion of this objective will be measured by the adoption of CEMS by pilot units and the collection of reliable data on total emissions from all pilot units. The rate of take-up of CEMS will be measured precisely as units come online to the central monitoring center in each state. The reliability of data will be assessed by developing and applying data validation procedures to the data collected at this center.

Objective 3. Create emissions market.

- *Objective.* The scheme will establish permits to emit as a commodity in demand that trades easily on established Indian commodity exchanges. The scheme will develop a platform to reconcile permit holdings and total emissions in order to determine compliance.
- *Metric.* The completion of this objective will be measured by the fraction of outstanding permits that are traded over the compliance period and

whether they are traded at reasonable, positive prices. Compliance will be measured by whether industries hold enough permits to cover all emissions. Intermediate steps towards this objective include the contracting of a vendor to design a permit accounting platform, the design and testing of this platform and the participation of pollution sources in emissions trading.

Objective 4. Document emissions cuts.

- *Objective.* The scheme will measure emissions using CEMS at both industries participating in the pilot trading scheme and industries that cannot trade permits.
- *Metric.* The completion of this objective will be measured by whether total emissions are less than the total emissions cap in both the trading and non-trading groups. Emissions will be measured in real-time for every participating industry from the date they first come online with CEMS. The goal of documenting emissions cuts will be with respect to aggregate emissions at source and not with respect to ambient emissions or the emissions of any individual unit.

Objective 5. Document cost savings.

- *Objective.* The scheme will measure industry compliance over two years using semi-annual field surveys of economic and environmental variables at both industries participating in the pilot trading scheme and industries that cannot trade permits.
- *Metric.* The completion of this objective will be measured by whether compliance costs are lower for industries permitted to trade. Compliance costs will be measured with five survey rounds covering both economic variables, such as investment expenditures on pollution abatement and labor costs for pollution abatement and compliance reporting, and engineering measures of abatement, such as boiler efficiency and air pollution control equipment efficiency.

2.5 Purpose and structure of evaluation

Emissions trading, while successful as a regulatory instrument, has never been introduced and evaluated at this high standard anywhere in the world. The Ministry of Environment & Forests has selected J-PAL South Asia at IFMR to serve as an independent evaluator of the completion of these objectives with respect to regulation, pollution and compliance costs. The Minister has written:

> Of course the practical issues associated with such a system will need to be addressed. These include reliability in data monitoring, estimation of accurate baselines, and a strong regulatory frameworks. A clear "benefits case" for such a emissions trading scheme versus the status quo will also need to be established. This is why a pilot programme with a robust design, which allows for such comparisons in a rigorous manner, may well be the way forward (Duflo et al., 2010, Foreword).

For these reasons the scheme will be structured to enable rigorous evaluation. The evaluation will be led by Professor Michael Greenstone, MIT, Professor Rohini Pande, Harvard University and Nicholas Ryan, MIT. The evaluation will be undertaken by J-PAL South Asia at the Institute for Financial Management and Research (IFMR). Evaluating the above objectives requires comparing the outcomes under the scheme to what outcomes would have been under more traditional regulation. The best way to measure this difference is with a randomized-controlled trial.

The structure of the roll-out will be for the State Pollution Control Boards to first allocate permits to all pilot industries under CEMS and then to begin trading with a subset of these units randomly chosen by J-PAL (the "trading units"). The group of all pilot units will number approximately 300 in each state of which 150 will be trading units. All units with permits, whether permitted to trade or not, will be subject to total emissions norms for the targeted pollutant. Comparing emissions and compliance costs between the trading units and non-trading units will directly measure the benefits of the scheme. This comparison is important as many are skeptical of letting markets help regulate pollution. The scheme must therefore demonstrate clearly that trading lowers compliance costs but keeps a strict limit on emissions.

Random allocation of pilot units to be trading units or non-trading units is not only necessary for evaluation but also a rational, fair way to introduce the emissions trading scheme. At present no trading in emissions is allowed, so industries in the non-trading group are not disadvantaged but rather represent the *status quo*, with the modification that they are subject to total emissions rather than concentration standards. Furthermore, as the scheme is new and intended as a model, it is reasonable to begin with a market of viable yet modest size so as to roll out regulatory change slowly.

3. Project Background

3.1 International experience with emissions trading

The Ministry of Environment & Forests (MoEF) requested a concept note on the international experience with emissions trading to draw lessons for the Indian context. The Ministry has published this note and solicited public comments (Duflo et al., 2010). This section briefly reviews the contents of the note to provide context for the proposed pilot emissions trading scheme.

In an emissions trading scheme, the regulator sets the overall amount of emissions but does not fix emissions from any particular source. Instead, pollution sources must purchase enough permits to cover their total emissions. Because the total number of permits is fixed, so is the total amount of emissions. International experience suggests that four areas are especially important for successful implementation of an emissions trading scheme.

- *Setting the Cap*. The target for aggregate emissions from the sector where trading is introduced must be set to produce reasonable prices and emissions reductions.

- *Allocating Permits*. The permits to emit must be distributed in an equitable way to build support for the scheme. In many successful cases this allocation has been made for free relative to baseline emissions, greatly reducing the cost of compliance for industries.

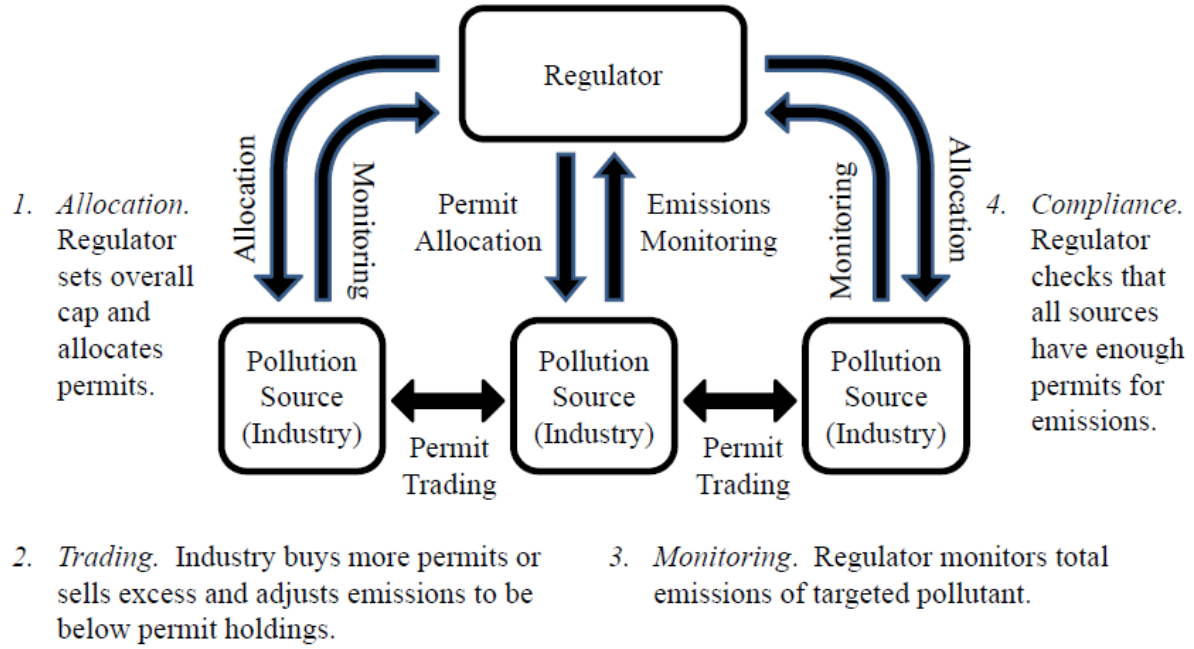
- *Monitoring*. The quantity of emissions from each industrial plant must be reliably and continuously monitored with high integrity recognized by all sides.

- *Compliance*. The regulatory framework must make industries confident that buying permits is the only reliable way to meet environmental obligations.

Figure 2 shows the place of these key components within the overall structure of an emissions trading scheme. The figure shows how emissions trading changes the role of the regulator. Rather than fixing emissions at the level of the individual polluting unit, the regulator sets an amount of overall emissions, which are what matter for environmental quality, and allocates these emissions amongst units in the form of permits. Units can then trade this right to emit. Trading does not change the overall cap but allows the required emissions reductions to be achieved by those units that can cut emissions at the lowest cost. At the end of each permit period the regulator checks emissions against permit holdings to verify compliance.

Figure 2: Mechanics of an Emissions Trading Scheme

Regulator ensures compliance but does not fix emissions for each source



Emissions trading schemes have proven successful at reducing pollution and compliance costs in practice. For example, the United States' Acid Rain Program reduced both levels of SO_2 emissions and compliance costs. Total emissions fell from nearly 9 million tons in 1994 to around 5 million tons in 1995, the first year the emissions cap was introduced, and remained beneath the emissions cap thereafter. The estimated savings to firms from using a trading scheme instead of fixed regulations was around $225 million to $374 million per year (Ellerman et al., 2000).

3.2 Progress towards emissions trading in participating states

The Tamil Nadu Pollution Control Board (TNPCB) and the Gujarat Pollution Control Board (GPCB) have been working with J-PAL South Asia to develop plans for pilot emissions trading schemes to meet the states' respective environmental goals. Maharashtra Pollution Control Board has also done a good deal of groundwork on monitoring and is also ready to take on a pilot emissions trading scheme. Background research and fruitful exchanges with the Boards have suggested the particular areas and pollutants the states would like to address and how the rollout of an emissions trading scheme might be conducted.

In Tamil Nadu, continuous emissions monitoring systems (CEMS) are already in place in many units. TNPCB has over 40 units online and targets having about 250 industries online by fiscal year-end. The Board has been constantly expanding the scope and depth of its monitoring capability. TNPCB's indication is that an ETS will be phased in across industrial areas near Chennai, starting in Manali, Cuddalore and Ambattur industrial areas, targeting particulate matter for emissions trading.

TNPCB has helped J-PAL South Asia in reviewing its work on the establishment of CEMS in Tamil Nadu. J-PAL South Asia has visited several units under CEMS and spent some time to understand the functioning of the Care Air Centre, through which data are collected. The growth of CEMS is impressive, but some areas of the system need to be firmed up to support trading. Data quality and the uniformity of CEMS requirements are important areas for improvement. Preliminary CEMS data, shown in Figure 3 on the following page, shows the comparative richness of data from CEMS as against manual monitoring. The manual monitoring data gives a very incomplete picture of the full distribution of emissions concentrations revealed by CEMS. This concentration data can be combined with flow data to calculate total emissions.

J-PAL is working with TNPCB to develop monitoring guidelines and data validation procedures robust enough to support emissions trading. At present, the CEMS system is somewhat tailor-made to each unit. To turn emissions into a commodity, the system must measure the same quantity everywhere. This makes uniform monitoring critical and also influences the choice of pollutant. Particulates are relatively easy to measure in a uniform manner.

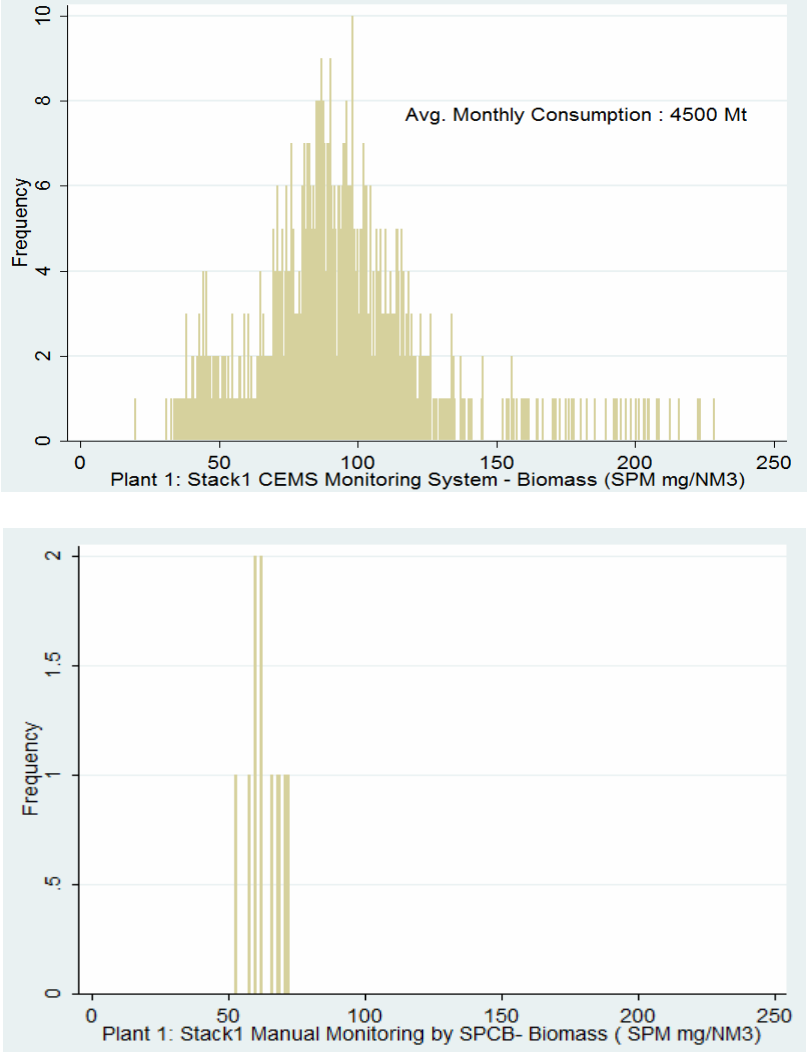
In Gujarat, GPCB and J-PAL have signed a Memorandum of Understanding on knowledge sharing and developed a proposal for a pilot emissions trading scheme. This proposal lays out the rationale for an ETS in Gujarat, the likely pollutant and industry targets, and a monitoring and evaluation protocol. It presents a plan to roll out continuous emissions monitoring systems (CEMS) and then an emissions trading scheme in four phases over 2011 and 2012. This plan provides for randomizing the phase-in of the ETS to accurately measure the effect on emissions and industry abatement cost.

GPCB at present considers the best prospects for a successful pilot emissions trading scheme would be in the Narol and Sachin industrial areas. These areas have a large number of textile units consuming solid fuel, which contributes to particulate matter pollution in the populous cities of Ahmedabad and Surat, respectively. The SPM concentration in Ahmedabad, at 227 µg per m3 in 2007, is, despite considerable improvement, nearly twice the old residential standard of 140 from 1994 and higher than the levels in the Vapi or Ankleshwar industrial estates. The emission trading scheme, encompassing 400 units, will include a significant share of particulate emitters in each metro area covered. For comparison, the Ahmedabad Air Action Plan of 2005 covered 129 industrial units.

In Maharashtra, MPCB has developed its regulation and monitoring over the past several years in a manner that will help support emissions trading. For about the past three years, large sources of particulate emissions have been required to install CEMS as a condition of their environmental Consents. A similar Consent provision will be a requirement of participating units in the ETS. In anticipation of broader CEMS adoption, MPCB has planned a conference for interaction between industries and CEMS vendors to which J-PAL will contribute to introduce the ETS concept. The Board also has some experience in setting load-based standards for pollutants other than particulates that will be useful in transitioning to a mass-based standard for the ETS units. Just this past month, MPCB has worked with the same vendor as TNPCB in order to install a central monitoring server and begin the process of bringing industries with existing monitoring systems online. MPCB views that particulates are the most severe and general air pollution problem facing the state and

therefore has preliminarily decided that the ETS should cover particulates from large industrial sources in Chandrapur and other densely industrialized and polluted areas.

Figure 3: Comparison of CEMS and Manual Monitoring Data



One concern regarding the introduction of an ETS, especially in Gujarat, is the relatively small size of many industrial units. An ETS requires that pollution permits be a freely tradable commodity, which can only happen if there are many buyers and sellers of permits. J-PAL estimates that the number of industries permitted to trade in a pilot ETS should begin with at least 150 and preferably 200 or more units. To have this number of market participants, relatively small industries must take up CEMS and participate in the ETS pilot. Once CEMS is in place, this diversity is an advantage for the function of the scheme. Units that differ in their compliance costs have more to gain from the trade of emissions permits.

4. Project Regulatory Framework

4.1 Existing regulations

The legal basis for an emissions trading scheme (ETS) can be drawn from India's existing environmental laws. The Air (Prevention and Control of Pollution) Act, 1981 (hereafter Air Act) and the Environment (Protection) Act, 1986 (hereafter EP Act) do not specifically establish emissions trading as a regulatory instrument, but the broad powers of the Central government, Central Pollution Control Board and State Pollution Control Boards under these laws would support the establishment of an ETS at the regulatory, as opposed to the legislative, level. Regulatory authority empowers both the Centre and the State to make the changes necessary for an ETS.

The Central Government has two alternate statutes under which an ETS could be deployed, the Air Act and the EP Act. Under Section 16(2)(h) of the Air Act, one of the functions to be performed by the Central Pollution Control Board (CPCB) is to lay down standards for air quality. The CPCB has also been given powers under Section 17(4) to do "such other things" and "such other acts" as it may think necessary for the purpose of carrying into effect the purposes of the Air Act. The purpose of the Air Act is very broad since it includes 'prevention, control and abatement' of air pollution. In the present case power may be derived from Section 17(4) of the Air Act to impose a cap on particulate matter emissions.

The EP Act provides a legal framework to support an ETS. The EP Act in Section 3 gives the Centre the power to lay down standards for the quality of environment. In Section 5, the EP Act grants power to the Central Government to give direction in exercise of its powers and performance of its functions under the EP Act. This includes the power to close, prohibit or regulate any industry, operation or process. The word 'regulate' implies a broad power and may include in its scope the power to stipulate emission caps for industrial clusters. The EP Rules are also relevant. Rule 5 provides for prohibition and restriction on the locations of industries and the carrying of processes and operations in difference areas, and Rule 5 (vii) explicitly notes that such restriction may take into account the net adverse environment impact likely to be caused by an industry or operation.

Given that the goal of an ETS is precisely to limit the net adverse environment impact of emissions over a certain area, the EP Act and the EP Rules are an especially appropriate framework under which to introduce an ETS. Utilizing the EP Act would also imply that no modification would be required for any future ETS regulating water pollutants.

State Pollution Control Boards are empowered by the Air Act to set terms of establishment or operation for industrial plants. Section 21 (1) specifically allows States Governments, in consultation with the SPCB, to establish air pollution control areas with special restrictions on establishment or operation. The SPCBs can stipulate conditions in the consents they issue and these conditions can be varied subsequently for any technological or other reason after giving an opportunity to the person holding the consent (Section 21 (5) and (6)). The availability and mandated adoption of CEMS technology may be viewed as such a reason,

else the SPCB can invoke the 'other reason,' in order to suitably modify the consent to allow flexibility in emissions and require the holding of emissions permits.

4.2 Required regulatory changes

The framework above suggests clearly how regulations would need to be modified in order to put emissions trading on firm regulatory footing. The MoEF will issue a notification stating the regulatory authority for emissions trading, the purpose of introducing an emissions trading scheme, the applicability of such a scheme by sector and area and the broad powers that enable SPCBs to implement the scheme themselves. The state government and SPCB may then institute the recommended total emissions norms and permit requirements in their place by revising the terms of industrial Consents to establish and operate for participating firms.

These changes will be undertaken on a collaborative basis between the Centre and participating states in order to gain support from all stakeholders for the scheme. The Centre may first recommend that the state notify the sectors and areas selected for emissions trading as Air Pollution Control Areas and require CPCB to relax concentration norms for emissions in these areas. The SPCBs themselves are empowered to revise Consents but may consult with the Centre to develop proper terms for this revision.

The regulatory changes will be made to ensure compliance with the new regulatory regime. The revised consent will specify clear, automatic financial penalties that an industry will incur by not holding enough permits to cover its emissions. It will lift the concentration norms for SPM so that holding enough permits is the only regulatory requirement for that pollutant. The existing regulatory system will remain in place for all other pollutants and industries will remain liable for all past violations relating to SPM and other pollutants under the pilot emissions trading system. The Consent amendments will be issued in a batch to all units coming under the pilot emissions trading scheme. Batch issuance not only makes the revision logistically simpler but also signals to industry that all regulatory changes are being taken uniformly for their sector.

5. Project Activities and Proposed Timeline

5.1 Relevant institutions and decision process

The proposed pilot emissions trading scheme will be a collaboration amongst many parties. The scheme is taken up under the authority of the Ministry of Environment & Forests (MoEF), Government of India. The Central Pollution Control Board (CPCB) will advise on technical aspects of the scheme implementation. The respective State Pollution Control Boards (SPCBs) of Gujarat, Maharashtra and Tamil Nadu will be responsible for implementing the scheme, both directly and indirectly, through private consulting firms with expertise in relevant technical and financial fields. J-PAL South Asia at IFMR will serve as independent advisor and evaluator for the scheme.

A governing council will be formed in MoEF to oversee the development and implementation of the scheme. The committee membership, comprised of representatives of the above bodies, is listed below. The standing committee will be responsible for overseeing the implementation of the scheme. It will meet approximately three times per year during the first two years of the scheme, though it may meet several times during the first and second quarters of 2011 in order to review regulatory changes and delegate technical work.

Table 1: Governing Committee Membership

Person	*Position*
Mr. Jairam Ramesh	Minister of State (Independent Charge) for Environment & Forests Member (Environment) Planning Commission
Dr. T. Chatterjee	Secretary, Enviroment and Forests
Dr. Indrani Chandrasekhar	Advisor, Planning Commission
Mr. Rajneesh Dube	Joint Secretary, MoEF
Mr. Varad Pande	OSD, MoEF
Prof. S. P. Gautam	Chairman, CPCB
Ms. Valsa Nair Singh	Secretary (Environment), Maharashtra
Dr. S K Nanda	Secretary (Environment), Gujarat
Dr. Irai Anbu	Secretary (Environment), Tamil Nadu
Mr. Hardik Shah	Member Secretary, GPCB
Mr. Ramachandran	Member Secretary, TNPCB
Mr. Radhe Shyam Mopalwaar	Member Secretary, MPCB
Mr. Charles Cormier	Country Sector Coordinator, World Bank
Mr. Arvind Pande	Advisor, J-PAL South Asia

Prof. Esther Duflo	Professor, MIT, J-PAL
Prof. Michael Greenstone	Professor, MIT, J-PAL
Prof. Rohini Pande	Professor, Harvard, J-PAL

The technical task force will report to the governing council. MoEF will be responsible for drafting the regulatory notification and consent revision and will engage an environment lawyer as required. After the initial regulatory revisions have been completed, the technical task force will turn to establishing emissions permits as a commodity and reviewing the trading platform and compliance reconciliation system.

The technical task force led by MOEF will be responsible for drafting the instrumentation standards for continuous emissions monitoring systems, drawing on the extensive international experience in this area for SPM. The standards will be in terms of accuracy of emissions measurement rather than requiring a particular measurement principle.

Table 3: Technical Task Force

Person	*Position*
Mr.Rajneesh Dube	Joint Secretary, Environment and Forests
Mr.R.N.Jindal	Scientist, Enivornment and Forests
Mr. J. S. Kamyotra	Member Secretary, Central Pollution Control Board
Mr.Kori	Scientist, CPCB
Mr.Danasekaran	Manager, TNPCB Care Air Centre
TBD	Manager, GPCB Care Air Centre
Mr.Ajay Deshpande	I/C Zonal Officer (PAMS)
Mr. Anant Sudharshan	Senior research manager, J-PAL SA
Mr. Harsh Singh	Research Manager, J-PAL South Asia
TBD	Consultant from industry
TBD	Consultant from US EPA

After the initial drafting of technical standards, members of this committee will work with the Procurement Committee of the Central Pollution Control Board to review bids from vendors to be certified for installation of CEMS.

5.2 Regulatory review process

MoEF in consultation with an environmental lawyer, will make specific take action and direct CPCB and SPCBs regarding steps to be taken in several important areas towards the implementation of the pilot emissions trading scheme. The present section gives steps for reviewing and revising regulations and the following sections deal with technical and economic aspects of the scheme. The dates given in all sections are approximate and will be taken as a reference for Tamil Nadu, which has already begun roll-out of CEMS. Gujarat may be about six months behind this schedule due to a later start.

1. *Draft notification.* (February, 2011)
   - Lawyer drafts regulatory notification to establish power for emissions trading scheme.

2. *Draft consent.* (February – April, 2011).
   - SPCBs secure necessary state government approvals.
   - SPCBs draft revised terms of Consent.

3. *Public review.* (March, 2011).
   - MoEF issues notification for public comment period.
   - MoEF considers comments received.

4. *Issue notification.* (April, 2011).
   - MoEF issues final notification to establish outline of emissions trading scheme.

5. *Issue consent.* (April – May, 2011).
   - Establishment of eligibility criteria by SPCBs in accord with terms of notification.
   - Issuance of revised consents by SPCBs with CEMS mandate.

6. *Draft scheme parameters.* (July – December, 2011).
   - Standing committee develops emissions cap and allocation rules.
   - SPCBs communicate emission caps and allocate permits

5.3 Technical review process

The scheme will rely on accurate, continuous monitoring of emissions. The technical task force will oversee the development and adoption of appropriate instrumentation and data validation standards.

1. *Draft instrumentation standards.* (February – March, 2011)
   - Task force drafts instrumentation standards for CEMS covering SPM and flow volume.

2. *Certify CEMS vendors.* (April – June, 2011).

- Task force solicits and reviews bids to provide CEMS. Bids considered on the basis of the technical merit of the monitoring principle and the cost to monitor total emissions of SPM. All technically sound and competitive bids will be certified, and the bidding company will become eligible to install CEMS for industries required to adopt under the scheme.

3. *Technical capacity building.* (April, 2011).
   - SPCBs host Conference and trade fair on options for SPM CEMS in both states. Technical committee introduces scheme requirements. Vendors invited to present CEMS systems.

4. *CEMS adoption.* (April – August, 2011).
   - Certified vendors install CEMS for participating industries.
   - MoEF allocates subsidy for Industry adoption cost.
   - SPCBs require roll out of CEMS across industries.
   - Technical task force and SPCBs organize capacity-building for SPCB staff on CEMS instrumentation standards.

5. *Raising data quality.* (April – December, 2011).
   - Technical task force reviews data quality and establishes uniform validation and missing data procedures.
   - SPCBs and J-PAL SA undertake collection and compilation of baseline data from CEMS.

5.4 Trading review process

The emissions trading system itself will be based on the reliable, established platforms of India's commodity exchanges. To allow multiple parties to conduct trading and to verify the right of parties to trade, the project will develop a single permit accounting and compliance reconciliation system.

1. *Permit accounting.* (June – July, 2011).
   - Governing Council and J-PAL solicitation and review bids from information technology consultant for permit accounting and compliance reconciliation system.

2. *Registration of emissions permits.* (July – September 2011).
   - MoEF requests registration of emissions permits as a commodity with the Forward Markets Commission under the Forward Contracts (Regulation) Act.
   - Permits may or may not be notified under Section 15, which requires that futures in permits be traded only on exchanges.

3. *Accounting platform.* (August – October 2011).
   - Information technology consultant contracted by governing council designs and tests permit accounting and compliance reconciliation system.

- Information technology consultant and commodity exchanges link permit accounting system to commodity exchanges to allow verification of permit holdings and posting of trades.

4. *Trading capacity building.* (September, 2011).
   - SPCBs host capacity building conference and trade fair on trading and permit accounting system. Presentations by and interactions with information technology consultant, commodity exchanges and brokers.
   - Consultants present trading system, sources of information on permit holdings and emissions and how to execute trades.
   - SPCBs present compliance rules under the new permit system and automatic penalties for exceedance.

5. *Interim conference on trading.* (February, 2013).
   - MoEF and SPCBs present results from first compliance period for all stakeholders.
   - J-PAL SA presents interim lessons learned for function of emissions market.

5.5 Pilot emissions trading scheme and evaluation

The pilot emissions trading scheme is closely integrated with evaluation components. The structure of the roll-out will be to first allocate permits to all pilot industries under CEMS and then to begin trading with a subset of these units. All units with permits, whether permitted to trade or not, will be subject to total emissions norms for the targeted pollutant.

1. *Plant survey.* (November 2011 – February 2014).
   - J-PAL SA conducts semi-annual plant survey, covering pollution abatement costs, investment and other economic and environmental variables.

2. *Permit allocation.* (December 2011).
   - SPCBs make initial allocations of grandfathered permits free of cost according to allocation formula decided with agreement of standing committee and regulatory task force.
   - Commodity exchanges hold initial auction of non-grandfathered permits for trading units.

3. *Selection of trading group.* (December 2011).
   - J-PAL South Asia, as independent evaluator, selects units to be permitted to trade out of those units connected to CEMS.

4. *First compliance period.* (January – December 2012).
   - All pilot units required to hold permits in excess of total emissions for the period.
   - Trading units permitted to trade initial allocation.

5. *First reconciliation.* (January 2013).
    - SPCBs total emissions and apply data validation procedures. Standing committee reviews procedures and certifies results.
    - SPCBs compare total emissions to permit holdings at period-end to assess compliance.
    - SPCBs assess fines for non-compliance during first compliance period. Additional penalties may be added for failure to pay fines within one month, as specified in revised consent.
    - Standing committee and J-PAL SA monitor industry compliance and penalties to assure agreement with scheme notification and revised consents.

6. *Second compliance period and reconciliation.* (January 2013 – January 2014).
    - Same as (4.) and (5.) but applicable to second compliance period.

7. *Continuation and scale-up.* (January 2014).
    - Trading industries under pilot scheme continue under total emissions regulation.
    - MoEF may bring additional states, industry sectors or pollutants under emissions trading schemes.

8. Dissemination of results (Jan 2013- June 2014)
    - J-PAL, MoEF and SPCBs will hold two conferences – one interim and one at the end of the pilot to disseminate findings and review the implementation of the scheme, so that the learnings from the pilot could be used as a base for introducing ETS in other states, industry sectors or pollutants. In addition, the implementation of the scheme and findings from the evaluation will be documented in detail and disseminated via policy memos, reports and other publications.

6. Project Cost

The overall project cost is summarized in the table below. The costing is for the complete design, roll-out and evaluation of an emissions trading pilot scheme in three states over a roughly three-year period. The budget for the initial, six-month design phase is presented separately from the ongoing oversight and evaluation cost and the cost of continuous emissions monitoring systems. This distinction between the Emissions trading scheme design phase costing and the Ongoing oversight and evaluation costing is maintained in sub-budgets for MoEF, SPCBs and J-PAL South Asia. The CEMS cost is not broken out by timing but will depend on cost-sharing arrangements and the speed of adoption.

Total project budget

Phase 1 – Design March – August 2011

Activity	Total cost (Rs. lakh)	Total cost (USD, '000)
Emissions trading scheme design (March - August 2011)		
Ministry of Environment & Forests	69	152
Gujarat Pollution Control Board	33	73
Maharashtra Pollution Control Board	21	47
Tamil Nadu Pollution Control Board	25	56
J-PAL South Asia at IFMR	86	191
	234	**520**
Phase 2 – Ongoing Oversight and Evaluation Sep 2011 – Jun 2014		
Ministry of Environment & Forests	157	350
Gujarat Pollution Control Board	65	145
Maharashtra Pollution Control Board	44	97
Tamil Nadu Pollution Control Board	44	97
J-PAL South Asia at IFMR	366	813
J-PAL South Asia at IFMR - Industry surveys	791	1758
	1467	**3259**
Continuous emissions monitoring system installation		
Gujarat industry	10037	22304
Maharashtra industry	7500	16667
Tamil Nadu industry	7500	16667
	25037	**55638**
Continuous emissions monitoring system maintenance		
Gujarat industry	3680	8178
Maharashtra industry	2760	6133
Tamil Nadu industry	2760	6133
	9200	**20444**

Total cost	**35938**	**79862**

A significant part of this cost will be an investment in the future of environmental regulation in India. For example, the development of regulatory changes, technical standards and a trading platform are one-time costs that will make expanding emissions trading to different pollutants and states much easier in the future. The installation of continuous monitoring systems is also an investment. This is a capital cost that will pay back in terms of facilitating comprehensive, accurate monitoring of large industries in Gujarat and Tamil Nadu for many years and should not be taken as an annual expense.

The costing is presented to give an overall budget without regard to funding source. Cost-sharing with industry for the adoption of continuous emissions monitoring systems could defray a significant portion of the up-front project costs, as industry costs account for over 95% of the overall project budget. For example, in Tamil Nadu a small number of the largest industries to initially adopt CEMS joined the monitoring system by connecting their existing monitoring instruments to TNPCB's infrastructure. Most industries do not have such systems installed, however, and so the pilot could encourage cost-sharing for CEMS adoption.

The table below gives an example of how the budget, from the perspective of the Centre, may change under cost-sharing. This cost-sharing budget assumes that the Centre subsidizes 50% of the CEMS installation cost but that thereafter industries are accountable for CEMS maintenance costs. Under these assumptions the project budget falls to Rs. 142 Crores. These assumptions are consistent with the manner of cost-sharing under past environmental projects in India, where state governments and Govt. of India have supported from one-quarter to more than one-half of costs. However, given the innovative nature of the present scheme, and the need to bring in a large number of industries in a time-bound manner, the right cost-sharing for the emissions trading scheme may put relatively more cost on the Centre.

Project budget at Centre under Cost Sharing

Activity	Total cost (Rs. lakh)	Total cost (USD, '000)
Emissions trading scheme design (March - August 2011)		
Ministry of Environment & Forests	69	152
Gujarat Pollution Control Board	33	73
Maharashtra Pollution Control Board	21	47
Tamil Nadu Pollution Control Board	25	56
J-PAL South Asia at IFMR	86	191
	234	**520**
Ongoing oversight and evaluation (September 2011 -June 2014)		
Ministry of Environment & Forests	157	350
Gujarat Pollution Control Board	65	145

Maharashtra Pollution Control Board	44	97
Tamil Nadu Pollution Control Board	44	97
J-PAL South Asia at IFMR	366	813
J-PAL South Asia at IFMR - Industry surveys	791	1758
	1467	**3259**
Continuous emissions monitoring system installation		
Gujarat industry	5019	11152
Maharashtra industry	3750	8333
Tamil Nadu industry	3750	8333
	12519	**27819**
Continuous emissions monitoring system maintenance		
Gujarat industry	0	0
Maharashtra industry	0	0
Tamil Nadu industry	0	0
	0	**0**
Total cost	**14219**	**31598**

The parameters of cost-sharing would be negotiated between MoEF and SPCBs, with the advice and consent of the Standing Committee, in order to maximize CEMS take-up and establish industry buy-in. Industries could pay for a portion of the CEMS cost determined by the size of their boiler or another parameter fixed *ex ante*, with larger industries responsible for a greater share of the CEMS cost. Any fixed subsidy would partly be a sliding scale in practice, as larger industries may have additional stacks to monitor and greater operations and maintenance costs.

In order to encourage CEMS adoption, the cost-sharing formula may also depend on the timing of adoption. For example, industries might receive a partial subsidy conditional on installing CEMS by 1 July, 2011 and an additional subsidy, up to the full cost of CEMS, for having achieved 90% CEMS uptime by 31 August, 2011. Industries that lag this timetable would still be required to install CEMS and participate in the scheme, as per the regulatory notification and Consent modification, but would not be eligible for a subsidy.

6.1 Industry cost

The primary cost of introducing an emissions trading scheme is the capital cost of continuous emissions monitoring systems to be installed in industry. Given that CEMS is such a large share of the overall project cost the justification for requiring CEMS adoption is given at length in Annex I. Detailed project cost on the industry side is presented below.

The CEMS expense would not be paid in any single contract but rather provided to all qualified engineering consultancies, as detailed in the project activities section. All firms that submitted reasonable and technically sound bids would be allowed to solicit industry business for both installing CEMS and for operations and maintenance contracts. The open nature of

this contracting is crucial to the project, as it will encourage the growth of domestic capacity for continuous monitoring and likely bring down costs over time as firms compete and more industries come online.

The per-unit CEMS costing is based on each industry installing an opacity monitor and flow meter in one stack. If industries have more than one stack this cost would be proportionally higher. The combination of opacity and flow meters is required to measure total mass of particulates emitted. The share of these particulates less than 10 micrometers in diameter would be assessed using fixed emissions factors by sector or process type.

This monitoring method will generally provide a very reliable measure of total particulate mass emitted. Any industry that wishes to contest this method, or for which this method does not appear suitable, may install additional instruments to measure particulates with a sampling method or to measure the oxygen content of stack gas. These additional instruments would cost 5-10 lakh more per industry, but are excluded as they are inessential to the accurate measurement of particulate emissions.

Industry cost in Gujarat

Activity	Total (number)	Units	Per unit (stack) cost (Rs. lakh)	Total cost (Rs. lakh)
CEMS Installation				
SPM analyzer	400	industry	6	2400
Flow analyzer	400	industry	4	1600
Data acquisition and handling system	400	industry	10	4000
Additional industry infrastructure	400	industry	5	2000
Care Centre infrastructure	1		20	20
Ambient Monitor (PM10)	2	monitor	8.5	17
				10037
Operation and maintenance			**(Rs.)**	
Calibration gas replacement	800	event	55000	440
Sensor maintenance	5600	person-day	10000	560
Hardware Failure	2800	person-day	10000	280
Other downtime	24000	person-day	10000	2400
				3680
Total cost				**13717**

Industry cost in Maharashtra

Activity	Total (number)	Units	Per unit (stack) cost (Rs. lakh)	Total cost (Rs. lakh)
CEMS Installation				
SPM analyzer	300	industry	6	1800
Flow analyzer	300	industry	4	1200
Data acquisition and handling system	300	industry	10	3000
Additional industry infrastructure	300	industry	5	1500
				7500
Operation and maintenance			**(Rs.)**	
Calibration gas replacement	600	event	55000	330
Sensor maintenance	4200	person-day	10000	420
Hardware Failure	2100	person-day	10000	210
Other downtime	18000	person-day	10000	1800
				2760
Total cost				**10260**

Industry cost in Tamil Nadu

Activity	Total (number)	Units	Per unit (stack) cost (Rs. lakh)	Total cost (Rs. lakh)
CEMS Installation				
SPM analyzer	300	industry	6	1800
Flow analyzer	300	industry	4	1200
Data acquisition and handling system	300	industry	10	3000
Additional industry infrastructure	300	industry	5	1500
				7500
Operation and maintenance			**(Rs.)**	
Calibration gas replacement	600	event	55000	330
Sensor maintenance	4200	person-day	10000	420
Hardware Failure	2100	person-day	10000	210
Other downtime	18000	person-day	10000	1800
				2760
Total cost				**10260**

6.2 State Pollution Control Board cost

The primary cost for SPCBs is capacity-building and labor to oversee the introduction of the scheme. Unlike for industry, the capital cost for the monitoring equipment is relatively small for SPCBs. The capacity-building element will be important for SPCBs. Staff must be trained to understand the function of the new continuous monitoring equipment, from recognizing signs of erroneous data in the office to calibrating equipment in the field.

Gujarat Pollution Control Board

Activity	Total (number)	Units	Per unit cost (Rs. lakh)	Total cost (Rs. lakh)
Emissions trading scheme design - Personnel				
CEMS Expert	6	person-month	50000	3
Care Centre Manager	12	person-month	50000	6
Care Centre Assistant	18	person-month	30000	5.4
CEMS Field Personnel	18	person-month	30000	5.4
Training Cost	8	person-month	30000	2.4
Overhead				2.22
				24.42
Ongoing oversight and evaluation - Personnel				
CEMS Expert	18	person-month	50000	9
Care Centre Manager	36	person-month	50000	18
Care Centre Assistant	54	person-month	30000	16.2
CEMS Field Personnel	54	person-month	30000	16.2
Overhead				5.94
				65.34
Emissions trading scheme design - CEMS Capacity Building Workshop				
Expert Speaker - CEMS System	2	person-day	25000	0.50
Domestic Travel (Exec - Director , J-PAL SA)	2	return flight	10000	0.20
Domestic Travel (MOEF , GOI)	2	return flight	12000	0.24
Domestic Travel (CPCB , GOI)	2	return flight	12000	0.24
Domestic Travel (Standing Committee, ETS)	2	return flight	12000	0.24
Accommodation	12	person-day	5000	0.60
Local travel	4	person-day	1500	0.06

Conference Hall	1	Room	30000	0.30
Printing Material	75	Packets	300	0.23
Lunch	75	People	1500	1.13
Overhead	10	Percent of total	0	0.37
				4.10
Emissions trading scheme design - Trading Workshop (budgeting as for CEMS workshop)				
				4.10
Total cost				**97.97**

Maharashtra Pollution Control Board

Activity	Total (number)	Units	Per unit cost (Rs. lakh)	Total cost (Rs. lakh)
Emissions trading scheme design - Personnel				
CEMS Expert	6	person-month	50000	3
Care Centre Manager	6	person-month	50000	3
Care Centre Assistant	12	person-month	30000	3.6
CEMS Field Personnel	12	person-month	30000	3.6
Training Cost	8	person-month	30000	2.4
Overhead				1.56
				17.16
Ongoing oversight and evaluation - Personnel				
CEMS Expert	18	person-month	50000	9
Care Centre Manager	18	person-month	50000	9
Care Centre Assistant	36	person-month	30000	10.8
CEMS Field Personnel	36	person-month	30000	10.8
Overhead				3.96
				43.56
Emissions trading scheme design - CEMS Capacity Building Workshop (already budgeted)				
				0.00
Emissions trading scheme design - Trading Workshop (budgeting as for CEMS workshop)				
				4.10
Total cost				**64.82**

Tamil Nadu Pollution Control Board

Activity	Total (number)	Units	Per unit cost (Rs. lakh)	Total cost (Rs. lakh)
Emissions trading scheme design - Personnel				
CEMS Expert	6	person-month	50000	3
Care Centre Manager	6	person-month	50000	3
Care Centre Assistant	12	person-month	30000	3.6
CEMS Field Personnel	12	person-month	30000	3.6
Training Cost	8	person-month	30000	2.4
Overhead				1.56
				17.16
Ongoing oversight and evaluation - Personnel				
CEMS Expert	18	person-month	50000	9
Care Centre Manager	18	person-month	50000	9
Care Centre Assistant	36	person-month	30000	10.8
CEMS Field Personnel	36	person-month	30000	10.8
Overhead				3.96
				43.56
Emissions trading scheme design - CEMS Capacity Building Workshop				
Expert Speaker - CEMS System	2	person-day	25000	0.50
Domestic Travel (Exec - Director , J-PAL SA)	2	return flight	10000	0.20
Domestic Travel (MOEF , GOI)	2	return flight	12000	0.24
Domestic Travel (CPCB , GOI)	2	return flight	12000	0.24
Domestic Travel (Standing Committee, ETS)	2	return flight	12000	0.24
Accommodation	12	person-day	5000	0.60
Local travel	4	person-day	1500	0.06
Conference Hall	1	Room	30000	0.30
Printing Material	75	Packets	300	0.23
Lunch	75	People	1500	1.13
Overhead	10	Percent of total	0	0.37
				4.10
Emissions trading scheme design - Trading Workshop (budgeting as for CEMS workshop)				
				4.10

Total cost	**68.93**

6.3 Ministry of Environment & Forests and Central Pollution Control Board cost

The cost from the MoEF and CPCB side is purely labor and services, and hiring of technical and legal consultancy services for the establishment of the standing committee and the development of the scheme.

Ministry of Environment & Forests

Activity	Total (number)	Units	Per unit cost (Rs.)	Total cost (Rs. lakh)	Total cost (USD)
Emissions trading scheme design - Personnel					
MOEF - Scientist	6	person-months	50000	3.00	6667
CPCB - Accounts manager	6	person-months	50000	3.00	6667
CPCB - Air Quality Lab Expert	6	person-months	50000	3.00	6667
CPCB - Appointed CEMS Expert	6	person-months	50000	3.00	6667
Expert – Engineering	6	person-months	150000	9.00	20000
Expert – Emissions markets	3	person-months	562500	16.88	37500
Expert – Exchange Set-up	3	person-months	150000	4.50	10000
Legal Consultants	20	person-months	100000	20.00	44444
Overhead (10%)				6.24	13861
				69	**152472**
Ongoing oversight and evaluation - Personnel					
MOEF - Scientist	18	person-months	50000	9.00	20000
CPCB - Accounts manager	18	person-months	50000	9.00	20000
CPCB - Air Quality Lab Expert	18	person-months	50000	9.00	20000
CPCB - Appointed CEMS Expert	18	person-months	50000	9.00	20000
Expert – Engineering	18	person-months	150000	27.00	60000
Expert – Emissions markets	9	person-months	562500	50.63	112500
Expert – Exchange Set-up	9	person-months	150000	13.50	30000
Legal Consultants	16	person-months	100000	16.00	35556
Overhead (10%)				14.31	31806
				157	**349861**
Total cost				**226**	**502333**

6.4 Evaluation cost

The cost of evaluation will support J-PAL South Asia staff in designing and supervising an evaluation of the ETS roll-out. Some of this cost is for expert consultancy from the public, private and non-profit sectors in order to ensure a sound scheme design. The bulk of this cost

is for field surveys of pollution abatement efforts and expenditures at an industry level for all industries participating in the scheme. The data collected by these five survey rounds, along with the emissions data collected from the CEMS, will be the basis for evaluating the success of the pilot scheme.

Evaluation costs of J-PAL South Asia

Activity	Total (number)	Units	Per unit cost (Rs.)	Total cost (Rs. lakh)	Total cost (USD)
Emissions Trading Scheme Design					
Emissions trading scheme design - Personnel					
Standing Committee Chairperson	30	person-days	10000	3.0	6667
Standing Committee Members	3	persons	90000	2.7	6000
JPAL SA personnel	3	persons	320000	9.6	21333
				15	**34000**
Emissions trading scheme design - Travel and accommodation					
Domestic Travel and accommodation	18	person-trips	25000	4.5	10000
International Travel	3	person-trips	85000	2.6	5667
				15.3	**15667**
Emissions trading scheme design - Research staff and supervision					
Research staff salaries				33.4	74218
Travel and allowances				4.4	9667
Support, supervision and benefits				10.0	22167
				47.7	**106052**
Emissions trading scheme design - Overheads and Miscellaneous					
	10	percent of	78	**7.8**	**17405**
Emissions trading scheme design - Subtotal					
				86.2	**191457**
Ongoing Oversight and Evaluation					
Ongoing oversight and evaluation - Personnel					
Standing Committee Chairperson	72	person-days	10000	7.2	16000
Standing Committee Members	3	persons	900000	27.0	60000
				34	**76000**
Ongoing oversight and evaluation - Travel and accommodation					
Domestic Travel and accommodation	36	person-trips-years	25000	9.0	20000
International Travel	12	person-trips-years	85000	10.2	22667
				34.2	**42667**
Ongoing oversight and evaluation - Research staff and supervision					
Research staff salaries				167.0	371092
Travel and allowances				21.8	48333

Support, supervision and benefits				49.9	110833
				238.6	**530258**
Ongoing oversight and evaluation - Dissemination and Conferences					
Conferences	2			16.5	36556
Publications and other dissemination				9.1	20289
				25.6	**56844**
Ongoing oversight and evaluation - Overheads and Miscellaneous					
	10	percent of	333	**33.3**	**73910**
Ongoing oversight and evaluation - Subtotal					
				365.9	**813013**
Survey Expenses					
Each of two detailed survey rounds (Base Line and End Line)					
Technical Survey Team	160	person-month	100000	160.0	355556
General Survey Team	40	person-month	80000	32.0	71111
Travel Allowence (general survey team)	40	person-month	10000	4.0	8889
Travel allowance (technical survey team)	160	person-month	20000	32.0	71111
Supervisor	21	person-month	80000	16.8	37333
Travel allowance (supervisor)	21	person-month	10000	2.1	4667
				246.9	548667
Two detailed surveys together					
				493.8	**1097333**
Each of three midline survey rounds					
Technical Survey Team	40	person-month	35000	14.0	31111
General Survey Team	40	person-month	80000	32.0	71111
Travel Allowence (general survey team)	40	person-month	10000	4.0	8889
Supervisor	8	person-month	80000	6.4	14222
Travel allowance (supervisor)	8	person-month	10000	0.8	1778
				57.2	127111
Three midline surveys together					
				172	**381333**
Data entry					
Data Entry and Reconciliation software	1	number	200000	2	4444
Number of Data Entry Operators	48	person-month	7500	4	8000
Data Manager	0.9	person-month	40250	0	805
Supervisor	18	person-month	15000	3	6000
Computers for Data entry - rental and mainetance	72	computer-month	25000	18	40000
				27	**59249**
Miscellaneous survey expense					
Training venue hire	10	days	4000	0.4	889

Stationery/Miscellaneous supplies	1		10000	0.1	222
Questionnaires - Training/buffer	5400	questionnaires	1	0.1	120
Questionnaires - Baseline and Endline	72000	pages	1	0.7	1600
Questionnaires - Continuous surveying	54000	pages	1	0.5	1200
				1.8	**0.040**
Administration and Office expenses					
Office rent	60	office-month	30000	18.0	40000
Office supplies and maintenance				7.2	16000
				25.2	**56000**
Survey expenses - Overheads and Miscellaneous					
	10	percent	719	**71.9**	**159795**
Survey expenses - Subtotal					
				791.0	**1757742**
Total cost				**1243**	**2762212**

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Annex 1. Requirement for Continuous Monitoring to Support ETS

An emission trading system requires sound monitoring of total emissions, respected by the regulator, market participants and the public at large. This requirement dictates that only continuous emissions monitoring systems (CEMS) at each participating industry are adequate to support emissions trading. The reasons for this requirement are reviewed here.

- *Monitoring Total Emissions*. The unit of exchange in an emissions market is some measure of total industry emissions into air or total effluent load into water. To monitor this total quantity, emissions concentrations and the rate of flow must be measured continuously and totaled over the whole trading period, often a quarter, half-year or full year.

- *Integrity of Emissions Trading System*. All participants in emissions markets must have confidence that the unit of exchange, for example a ton of emissions, represents a commodity of equal value no matter its source. Online monitoring and constant scrutiny of each participating unit creates this confidence by showing units the rigor of the system.

- *Equity of Compliance System*. The value of permits that each unit must buy or sell depends on emissions at all other units. If any emissions from any unit are reported low, for example, it lowers the demand for and thus the value of permits and reduces incentive for all units to achieve additional abatement. Any lower standard of monitoring is therefore especially unfair to the units achieving the most abatement.

The alternative to continuous emissions monitoring would be spot-monitoring of emissions combined with some model to relate these spot observations to total emissions. For example, in the Chilean total suspended particulates trading scheme, the actual trading units were based not on monitored emissions but on the capacity to produce emissions, which the regulator determined by measuring the boiler size and fuel type of each unit during annual inspections. Under the Clean Development Mechanism (CDM), units project carbon emissions based on fuel consumption and emissions factors, which are then verified on-site during annual validation by a Designated Operating Entity (DOE), basically a third-party auditor.

These alternative spot-check designs undermine many of the benefits of emissions trading and often generate controversy. As noted in the paper "Towards an Emissions Trading Scheme for Air Pollutants in India," the monitoring protocol of the Chilean scheme limited its success. The CDM is one of the most controversial aspects of the Kyoto protocol. There are many reasons why spot-check systems are a worse basis for trading than CEMS:

- *Maximizing Cost Savings*. The main benefit of emissions trading is to allow flexibility in how industries may abate emissions, which lowers the costs of meeting a given pollution target. This flexibility is greater when trading is based on monitoring of total emissions, the final output of pollution abatement. Trading being based on any input or intermediate stage of emissions abatement forecloses the possibility of any cost savings that could be found after that stage. For example, if emissions

estimates are based on heat input and fuel type, an industry receives no benefit for more efficient combustion or APCM operation. In this way, only continuous monitoring at the end-of-pipe can achieve the greatest cost savings.

- *Pressure on Spot Checks.* An alternative system to estimate total emissions, as introduced above, would be based on spot-checks of emission concentrations and measures of equipment installed. The total estimated emissions for the year will depend on emissions concentrations that would be measured only occasionally. These occasional measurements would therefore determine a large potential cost in terms of required emissions permits for each unit. The occasional concentration measurements would therefore be done under great pressure and expose industries to a great deal of risk.

- *Limited Market Scope*. Because spot-check monitoring calculates total emissions based on a formula that applies to a particular sector, it limits the scope of emissions markets to that sector. This limited scope impairs easy trading of permits and lowers cost savings from emissions trading. In contrast, a market based on the pollutant itself can grow to include sources of many different types.

- *Nature of Pollutants.* CO_2 is a relatively predictable function of fuel combustion. Every industry has an incentive to maintain efficient combustion so as not to waste fuel. Other pollutants, such as SPM or COD in wastewater, are much more variable at the end-of-pipe, depending on the conditions of combustion or the operation of the effluent treatment plant. Therefore it would be harder to form a clear picture of emissions from spot-checks. Moreover, industry has no natural incentive to economize on these pollutants, unlike for CO_2.

- *Cost of Rigorous Spot-Checks.* The primary reason for a spot-check system, lowering monitoring cost, is weak in practice. The cross-verification required in a rigorous spot-check system requires a great deal of labor from skilled technical staff. In the case of the CDM, for example, the initial project design and monitoring protocol typically costs Rs. 20 lakh or more and the annual validation thereafter costs Rs. 5 – 10 lakh. These monitoring visits are often done in addition to continuous self-monitoring of combustion by industries that have taken up projects. The total cost of a rigorous spot-check monitoring system can thus equal or exceed that of CEMS.

The overarching concern with such a spot-check design is that it could not match the transparency and fairness of a system based on continuous monitoring. A spot-check system would not have the rigor to earn the confidence of market participants, that they were buying and selling a tangible quantity, and of the public at large, that the emissions trading scheme was achieving real environmental gains.