Introducing Green Technology in Developing Nations: A case of Indian Railways

Teaching Note

CASE SUMMARY

The case highlights the use of a sustainable procurement policy to facilitate introduction of green technology with high initial costs, resulting in economic and environmental benefits.

Background

The total volume of public procurement in India has been estimated to constitute about 30% of the GDP (Sinha 2009; OECD 2010). There is no law that governs public procurement in India. The General Financial Rules (GFR), issued by the Ministry of Finance in India, list the basic principles of efficiency, economy, fairness, equitability, equality, and promotion of competition in public procurement. The current guidelines do not mandate public authority to integrate environmental and social concerns in public buying. However, awareness about the need for internalizing sustainability in decision-making has been growing in recent years. The use of public procurement as a tool to influence market trends in favour of environmentally and socially responsible products and services is a relatively new concept in India. The Ministry of Railways, which administers Indian Railways, a national railroad carrier of India, is one of the central ministries in the Government of India. The procurement of goods, works, and services in Indian Railways is governed by the GFR, codes, manual and departmental guidelines.

The *Indian Railways Vision 2020* document states its intention to conserve energy by achieving 15% enhanced energy efficiency and to usher in a low carbon, energy-efficient path. Many employees working for Indian Railways reside in railways colonies. Most of these households use energy inefficient incandescent lamps (ICLs) for their lighting needs, thus, increasing peak electricity demand in the evening.

Strategy to Implement Green Technology in Indian Railways

Despite the great energy saving potential of compact fluorescent lamps (CFLs) (see Table 1),

earlier attempts by government and industry in India to promote the use of CFLs in the Indian Market (unorganized and import based) had met with little success (penetration of CFLs in the household sector is only about 5-10%).

The team decided to use life cycle costing of products to demonstrate the economic benefit of choosing green products even if they have higher initial cost than browner products. Since sustainable procurement policy focuses not on 'initial cost' of materials but 'life cycle cost' of materials, governments using this policy can easily demonstrate the benefits of CFLs over ICLs. However, that would mean a departure from traditional evaluation criteria of looking just at initial cost of material. This strategy would work perfectly fine when the entity in question has sufficient financial resources in hand. However, in the case of individual consumers, though they may be aware of the value of using CFLs, this option may not work due to a first cost barrier. Therefore, the next challenge was how to finance the entire project. The team used the CDM to fund the entire project and simultaneously bring economic savings.

Table 1. CFL vs. ICL

Description	**ICL**		**CFL**	
Wattage	60 W	100 W	14 W	20/23 W
Lumen	620	1240	620	1240
Cost	Rs. 10-15		Rs. 80-130	
Life	1000-1500 Hrs		6000- 10000 Hrs	
Annual Energy Cost	Rs. 380	Rs. 640	Rs. 90	Rs. 140

A non-Annex I country such as India has great opportunity to leverage the use of the Clean Development Mechanism (CDM) under the Kyoto Protocol. This removes the first cost barrier for introduction of energy efficient solutions such as CFLs in residential use. The government or electric utility company can enter into a contract with a private player having expertise in CDM business, wherein the private player bears the initial cost of CFLs. Nevertheless, the CDM itself, is very complex, involves a time consuming process, and requires sufficient know-how (to handle it) from beginning to the end.

Project Implementation

In 2008, Indian Railways undertook a unique initiative to improve efficiency of the peak

lighting loads in its residential quarters by replacing ICLs with energy efficient CFLs. The project aimed at leveraging the sale of Certified Emission Reductions (CERs) under the Clean Development Mechanism (CDM) of the Kyoto Protocol and awarded the contract to M/s C-Quest Capitals (M/s CQC), Malaysia based on open bidding process. The project envisaged replacement of approximately 2.6 million ICLs by 14W and 20/23W CFLs of equivalent lumens, free of cost in about 650,000 residential quarters.

Under the agreement, M/s CQC was responsible for procuring high quality CFLs having a power factor of more than 0.85 and an average life of 10000 burning hours from M/s Phillips and supplying maximum of 4 CFLs to each household. Each CFL was marked with the logo of CQC, Philips, and Indian Railways to avoid pilferage. M/s CQC was to recover the cost of CFLs through trading of Certified Emission Reductions (CERs), to be acquired by registering the project under the CDM mechanism of the Kyoto protocol of United Nations Framework Convention on Climate Change (UNFCCC). As per the agreement, 3% of the CER were to be transferred to Indian Railways as well. Further, M/s CQC was responsible for undertaking all processeses involved in acquiring CDM status by way of development of project design documents, obtaining host country approval, project validation and registration, project monitoring, verification, and certification with the UNFCCC. The Ministry of Railways as the project beneficiary was responsible for distribution of the CFLs in housing colonies of the Railways on replacement basis, record keeping, storage of CFLs, and released ICLs.

Household consumers were adequately briefed on the proposed project activity during stakeholder meetings conducted at different places. It was also explained to them that CFLs need to be installed in areas of maximum usage like the kitchen, drawing rooms and common utility areas where average lighting is at a minimum of 3.5 hours per day so as to gain the maximum benefit. As per the agreement, all CFLs which fused within one year were to be replaced by new ones by M/s CQC. Any CFL fusing after one year were to be returned by the resident to the Railways authority. The stakeholders were advised to deposit fused CFLs after their useful life at select locations for onward transmission to M/s CQC for environmentally safe disposal. 1.4 million CFLs were distributed on a door-to-door basis to 400,831 Indian Railways households between January 2010 and May 2010 against the targeted replacement of 2.6 million CFLs covering about 0.65 million households. All details of the ICLs were replaced and CFLs fitted were recorded in detail both in hardbound ledgers and in electronic form in a centralized database server.

The project has already been registered with the UNFCCC as a CDM project after obtaining host country approval from the Ministry of Forest and Environment, Government of India. Apart from the regular benefits of the project, an additional key benefit is awareness amongst 0.4 million consumers about the energy efficiency potential of CFL. This will have a positive multiplier effect as 1.6 million ordinary citizens (considering size of an average households as four) are exposed to the nuances of conservation of energy and embraced a sustainable

change in their consumption behaviour.

Challenges and Risks

The project had two components: first, justifying procurement of CFLs, which was at substantially higher initial cost, based on life cycle costing concept instead of just initial economic cost; second, financing of the project using the Clean Development Mechanism (CDM) through the sale of Carbon Emission Reductions (CERs) generated during the project. The conceptualization and development of the bid document itself was a huge task for the project team, as both of these components needed to be merged while the project team managed the investment risks related to private players who were interested in the contract over a period of the project cycle.

Supplying CFLs free of cost to households is not a guarantee that consumers would buy CFL as replacements in the future as well. That required an awareness campaign to demonstrate to stakeholders the benefits of adopting CFLs even if they have a very high initial cost. The team organized various stakeholder meetings across India to buttress the saving potential of CFLs over its life and how they can save in monthly electricity bills by using a CFL in their households. This concept proved very useful as occupants of housing colonies could clearly visualize the benefits of adopting a CFL over an ICL. Here, the risk is if stakeholders are not fully convinced of the saving potential of a CFL, they may start reusing ICLs after end of life of first CFL supplied by Railways.

The CDM project has a transaction cost and the registration of such project with the UNFCCC itself takes about 12-24 months. The process is very complex, requiring coordination with several agencies and stakeholders throughout the life of the project. Further, the development of project a design document, obtaining host country approval, project validation and registration, project monitoring, verification, and certification with the UNFCCC requires lots of documentation and technical expertise. The team, not experts in handling such a project of this complexity, handled the project deftly by awarding project design & implementation work to professionals through open bidding and limiting its role to regulatory compliance.

The project was originally planned for distribution of CFLs to 2.6 million households. However, during actual distribution of CFLs in railways households, many houses were found vacant, locked, and/or abandoned. Hence, in reality, only 1.41 million CFLs could be distributed to the households, compared to 2.6 million CFLs originally planned for. This situation did not affect the economic viability of this project, but substantial variation between projected quantity and actual quantity may affect economic viability of such project.

The financing of this project is based on the sale of CERs in an international carbon market which keeps fluctuating. This project became a success, as during the 2010 period, the CER market was in an upswing and M/s CQC was able to sell CERs earned from this project to the Swedish Energy Agency at a good price. With the deepening of recession in Europe, which led to the crash in the international carbon trading market, the risks which comes with this kind of project are heightened.

LEARNING OBJECTIVES

- To use a sustainable procurement policy (SPP) as a basis to demonstrate the benefit of green technology.
- To use the Clean Development Mechanism (CDM) as a financial instrument for adoption of green technology.

The primary objective of this case is to demonstrate use of sustainable public procurement (SPP) as a tool to demonstrate potential benefits of using CFLs (green products) over ICLs (conventional products) for lighting needs, even though the upfront purchase cost of a CFL is approximately five-to-six times that of an ICL in the Indian market. This objective was achieved through involvement of stakeholders in project implementation phase so that they can experience the benefits of adopting greener products and services themselves.

The second objective of the project is to demonstrate use of the Clean Development Mechanism (CDM) under the Kyoto Protocol to finance the energy efficiency (adoption of green technology) project in emerging economies. It leveraged money earned through sale of Certified Emission Reductions (CERs) generated during project implementation, to distribute CFLs to the households.

TIPS FOR FACILITATORS

The countries in the Asia-Pacific region face compelling pressures on resources from industrialization and urbanization. In a business-as-usual scenario, the current level of the region's economic growth cannot be sustained without compromising the needs of future generations. Therefore, nations in this region need to decouple their economic growth from natural resource consumption through innovations in value chains, both in production and consumption. When the supply and demand side policy dovetails, these nations' growth would move towards the low carbon path, promoting sustainable public procurement (SPP) – the environmental and social criteria are integrated in the public procurement process (see

Box 1). However, its implementation would require clear understanding of the concept, its tools, and nuances of the implementation process.

Box 1: Sustainable public procurement (SPP)

Sustainable public procurement (SPP) is an affirmative action in the procurement process of selection and acquisition of products, works and services that most effectively minimizes negative environmental impacts over their life cycle of manufacturing, transportation, use and disposal. In other words, it lays a framework for taking into account environmental and social criteria in addition to conventional considerations such as price and quality, while making procurement decisions. It can be used to promote energy efficiency and environmental sustainability by buying energy efficient products that incur less cost over its life cycle than conventional products. This shall lead to reduction of environmental impact of goods, works and services. Procured by the government discharging its public responsibilities, the resulting competition between enterprises to supply environmental friendly goods at the least cost, can spur innovations among them and lead to popularization of environment friendly goods

The case would be particularly useful for the demonstration of the benefits of buying products and services based on their life cycle costs rather than on their upfront costs (in public buying). Such appreciation by stakeholders is very important for successful introduction of green technology, which generally has a high initial cost. In the current situation, where a procurement decision is based on the lowest upfront cost, green technology does not stand a chance. It is only when a government decides to integrate environmental concerns in public buying and change its evaluation criteria to the"best value for money over life cycle" does such a product have some chance. Therefore, this case is an excellent example which demonstrates both economic and environmental benefits of shifting to greener products and services.

The key component of deliberation should include explaining the actual solution implemented by Indian Railways. On the one hand, the case explains the use of a sustainable procurement concept and on the other hand, it explains the use of the CDM for financing green technology. Therefore, it is important that the facilitator is thorough when discussing on two key concepts used in this case: SPP and CDM (see References to Other Reading Materials).

Case participants could be encouraged to work on the Excel sheet, 'Data sheet for comparing net savings'. The use of the Excel sheet would prove very useful in class as participants could view the reduction in electricity bill, when the action shifts from ICL to CFL. This will also help in increasing awareness of participants on environmental benefits of using green products and services.

This case can be used for understanding demand side policy instruments such as sustainable public procurement to reduce consumption and production of resources. The ideal audiences

would be government policy makers from procurement, finance and environment streams working in SCP areas.

FACILITATION OF THE LEARNING PROCESS

Methodology

- Facilitator is advised to provide the case study in advance to participants with instruction to read before attending presentation.
- During the presentation, the facilitator would present the power point up to Slide no. 19 (about 20 minutes). Slide no. 20 represents the first discussion question.
- At this point, participants would be asked to form groups. The groups should be told in the beginning that they will need to present brief summaries of their discussion at the end of the session. Each group should preferably be limited to a maximum of five members to facilitate participation of all members in the discussion. The groups can discuss each question for 10 minutes and jot down points.
- The facilitator is expected to move around the groups and facilitate and encourage their discussion.
- At the end of discussion, the groups would be asked to nominate a group leader who would present the summary of discussion. Each group may be given 3 minutes for presenting their points of view. This process should be followed for all discussion questions.
- At this point, the facilitator sums up all the suggestions put forward by the groups and introduces tbe sustainable public procurement policy to them by presenting slides 21-26. Slide no. 24-26 can be used to demonstrate economic and environmental benefits of CFLs over ICLs using life cycle concept, which is the corner stone of sustainable procurement policy.
- Now the groups should be asked to discuss a probable solution for Indian Railways in response to question 2. The facilitator should note down the key features of the solutions presented by the groups on the board.
- Once they have finished, the facilitator should present the solution adopted by Indian Railways team in housing colonies. The facilitator may present Slide no. 28-33 and further discuss question 2 for 5 minutes. The facilitator should use information provided in the Teaching Note to convey the overall strategy.
- Question 3 is about how a different approach could be taken to address a particular problem. This has been covered while discussing the solution in Teaching Notes.
- Question 4 is about reasons for finding asymmetry in distribution of CDM projects across globe. The reasons for such asymmetry have been discussed in solutions in the Teaching Note. The facilitator may present Slide no 36-38 to buttress the challenges of designing CDM projects.
- Question 5 is an open question. It has already been discussed in the Teaching Note.
- In the end, the facilitator will present the remaining slide and sums up key learning from the case.

Timeframe for Presenting the Case Study

There could be two scenarios for presenting this case. The first is when discussion questions are not discussed by the participants and the facilitator simply presents the entire case. This makes up 36 slides that one can cover comfortably within an hour.
The other scenario could be participants form groups and discuss these questions themselves. And presenter facilitates the discussion and then sums up by presenting the actual solutions. In this case, the following time plan could be adopted:

- Presentation of first 19 slides by presenter: 30 minutes.
- Discussion of questions by groups: 5 groups x 10 minutes/group = 50 minutes.
- Presentation of discussion by groups: 5 groups x 15 minutes/group = 75 minutes (assuming 5 groups and approximately, 3 minutes for each presentation).
- Presentation of remaining slides: 15 minutes.
- Total time required: 170 minutes.

Suggested Answers for Discussion Questions

Question 1:

The answer is switching from a present system of evaluation of tender bids based on lowest upfront cost towards evaluation based on value for money over entire life cycle of products and services. This is very important to facilitate adoption of green technology, which normally has higher upfront cost but have competitive cost when viewed from the perspective of life cycle cost.
Worksheet 1 is designed to identify hurdles for implementing sustainable procurement policy in a country where the discussion is taking place. Depending on time, Worksheet 1 could be used to carry out a survey among stakeholders to find perceived hurdles for introducing green procurement in the country. The result of the survey can also be used for finding a strategy to tackle those hurdles. For example, if the majority of the people strongly agree to a Legal Framework for integration of environmental and social consideration in procurement decisions, then it shows it is a major hurdle for implementation. The authority involved in the implementation process should focus on relieving this hurdle by bringing legislation to support green procurement. If stakeholders strongly disagree with any barrier, it shows this is not a barrier at all in that particular country and authority need not pay attention to it.

Question 2:

This question is expected to generate various solutions. Each solution will also have some key challenges. Discussion of this question would provide participants opportunity to learn different possible solutionz for addressing challenges of introducing energy efficiency

technology in emerging economics. They can compare different solutions and decide which particular solution would work best for their country.

The strategy adopted by Indian Railways has already been discussed in the Case Summary section. However, the group may come with other possible strategies for removing first cost barrier. These could be:

- Providing a direct subsidy from the government to consumers for buying CFLs.
- Providing a free supply of CFLs to consumer from the Distribution Company which recovers the amount in monthly instalment from consumers.
- Reducing the subsidy to electricity consumption currently provided by the government to consumers in order to make energy efficient products attractive.
- Reducing the cost of CFLs by providing a subsidy to manufactures of CFLs in their country.

Nevertheless, each of these strategies will have unique challenges in its implementation since the government lacks sufficient resources to give freely to consumers to bridge the financial gap, or to manufacturers of CFLs to reduce initial cost of CFLs.

The distribution company can work out the economics of providing CFLs to individual consumers and recover the amount in instalments. This appears as a win-win solution for the distribution company and consumers. The distribution company can sell energy saved in the process to industrial users at higher cost and earn more profit.

The average energy used by the majority of households in India is less than 100 units per month. The cost structure of most state electricity boards in India is graded; with increase in energy use, the cost of electricity per unit increases. Therefore, most of the consumers fall within the lower bracket of cost structure. To top it all, energy is provided at a subsidy to these consumers. Hence, for most of these consumers, the energy bill is low enough for them not to shift from ICLs to CFLs.

With an increase in the tariff, the benefit of using CFL as compared to ICLs increases (see Figure 1). This shows how government can play with the electricity tariff structure to facilitate introduction of energy efficient solutions. Also, as the number of hours of use of a CFL increases, the benefit increases. So consumers can drive more benefit by using a CFL in such areas where the lighting requirement is for more hours. Consumers, in general, are not aware of these facts. Therefore, for successful introduction of CFLs, the role of consumer education is very vital.

Further, it is important that any solution must focus on long-term sustainability of the solution. If the solution does not provide benefits to all stakeholders, it is certain to fail.

Therefore, a good strategy would be to safeguard the interest of the private player who is entering this field, and provide risk minimization opportunity to such players.

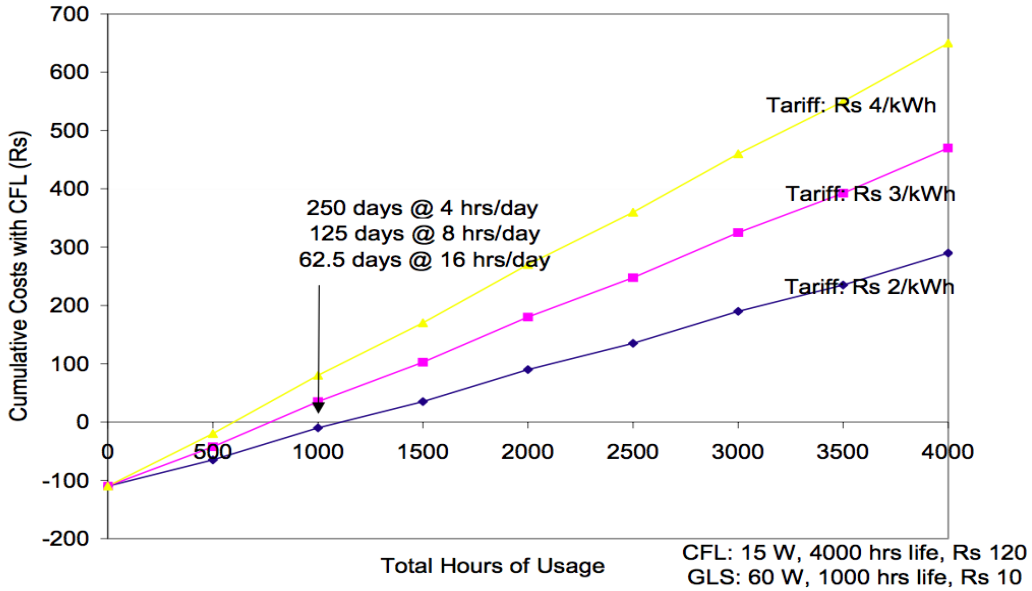

Figure 1. Electricity tariff vs. Consumer savings

Question 3:

This question allows participants to discuss challenges they are likely to face when they want to implement such a solution in their own country. Different countries will have different challenges depending on socio-economic condition prevailing in that country. Therefore, a solution that works in one country setting may not work in another country. Therefore, one has to find a solution to the particular challenge faced by them.

This question further prompts the participants to think critically and discuss measures for addressing those challenges. The solution to particular challenge could be administrative, legislative, capacity building and so on. Therefore, participants need to identify whether training and capacity building would be enough to address a particular challenge or if a legislative measure would be necessary or both. Participants could work this out themselves first and then they can compare their results.

Question 4:

The reasons for asymmetry in uptake of CDM projects is discussed comprehensively in related articles (see References to Other Reading Materials). The facilitator shall have a thorough understanding of these articles to encourage discussion among participants.

The discussion of this question will help participants in understanding the key success factors for CDM projects in a particular country. This understanding will help them identify gaps in prevailing condition in their country and take measures to bridge those gaps.

Question 5:

There is no specific answer to this question. It would depend on the kind of discussion that is going to take place. The facilitator may use a table to list out differences between financial instruments suggested by participants and Kyoto's CDM. This process would aid in comparing different solutions in place and choosing the best for the particular country.

Note: If time permits it would be great to show calculation of benefits of this project on the board for a more impactful discussion.

Calculation of Benefits of Project

Electricity Savings

No. of CFLs	-	1.4 Million
Power Savings	-	(80-18) Watt x 1.4 Million = 88 Mega Watt
Annual Energy Savings per CFL	-	Savings per CFL x Average usage per day x 365 = 62 x 3.5 x 365 = 79205 => 80000 kWh
Total Energy Savings	-	80 kWh x 1.4 Million = 112 Giga Units per year

Reduction in Carbon Emissions

CO_2 Emissions Reduction	-	0.8 kg per kWh
Total CO_2 Emissions Reduction	-	0.8 x 112 x 1000 = 90000 (without considering transmission loss)

Economic Savings

Savings per CFL per annum (Assuming Rs 4 per kWh)	-	80 kWh x Rs 4 / kWh = Rs 320
Savings per Household	-	4 x 320 = Rs 1280 per annum
Total savings in Energy Bill	-	Rs 320 x 1.4 Million = INR 448 Million

Actual cost of electricity in Indian Railways is Rs 6-7 per kWh

Key Learning Points from the Project

This project demonstrates how government can use public procurement as a tool for creating synergy with business and consumers to encourage penetration and adoption of green technology. The current project addressed the issue of poor quality of CFLs in the market by providing high quality CFLs as per standard IS: 15111 of a reputed brand (Phillips), backed by an exchange program for faulty CFLs. The supply of CFLs, with 10,000 burning hours, helped to remove misgivings about energy savings potential of CFLs amongst the users.

However, designing the programme of activity under the Clean Development Mechanism (CDM) of the Kyoto Protocol is not without challenges. The development of a project design document, obtaining host country approval, project validation and registration, project monitoring, verification and certification with the UNFCCC requires lots of documentation and technical expertise. The energy efficient CFL project under Clean Development Mechanism (CDM) has transaction cost and comes with an initial price tag of approximately Rs. 30 lacs ($0.60 million). Further, the entire process itself takes about 12-24 months and is very complex, requiring coordination with several agencies and stakeholders throughout the project. Therefore, development of technical expertise to handle such a project and selection of a partner with comprehensive knowledge of the carbon credit business and sound financial backing appear very crucial for success of such a project.

The project was originally planned for the distribution of 2.6 million CFLs in railway households. However, during actual distribution of CFLs in railway households, it was found that many of the houses were vacant, locked, and/or abandoned. Due to thisonly 1.41 million CFLs could be distributed in railway households ,compared to the 2.6 million CFLs originally planned. This did not affect the economic viability of this project, but substantial variation between projected quantity and actual quantity may affect economic viability of such project. Such a project can become economically viable only when the minimum replacement of CFLs is more than 250,000.

One of the key success factors for such a complex project is an unambiguous mandate for all project participants (see Table 1).

Table 1. Role and responsibility matrix

No.	Activity	Responsibility
1.	Supply of CFLs	Philips and CQC
2.	Distribution of CFLs	Indian Railways
3.	Collection & Storage of ICLs, CFLs	Indian Railways
4.	Replacement of fused CFLs	CQC and Indian Railways
5.	Disposal of fused CFLs	CQC
6.	Monitoring of project	Indian Railways and CQC

Further, when this project became a success, it was during the 2010 period, when the CER market was in an upswing and M/s CQC was able to sell CERs earned during this project to Swedish Energy Agency at a good price. With the deepening of recession in Europe, which led to the crash in the international carbon trading market, such projects carry heightened risks. The Ministry of Railways could sell the earned CERs (3% of total CERs) due to global meltdown of the carbon credit market and delay in making the right decision at the right time.

The project is expected to cost around USD 2.4 million (by 2012) – a level of subsidy that would not be possible by public or private entities without the assistance of CDM revenues.This project exemplifies the importance of multilateral agreement such as the Kyoto Protocol and the need to cooperate with each other in order to fight climate change.

FURTHER SOURCES OF INFORMATION

Literature on sustainable public procurement (SPP): *Public Procurement as a Tool for Promoting More Sustainable Consumption and Production*, 2008.
http://esa.un.org/marrakechprocess/pdf/InnovationBriefs_no5.pdf

Literature on CDM: *The Kyoto Protocol's Clean Development Mechanism*, 2009.
http://www.aph.gov.au/About_Parliament/Parliamentary_Departments/Parliamentary_Library/pubs/BN/0809/KyotoProtocolCDM

Data Sheet for Comparing Net Saving

1	Wattge of ICL (in Watt)	100	100	60
2	Wattage of CFL of Equivalnet Lumen (in Watt)	20	23	14
3	Consumption of Electricity in burning ICL for 6000 Hrs.= Wattage X Hours/ 1000 KWH	600	600	360
4	Consumption of Electricity in burning CFL for 6000 Hrs.= Wattage X Hours/ 1000 KWH	120	138	84
5	Saving in Electricity over Life Cycle of CFL i.e burning for 6000 Hrs. = (3-4)	480	462	276
6	Cost of Electricity per KWH (in INR)	5	5	5
7	Saving in Electricity Bill over Life Cycle of CFL = (3-4)*6	2400	2310	1380
8	Initial Cost of each ICL (in INR)	15	15	11
9	Initial Cost of CFL of equivalent lumen (in INR)	130	130	90
10	Initial Cost of ICL for burning 6000 Hrs (in INR)	90	90	66
11	**Net Saving per CFL over Life Cycle (in INR) = 7-9+10**	2360	2270	1356