4 An analysis of cost and benefit of various environmental norms

Introduction

The environmental impacts of the different power technologies have already been broadly outlined in the previous chapter. This chapter attempts to provide a measure for these impacts for the specific technologies. In literature, the impact measure is termed as “environmental risk assessment”, and the cost benefit analysis implies that an economic analysis besides, the financial assessment of compliance will be taken into consideration. However, given the constraint in terms of data availability, applicability of impact assessment and dependence on secondary information, the cost benefit analysis will be restricted in nature. In many areas it is also very difficult to quantify the external effects of energy systems and it is even more difficult to monetarise these effects. However, some rough estimates have been attempted wherever possible, as it makes more sense than to ignore totally the external effects. And wherever it has not been possible to include any monetary value, the impacts have been highlighted to ensure that the corresponding under-estimation is emphasised.

Background

"Environmental risk" is defined as the probability of occurrence of a particular adverse effect on human health or the environment as a result of exposure to an environmental hazard; an "environmental hazard" may be a hazardous chemical in the environment, a natural hazard, or a hazardous technology (for example, a dam).

"Environmental risk assessment" refers to any formal or informal scientific procedure used to produce a quantitative estimate of environmental risk. For example, risk assessment is often used to estimate the expected rate of illness or death in a human population exposed to a hazardous chemical based on the number of experimental animals affected by various doses of the chemical as measured in laboratory experiments[a]. "Environmental risk analysis" is defined more

[a] Laboratory studies of toxicity are supervised and interpreted by toxicologists. Epidemiologists, who also contribute data for risk assessment, study the health of human populations who have been exposed, usually accidentally or occupationally, to a hazard.

broadly to include any quantitative or qualitative scientific description of an environmental hazard, the potential adverse effects of exposure, the risks of these effects, events and conditions that may lead to or modify adverse effects, populations or environments that influence or experience adverse effects, and uncertainties with regard to any of these factors[a] Generally, risk analyses are based on scientists' evaluations of results of scientific research, extrapolations of these results to predict the type and to estimate the extent of effects in exposed populations, and judgements about the number and characteristics of persons exposed to hazards at various levels. The final step in risk analysis is "risk characterisation," which summarises scientific judgements about the existence and overall magnitude (that is, the incidence) of adverse effects given specified levels of exposure to a pollutant.

"Economic analysis" refers to any systematic procedure to evaluate real or anticipated resource expenditures and losses (costs) relative to real or anticipated gains (benefits). "Cost-benefit-risk assessment" is the quantification and monetary valuation of the expenditures, gains, and losses, and the calculation of net benefits to society associated with the adoption of a particular regulation (or alternative management strategy) to address an environmental pollutant. Quantitative environmental risk analysis (that is, risk assessment) is a necessary prerequisite to the conduct of cost-benefit-risk assessment of environmental regulations, because the " benefits" are the risks avoided (that is, the adverse effects on human health or the environment, or risks of such effects, that the regulation is meant to address). Risk assessment may be used to estimate the number of people or animals likely to be harmed by exposure to the hazard under each regulatory strategy, including a "do-nothing-different" strategy that reflects the current policy, or regulation, or laissez faire. Benefits may be expressed in such terms as numbers of lives saved or illnesses or species extinction avoided. Risk that is expected to remain after a regulation is implemented may be subtracted from the risk under current conditions to estimate risk reduction opportunities -- that is, the "expected benefit " -- of each regulatory alternative. If benefits are translated into monetary terms to allow cost-benefit-risk assessment, various techniques may be used to calculate the

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Note: The figures used for calculation in this report have been obtained from CERC.

[a] Others might use these terms differently. The important point is that it is necessary to distinguish between an analysis that focuses exclusively on the numbers associated with a hazard and a broader analysis that also considers such qualitative features as the dread a hazard inspires or the irreversibility of harm. A similar distinction is drawn between "economic analysis" and "cost-benefit-risk assessment" below.

dollar values of health effects, which have already been discussed in the previous chapter.

The intent is to estimate the gross monetary value of benefits to society, rather than to individuals. "Net benefit" is the expected monetary benefit less the cost of implementing the regulation.

The cost benefit analysis

Presently, the new project submissions for clearance have to necessarily include environmental costing as a part of the project cost. In order to comply with the legislation and norms laid down by the umbrella EPA, 1986 and the Water Act 1974, and Air Act 1981, the power projects need to install certain specific equipment. These norms are site specific, being more stringent for the environmental sensitive areas as discussed in chapter 1. Hence the costs vary depending on the sensitivity of the area in which the plant has been located.

Besides, the land under consideration, if requires relocation of human settlement, associated costs have to be taken into consideration. These costs include not only resettlement costs in terms of compensation packages, but also valuation of suffering meted out to the oustees and the loss of productivity of land. Then, there is a separate cost in case of deforestation, i.e. if setting up of plants or transmission lines need clearance of forest area, compensatory afforestation needs to carried out. A cost for the same has to be then included in the project cost.

The environmental costs thus addressed can be related to the size of the plant in some cases, namely for technical equipment. And in certain other cases related to the unit cost of the project or the land size (area) under consideration for the plant construction. Thus with respect to these costs a generic worksheet can be worked out to determine the environmental cost, the plant size, land size and cost per MW being the variables. However, certain costs are highly project specific, namely cost of resettlement, hence the worksheet reflects only an average cost in this respect.

These costs thus reflect the cost of compliance and hence could be termed as abatement cost. And subsequently it ensures that the environmental conditions are controlled and adverse impacts are contained. Thus these control measures have a beneficial impact on the environment in terms of arresting degradation and contamination, which would have occurred otherwise.

On the other hand the other socio-economic-biological impacts, which are a fall-out of installation of a power plant and cannot be controlled by the environmental norms, are at times intangible and hence the associated costs cannot be directly quantified in money terms. These impacts have to be economically evaluated. As the impacts can be subject to different interpretations and also several valuation methodologies, it leads to innumerable debates. Hence these valuations suffer from subjectivity bias, which needs to be kept in mind while interpreting the results.

The environmental aspects

Air

Air pollution from power projects is a problem primarily in case of fossil fuel based technology. The pollutants identified are oxides of sulphur, nitrogen and carbon and SPM. As already mentioned in the previous chapters, sulphur and nitrogen and SPM are emissions from coal based plants. But since the sulphur content for Indian coal is low and even the nitrogen oxide emission is quite low (lower than even the prescribed World Bank standard), no prescribed emission limits have been identified for them, nor control mechanisms prescribed by the environmental authorities. However, SPM is a problem for the Indian environment and hence the prescribed limit for the same is $150 mg/m^3$. The control measure for the same is the ESP as mentioned in the previous chapter. Hence the cost of containment of air pollution is the cost of installation of the ESP. Besides, to control the pollution level in the immediate surrounding of the power plants or in other words maintain the ambient air quality, chimneys with specific stack heights need to be constructed.

In case of gas based plants, carbon emission is the major problem, and the only solution is to ensure full combustion of the fuel. Another control measure usually installed is improved burners to control NO_x emissions. The cost of the same reflects the associated benefit accrued to the environment through low nitrogenous emissions.

There are other impacts of air, which do not have monetary values, like the health impact, impacts on materials – corrosion or soiling, loss in productivity, etc. Some of these impacts have been monetarised using economical valuation techniques in literature. But these valuations are site-specific.

Water

The impact on water is maximum in case of hydro-projects. The impact being mostly hydrological, economical valuation becomes necessary, as financial costing does not capture the total impact. In case of thermal plants, the impact is from the effluents discharged. Hence control mechanisms have to be installed for treatment of the discharges, which includes temperature control of the water discharged. This treatment facility is accounted in the financial costing of the environment, which is a part of the project cost. However, since the effluent treatment facilities are project specific, the cost cannot be related to the total project cost. Moreover most of the bigger power plants have closed circuit system, which does not involve effluent discharge, as the water is recycled. But once again, the associated ecological and hydrological impacts remain unaccounted.

Land

Construction of any power project requires acquisition of land. The land under consideration is either government holding or private holding. In case of the former, no accounting is carried out for power plants constructed by government institutions, as exchange of land takes place on mutual agreement basis. In case a private power producer needs to acquire the same land, the cost of land needs to be paid to the concerned government authority. In case of private land holding, the land type is classified into certain broad categories depending on its fertility and source of irrigation. Thereafter the State government revenue department defines compensation packages for the different categories. This package is highly state specific and can range from a few thousand rupees to lakhs per acre. This cost is assumed to take into consideration the loss incurred by the landowner in terms of livelihood and cost of land. However, the psychological impact and impact of relocation is not accounted for. The latter considerations need to be economically evaluated and corresponding monetary value considered.

Again the land under consideration, could be a forest area, which would require deforestation. Though the MOEF have certain afforestation schemes, but in case of power plants, the specific state forest department assesses the value of the forest lost and the equivalent amount has to be paid up by the plant owners. Thus the associated cost of deforestation is also site specific depending on the density of the forest, type of plants and the total land area under consideration. However, the project report prepared by Metaplanners and Management Consultant, have provided certain value for environmental loss due to deforestation. Since the values pertain to the year 1989, suitable inflation index has been used to provide a value in the present context However the value used is a rough average and actual project cost will vary for different cases.

Besides, deforestation impacts, for the other ecological system loss, in terms of loss in flora fauna and species inhabiting the forest area, economic valuation is necessary. This does not get reflected in the financial cost recovered by the forest department and accounted for in the environmental cost of the project. But as there has been no Indian study on the same, no equivalent valuation is available.

And to develop an assessment of the same, a rigorous survey exercise needs to be done, which is beyond the scope of the present study.

The environmental cost assessments[a]

Coal based projects

The environmental control measures of coal based projects have already been listed in the previous chapter. The costing of the same is provided in Annexure 4.1(i & ii). The costing is a rough estimate of the actual environmental cost, the objective being to provide a rough worksheet and an indication of the cost of different sizes of plants. It would also provide a base to reflect the variance in magnitude of the cost depending on the location of the plant. The cost as shown in Annexure 4.1(i & ii) is obtained from analysis of two coal based projects and the study done by Metaplanners and Management Consultant. The latter makes certain generalisation of the environmental costs based on actual data of a few projects. As already mentioned, since it is a dated study (1989), appropriate inflation index has been used wherever their observations have been applied.

The technical installation costs have been obtained from current projects. And on analysis some of these installations, namely cost of ESP, chimney stack construction, civil and mechanical works for ash handling one can establish a percentage-based relation with project cost or project size. Hence the worksheet provides the respective relation, assuming the unit size and project cost as the variables. Similarly other non-technical and social costs, like grant to oustees, loss in animal husbandry and forest produce and loss in public facility are related to the area under consideration or the number of people displaced. Thus accordingly a list of variables have been defined as shown in Annexure 4.1(i & ii) - and for changes in these variables, the corresponding change in environmental costing can be obtained.

However certain costs are very region specific like rehabilitation cost, hence it has not been possible to provide any rough estimate or any correlation for the same. The variation from one case to other has a broad range and any averaging will be a distortion. The value of the resettlement package depends on the fertility of land, the earnings obtained from the land, the facilities available to the oustees and the development of the region.

As for the impact costing, there has been only one study done by Brandon and Hommann specifically for India. The study provides mortality and morbidity valuation for 23 Indian cities. These equations however assesses the air pollution impact from different sources in these cities and not specifically for power plants.

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[a] Explanations of the Annexures are provided later in the chapter

Hence adopting the same for any power plant will not be justified. Especially because power plants are generally located at a distance from city nodes for which the equations have been provided. And the colonies or townships built for the respective plants are generally located in the upwind direction and hence are exposed to less pollution. Moreover marginal contribution of a single power plant is negligible. The impact assessment makes more sense if carried out for the economy as a whole or for a region.

However, the different heads under impact assessment has been highlighted to ensure that one recognises the underestimation of the costing exercise provided by power plants. The immediate effect of the plant might not be serious in terms of morbidity, mortality or loss of ecological balance but the cumulative impact after a few years, needs to be kept in mind.

Gas based projects

In case of gas based projects too, a similar exercise has been done. The result of the same is provided in Annexure 4.2. The individual environmental component costs are correlated to certain variable and the ultimate total cost varied according to the changes in these variables. However, the data is provided for an actual case and as the Metaplanner study has not provided any rigorous exercise for a gas-based plant, it is not possible to provide an elaborate worksheet for the same. However, the project cost itself included separate heads for cost of afforestation and green belt development, hence no detailed break up is provided as the coal based project. Compared to coal based projects, the environmental cost of gas based projects are quite low and the percentage varies from 2 to 5 per cent of the total project cost.

Hydro projects

Hydel projects involve rehabilitation and resettlement package as a majority component. Since costing of the same has not been carried out, the hydel projects are under-estimated to that extent. Moreover, the environmental costs are highly project specific and site specific. The environmental costs addressed here in Annexure 3 are the ones associated with submergence of the forest lands and cultivable lands. The actual calculation of hydroprojects being very project specific, the same has not been attempted. However some cost indications relating to major components for small hydro projects and large ones are provided in Annexure 4.3(i & ii). The hydrological impacts have not been evaluated, as no similar exercise has been available in literature, from which results can be used for assessment.

Impact on tariffs

The environmental cost as assessed above constitutes 10-20 per cent of the project cost depending on the technology. This cost however reflects only the financial cost incurred by the projects to adhere to the norms and conditions laid down by the different environmental authority. The generation cost thus reflects both the environmental related investments and other project construction related investments. The total cost thus includes the two investment costs along with the standard rate of return.

In case generation tariffs are simply cost plus in nature, the generators could include 'gold plating' in the pretext of environmental related investment and accrue higher returns. Thus the stringency of norms or additional environmental related investments would simply be a pass through for the projects. However if the tariffs are in some way related to their performance not only technical but environmental also, the plants would be incentivised to make prudent investments. Moreover they would also be forced to be more environmental conscious. However, implementation of the same would require stringent supervision and accounting of the environmental performance of the plants.

Sensitivity analysis

An attempt has been made to decipher the additional cost involved in meeting the World Bank norms. In case of thermal plants, the SPM standard is more stringent, which involves additional cost burden. The ESP needed to be installed for meeting such stringent norm is nearly double the cost of the ones installed presently in the Indian power plants. However the SO_x norms are not applicable to the Indian context due to the low sulphur content coal used. But keeping in mind the long term, CPCB has made it compulsory to provide for space for FGD instalment, if required. In case of FGD instalment, an additional investment requirement would be necessary, which would be quite substantial. Again NO_x and the other air emissions are within WB norms or more stringent in the Indian case, hence does not involve additional requirements.

In case of water discharge, the WB norms are highly stringent and mostly not applicable to Indian conditions, specifically the temperature control and the suspended solids norms. Considering the Indian ambient temperature and coal quality, it is not feasible to adhere to WB norms. However any attempt to improve on the present norms, will require additional costs, which will vary depending on the standards set by the plants. Since there is no linear relationship between the cost and the levels set by the norms, hence estimates are difficult to provide.

This chapter attempts to provide a simulation exercise on the environmental costs associated with the different power plants namely, coal, gas and hydro plants.

This simulation is based on information collected on the environmental compliance cost for sample plants. A comparison of the compliance cost across different plant size of the same technology provides certain fixed ratios for some components with respect to the size of the plant or the total cost. However, certain costs are fixed across board, while some costs are purely project specific. For purpose of this exercise, on the basis of some broad assumptions regarding variables like the project size, cost per MW, land area, type of land, etc., an indicative environmental cost is calculated. And certain alternative scenarios are built by varying the assumptions of a few sensitive variables.

Based on the available information, it can be concluded that the environmental cost is highly sensitive to size of the plant, area developed for ash dykes (specifically for coal based plants), need for compensatory afforestation and R&R package. Thus the alternate scenarios try to capture this sensitivity element of the cost structure. Besides, another important scenario is also evaluated, i.e. the cost of adherence to World Bank norms. Therefore the scenarios that are evaluated are:

1. Alternate plant size (PS)
2. Alternate land type (namely forest area)
3. World Bank norm (WB), wherever applicable

The exercise however, has not attempted to capture any R&R packages, as it is highly project specific and subject to conditionality. However, though afforestation component also suffers from similar subjectivity constraint, this exercise has tried to provide some valuation for the same. Using valuation method and valuation numbers as conducted by the Metaplanner study (1989), this study calculates the same after adjusting for the inflationary impacts. However one needs to be sensitive to the fact that the afforestation package is only an indicative number and hence the actual values might substantially differ. Moreover, as already stated, the afforestation packages are highly state specific and also dependent on the type of forest (i.e. the plant types) and area under consideration. And another fact that one needs to keep in mind while analysing the numbers are the basic assumptions taken into consideration, as the cost numbers are highly sensitive to these. The actual environmental cost will necessarily be quite different from the one reflected in this exercise as most of the costs are highly project specific, hence this simulation provides only an indication to the type of costs associated with environmental compliance and hence should not be taken to be an actual cost.

Thermal Plants

The cost calculation is carried out on the basis of certain broad headings as discussed in the earlier chapter and provided in Annexure 4.1(i & ii). However the information collected from some of the projects was not as detailed, it covered only the following components as provided in Table 4.1.

Table 4.1 environment cost components (coal based plants)

S.N.	Item Description
1	Electrostatic Precipitator
2	Chimney
3	Cooling Towers incl. Civil Works
4	Ash Handling Civil Works
5	Ash Handling Mechanical Works
6	Ash Dyke
7	Ash Water Recirculation (incl. in ETS, i.e. component 5)
8	Effluent Treatment Plant
9	Dust extraction & suppression systems
10	Control of fire & explosion hazards
11	DM plant waste treatment systems
12	Sewerage collection, treatment & disposal
13	Environmental lab. Equipment
14	Rehabilitation & Resettlement
15	Green Belt
16	Afforestation
17	Liquid Fuel Handling System

The environment cost information collected on some of the thermal plants however did not provide any values corresponding to afforestation and R&R. And on R&R, there was no relevant study that could be referred, hence the same has not been addressed in this study at all. However, as mentioned an estimation of afforestation has been carried under LT scenario assuming that a forest area of 500 Ha had to be cleared with a density parameter of 1[a]. One could also develop alternate scenarios within LT scenario by varying the density factor, which has however not been addressed here. For calculation of cost of afforestation, the value as stated by the Metaplanner study has been adopted and an inflation factor used to calculate the present value. The cost components addressed for calculating the environmental cost is as per Table 4.2, where the components under the broad headings, Air, Water, Ash disposal and Visual is as per information collected from relevant sources, while components under Forest and Others are arrived at on the basis of assumptions and values as provided in the Metaplanner study. The Land and Noise components are not addressed due to unavailability of accurate data.

[a] In the Metaplanner study, the cost component calculated for afforestation is dependent on the density of the forest assumed, which ranges from 0.4 to 1, with associated cost varying from approximately Rs 4 lakhs to Rs 10 lakhs per Ha.

However, as far as noise pollution is concerned, it is assumed that the construction plan takes care of the same.

The calculation for afforestation is already discussed above, and as far as other costs are considered, the relevant assumptions regarding the number of oustees, the per capita income per oustee, the loss of agricultural land, loss of rural facilities, annual benefit foregone due to deforestation etc is obtained from the Metaplanner Study and appropriate inflation factor used. The details of the numbers used are available in Annexure 4.1(i & ii). The costs addressed under the 'other costs' are primarily annual expenses.

Table 4.2 environmental cost components addressed for cost calculation

Categories	Cost components
Air pollution	
SPM	Electrostatic precipitators
SO_2, NO_X	Chimney with Stack height:
SO_2	Flue gas desulphurisation unit
	Dust extraction & suppression systems
	Equipment to monitor environment
	Equipment to monitor ambient air quality
Water pollution	
	Effluent treatment facility
	Condensate cooling water including Reservoir, Tube wells, etc. & sanitation
	DM plant waste treatment systems
	Sewerage collection, treatment & disposal system
Land	
	Rehabilitation & resettlement of displaced persons
	Restoration of land in construction area
Ash disposal	
	Ash handling system - Civil Works and Mechanical Works
	Treatment of ash pond effluent
	Ash Dykes
Forest	
	Environmental losses (when compensatory afforestation is not done) or afforestation
	Cost of supplying free fuel wood to workers during construction
Noise	
	Measures to control noise impact (ear muffs)
Visual	
	Green belt development
Other costs	
	Control of fire & explosion hazards (safety measures)
	Loss of value of timber, fuel wood and minor forest produce and manhours lost on annual basis
	Loss of animal husbandry, productivity, fodder, agriculture produce, public facilities
	Social cost for suffering to oustees

The scenarios thus developed as provided in the Table 4.3, assumes two plant sizes (PS) namely 1000MW (PS1) and 750MW(PS2) with locations (LT) either in a cleared forest area (LT1) requiring afforestation or in a non-forest area (LT2). Moreover, from the data available, the other major component in a thermal plant with a wide cost variation is ‘construction of ash dykes’ (AD). The range obtained is 2.5(AD1) to 7.5(AD2) per cent of total cost of plant construction. For scenario purpose the two bound values are only considered. The different scenarios are studied for both Indian as well as WB norms. Thus ultimately 8 scenarios are developed as provided in Table 4.3.

Table 4.3 Environmental cost comparison (Rs. Cr)

	LT1/AD1		LT2/AD1		LT2/AD2		LT1/AD2	
	Indian norm	WB norm	Indian norm	WB norm	Indian norm	WB norm	Indian norm	WB norm
PS1	689.33	760.28	410.91	481.86	585.91	656.86	864.33	935.28
PS2	589.83	643.04	277.63	330.84	408.88	462.09	721.08	774.29

Note. PS1-1000MW LT1-Afforestation done AD1-2.5 per cent
PS2- 750MW LT2-No afforestation AD2-7.5 per cent

An analysis of the cost shows that incorporation of forest area and cost of ash dyke construction can change the total environmental cost from 12 per cent to 25 per cent of total cost for the same plant size. The cost rises further to 27 per cent of total cost for adherence to WB norms, which involves only an additional expenditure on ESP as already discussed earlier. Hence any environmental cost analysis for a thermal plant needs to focus on these two cost components. The detailed calculation, along with assumptions is provided in Annexure 4.1(i & ii), where Annexure 4.1(i) pertains to plant size 1000MW and Annexure 4.1(ii) relates to 750MW plant size.

Gas based plants

In case of gas based plants, the components involved in environmental costing as collected from actual projects are as provided in Table 4.4. The information thus collected has been used in developing a simulation model for cost analysis.

Table 4.4 Environmental cost components (gas based plants)

S.N.	Item Description
1	Cooling Towers incl. Civil Works
2	Control of fire & explosion hazards
3	DM plant waste treatment systems
4	Sewerage collection, treatment & disposal
5	Environmental lab. Equipment
6	Rehabilitation & Resettlement
7	Green Belt
8	Afforestation
9	Nox Control
10	Liquid Fuel Handling System

The above costs are allocated under the broad heads similar to that provided for thermal plants. For some of the cost component a relation with the total project cost can be established, while others like, DM plant waste treatment system, R&R, afforestation, green belt development and liquid fuel handling system are ad hoc in nature with a wide range of cost variation. There are however, some components, like, control of fire and explosive hazards, sewerage treatment and environmental lab equipment, which are fixed in nature. Thus by varying the adhoc costs the sensitivity scenarios are developed.

As in the case of thermal plants the plant sizes (PS) are varied (PS1 = 675 MW, PS2 = 300 MW) and thereafter the two bounds of the adhoc costs are used to develop the alternate cost scenarios. The scenarios thus developed firstly involve varying the cost bounds of liquid fuel handling system (an **A**ir pollution control mechanism) and DM plant waste treatment (a **W**ater pollution control mechanism) and is termed as AW scenario (AW1 where the upper bounds of both are taken and AW2 where the lower limits are considered). Secondly the R&R package (Land factor), afforestation (Forest factor) and green belt development schemes are considered and is termed as LF scenario (LF1, where upper bounds are taken and LF2 where lower bounds for all are incorporated). The detailed assumptions are listed in the Table 4.5 along with the cost estimates.

Table 4.5 Environmental cost comparison (Rs. Cr)

	AW1/LF1	AW1/LF2	AW2/LF1	AW2/LF2
PS1	**94.05**	**75.29**	**86.84**	**68.09**
PS2	**44.33**	**35.99**	**41.12**	**33.73**

Note. PS1-675MW, PS2-300MW, AW1: Liquid fuel handling system-0.28 per cent of total cost, DM plant waste treatment-0.17 per cent of total cost, AW2: Liquid fuel handling system-0.03 per cent of total cost, DM plant waste treatment-0.06 per cent of total cost, LF2: R&R –0.7 per cent of total cost, Afforestation-0.2 per cent of total cost, Green belt development-0.1per cent of total cost, LF1 R&R – 0.01 per cent of total cost, Afforestation-0.04 per cent of total cost, Green belt development-0.01per cent of total cost

As evident from the cost estimates, the plant size has an eormous impact on the environmental cost, but besides, the R&R and afforestation schemes referred to in LF has also a high impact. In percentage terms, the environmental cost however involves merely 3 to 5 per cent of the total project cost. The detailed results are provided in Annexure 4.2.

Hydroprojects

The most subjective cost assessment is with reference to hydroprojects. The bulk of the cost is associated with catchment area treatment, R&R packages and compensatory afforestation, all of which are location specific and hence varies highly across all projects.

Table 4.6 Environmental cost components (hydroprojects)

S.N.	Item
1	Compensatory afforestation in the reservoir for soil conservation with selected trees & grass upto a height of 10m from MWL covering the fule submersion length.
2	Restoration of land in construction areas to prevent further erosion by stone soling assuming 15 cum/ha @ Rs. 518.00/cum
3	Control of aquatic weeds in submerged areas (for six years)
4	Enforcement of antipoaching laws (for 8 years)
5	Measurement to prevent fires overgrazing etc. (for 8 years)
6	Establishment of fuel depots etc to meet fuel requiremtn of labour force to prevent indiscreminate falling of trees (for 8 years)
7	Public Health measures to control spread of water and soil borne deseases (for 8 years)
8	Environmental Impact Assessment study
9	Catchment Treatment
10	Consultancy fee for environmental studies
11	Development of dumping yard
12	Afforestation of land for setting up of village woodlots in areas contiguous to resettlement
13	Relocation of temples and their approaches
14	Sustenance and enhancement of fisheries potential
15	Establishment of an environmental management cell
16	Effluent treatment plant
17	Seismological observations

The major components included in the cost assessment (as obtained from data collected) are as per Table 4.6. However for cost assessment the broad categorisation can be done as per Table 4.7. Since most of these costs are highly project specific, it is not possible to provide even any indicative number or percentage of total environmental cost accrued by a hydroproject.

Table 4.7 Categorisation of environmental cost

Environmental cost : Control / Stability measures	
Land	
	Cost of slope protection & landslide prevention
	Cost of rehabilitation
	Mines & minerals submergence
	Catchment area treatment/development
Forest	
	Environmental losses (when compensatory afforestation is not done) or afforestation
	Cost of supplying free fuel wood to workers during construction
Other costs	
	Loss of value of timber, fuel wood and minor forest produce and manhours lost on annual basis
	Loss of animal husbandry, productivity, fodder
	Loss of agriculture produce
	Loss of public facilities
	Social cost for suffering to oustees

However to provide an indication of the procedure of cost assessment the valuation of some of the components are provided for in Annexure 4.3(i) and 4.3(ii). These values are only indicative as it is based on a number of assumptions. For example the afforestation exercise, considers a particular forest type with specific plant types along with the number of trees planted per hectare and the total hectare under consideration. Similarly for catchment area treatment, the implicit assumptions regarding the agriculture output, livestock, habitat etc. These multiple variables, makes the assessment of cost quite complicated. Hence a simulation exercise in this case would be of limited value and hence has not been attempted.

Issues and concerns

There is a basic division of power between the centre and the states in India, reflecting the federal nature of the Indian Constitution. The mandate of the Central Pollution Control Board (CPCB) is to set environmental standards for all plants in India, lay down ambient standards, and co-ordinate the activities of the State Pollution Control Boards (SPCBs). The implementation of environmental laws and their enforcement, however, are decentralised, and are the responsibility of the SPCBs. Anecdotal evidence suggests wide variations in enforcement across the states. In fact it has been argued (Gupta 1996) that although states cannot compete by lowering environmental standards in order to attract new investment, they can get around this by lax enforcement.

The two main pollution control statutes in India are the Water (Prevention and Control of Pollution) Act of 1974, and the Air (Prevention and Control of Pollution) Act, which came into being in 1981. Thereafter, Parliament passed the Environment (Protection) Act in 1986. This was designed to act as umbrella legislation for the environment, with responsibility for administering the new legislation falling on the Central and State Boards. The law prohibits the pollution of air and water bodies and requires that generators of effluent/ discharges get the prior consent of the SPCBs. This consent to operate must be renewed periodically.

SPCBs have the legal authority to conduct periodic inspections of plants to check whether they have the appropriate consent to operate, whether they have effluent treatment plants, take samples for analysis, etc.[a] Some of these inspections are also programmed in response to public requests and litigation. The penalty for non-compliance is fines and imprisonment, but until 1988 the enforcement authority of the SPCBs was very weak. It was limited to criminal prosecution (with its attendant delays) and seeking injunctions to restrain polluters. Now, however, SPCBs have the power to close non-compliant factories or cut-off their water and electricity by administrative orders. The potential cost to the plants of non-compliance is thus not trivial, but at the same time there should be an incentive for plants to comply with the law.

However, compliance depends on both monitoring and enforcement of the law by the SPCBs. And it is often the case that organisations measure "success" in achieving their policy goals in terms of an increase in spending or the number of actions taken, rather than outcomes. For instance, assessing performance by counting the frequency or absolute number of inspections rather than the resulting environmental quality would be valid if, indeed, inspections have an impact on emissions. In the Indian context, despite a strong legal framework and the existence of a large bureaucracy for dealing with environmental regulation, the public perception is that implementation remains weak.

Given the penalties in force for non-compliance in India and keeping in mind the extent of the SPCBs’ powers, it should be emphasised that the impact of inspections on compliance will be only as strong as the threat of enforcement and punishment faced by the plant. In an environment of corrupt local inspectors or

[a] "...to inspect sewage or trade effluents, works and plants for the treatment of sewage and trade effluents... or in connection with the grant of any consent as required by this Act." Water (Prevention and Control of Pollution) Act, 1974.

bureaucratic procedures with sporadic action against errant behaviour, inspections alone are unlikely to be effective. Also, the reality is that resource constraints at the state level mean that environmental management often degenerates into crisis management.[a] Inspections are undertaken at the time that operating consent is granted and thereafter usually only in response to complaints, accidents or other emergencies.

Again, if the tariffs for the generating stations were so designed to be performance related, the present mechanism would need to be revisited. The plants are required to present the environmental audit reports annually and quarterly environment assessment report. The accuracy of the reports and the process of generating the reports are debated and questioned in all the states in India. With the enforcement mechanism being laxed along with low accountability, the actual conditions and reported conditions often vary. Hence linking the tariff to performance will require development of a stringent monitoring system simultaneously. This might require development of a cost-benefit analysis mechanism on a regular basis.

Even if the everyday practice of benefit-cost analysis improves, there is no assurance that these analyses will contribute to more informed and improved public policy toward the environment. Table 4.9 lists several procedural steps that can increase the usefulness of an analysis.[b] But there is still no assurance that regulatory assessments will be done and used well unless agencies have incentives to use resources for analysis and use analysis in decision making. If agency budgets for analysis are not sufficient, then analysis will suffer. If assessments are done solely by the same offices that seek new regulations and will have responsibility for implementing them, then a self-serving bias is likely to exist and there will inevitably be questions about the completeness and reliability of analysis.[c] However developing a statutory basis for cost benefit analysis of the environmental impact could be an efficient approach towards a balanced decision making but to assure effectiveness of such an approach one needs to ensure accountability in the quality of the analysis carried out.

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[a] Statement by Utpal Mukhopadhaya, former Environment Secretary in Maharashtra, India chronicled in World Bank document.

[b] The items listed in Tables 1 and 2 are drawn in part from such as the OMB guidelines, Arrow et al., and Morgenstern.

[c] Linda Babcock and George Lowenstein, "*Explaining Bargaining Impasse: The Role of Self-Serving Bias*," Journal of Economic Perspectives 11 (1997):109-126.

Table 4.8 Suggested Improvements in the Practice of Benefit-Cost Analysis

ISSUE	Good Practice
Problem	A clear statement of the problem to be addressed by regulation.
Baseline	A logical and consistent definition of baseline conditions.
Alternatives	Identification and at least some assessment of a range of alternatives, not just one preferred or "mandatory" alternative.
Integration	Provide information on the real "drivers" of benefits and costs in their natural units of measurement such as: sickness cases avoided, recreational visits, tons of pollution emitted, etc.
Valuation	Treatment of benefits and costs with attention to direct and indirect effects and monetisation of benefits and costs to the greatest extent possible using consistent valuation rules.
Equity	Some discussion of the incidence of benefits and costs and their implications for equity concerns.
Data	Evidence that data used in the analysis have been evaluated and are credible.
Uncertainty	Assessment of potential uncertainties and biases in the analysis. Uncertainties can be dealt with using sensitivity analysis. And at a minimum, implicit value judgments underlying risk assessments should be made explicit, and sensitivity analyses should be performed using other risk characterizations that account for a range of sensitivities and exposures as well as extreme cases.
Discounting	Consistent and logical procedures for discounting benefits and costs.
Communication	Presentation of the analysis in a standardized format, as transparently as possible, with a table at least summarizing categories of impacts and monetised values.

Source Resources for the Future, Discussion Paper 99-11 pg 17.

Table 4.9 Suggested Improvements in the Process of Benefit-Cost Analysis

ISSUE	Improved Process
Early start	Initiation of the analysis at the start of the rulemaking process or legislative deliberations to inform option development.
Value of information	Early (informal) identification of those decisions that might change as a result of benefit cost studies.
Participation	Identification of the key non-governmental stakeholders in a prospective regulation or law, with the assessment process made more transparent and accessible to them by inviting their contributions to it.
Review	Provision for an ongoing interagency process for economic analyses of major rules, to ensure consistency in basic assumptions and methodologies and an internal check on quality control. Consider external review.

Source: Resources for the Future, Discussion Paper 99-11 pg 17.

Since substantial costs (namely, intangible losses of the environment) to society are not reflected in the pricing of electricity, biased decisions are produced by the market mechanism (Solow, 1982, p. 32). And literature supports the argument that compared to conventional non-renewable energy sources, the renewable energy sources produces very few external costs and sometimes may even cause external benefits. But due to the present form of pricing and costing, the renewable energy sources are at an unjustified disadvantage vis-à-vis their non-renewable counterparts. It is felt that the renewable energy sources are not utilised to their full competitive potential. Thus a subsequent environmental analysis of the renewable sources would provide a basis of comparison for the impacts as well as the associated costs.

However, in order to obtain an exact valuation of the environmental impacts, a rigorous exercise for particular power projects need to be done, highlighting the unique environmental features of each project. Besides, for evaluation of the impact pathways, survey needs to be done. But to obtain a basic understanding of the associated costs and areas of concern, the rough worksheet exercise is sufficient. However, the issues being defined, the need of the moment is to outline appropriate measures and agenda.