White Paper on Use of Compact Fluorescent Lamps (CFL) for energy conservation for better load management and recent threat to eliminate CFL from Indian market

Submitted by Electric Lamp & Component Manufacturers Association of India (ELCOMA) the apex body of Lighting Industry in India to following:

1. **Secretary, Ministry of Power**
2. **Director General, Bureau of Energy efficiency**
3. **Director General, Bureau of**
4. **Secretary, DIPP, Ministry of Commerce**
5. **Secretary, Ministry of Consumer Affairs**
6. **Media**

I. Introduction:

There are nearly 2 billion lamp sockets in India. More than 800 million Incandescent Lamps (ICL) and 320 million Compact fluorescent Lamps were sold in India in 2010. The ICL growth is almost stagnant (growth between 2 to 4%) whereas CFL initially had a growth of around 40% per annum and has now stabilized to around 24% per annum. This is the scenario as on date. Now let us look back 6 years back. In 2005, More than 1 billion Incandescent Lamps and only 20 million CFLs were consumed in India. ICL was growing at around > 12% whereas CFL was growing around 5 to 6%. Price-wise, ICL was sold at Rs. 10 per piece and CFL at around Rs. 350 per piece in 2005, whereas the price of ICL remains the same i.e. around Rs. 10 per piece, but the price of CFL has been reduced to less than Rs. 100. More than 60% of CFL was imported whereas balance 40% were assembled in India i.e. most of the components were imported. In 2006, Elcoma in cooperation from Ministry of Power and Bureau of Energy Efficiency, launched CFL and pledged to make CFL a household name in 2 to 3 years. A national program was chalked out that contained awareness, workshops, media coverage besides encouragement to produce CFL in India. Side by side efforts were made to bring in anti dumping duty to avoid import of cheap quality CFL that was ruining image of CFL in India and also to make BIS CFL standard as mandatory. The Lighting Industry worked full force to achieve the goal. To stimulate CFL demand, most of State governments imposed regulation of changing in ICLs in commercial and government establishments with CFL. Some states even reduced VAT from 12% to 4 or 5%. The results started pouring in within few months. There was surge in demand and encouraged by it, new capacity was added by many manufacturers. BIS, that had around 8 to 10 licensees, received applications for more than 20 to 25 new manufacturing units. Today CFL capacity in India is around 500 million pieces with about 48 Licensees and is expected to grow to about 1 billion pieces by 2013.

China has been largest manufacturer of CFL and about 80% of its production is exported. China does not have any mandatory standards and therefore the lamps manufactured in China are of various qualities. They manufacture CFL of less than 3000 hours life to more than 12000 hrs life. There are about 1200 small, medium and large manufacturers in China with a capacity of 3 billion pieces per annum as against around 48 manufacturers in India vying for a capacity of 1 billion pieces per annum. After imposition of anti dumping duties, all the efforts of routing the CFLs through other countries were thwarted by certain actions by enforcement departments in India. Presently only a small quantity of High wattage CFL is imported from China and the Indian Lighting industry relies on local CFLs. India is the second largest consumer of CFLs and also has second largest capacity in the world.

Tri-band phosphor is very important component used for CFL manufacture. It is a powder coating on glass tube that allows light to glow to give a high lumen output to lamp. Phosphor layers provide most of the light produced by fluorescent lamps, and are also used to improve the balance of light produced by metal halide lamps. Various neon signs use phosphor layers to produce different colors of light. Electroluminescent displays found, for example, in aircraft instrument panels, use a phosphor layer to produce glare-free illumination or as numeric and graphic display devices. Earlier, "halo phosphor" was used which was much cheaper and less efficient. Tri-band phosphor is produced from rare earth and more than 90% reserves are with China. In fact all CFL manufacturers around the world used to import tri-band phosphor processed in Japan and Holland / Germany. Over the last few years China started processing this powder in China and offered at cheaper price. All CFL manufacturers started importing it from China. Having captured almost whole of world's demand, now China has started restricting mining of rare earth and the tri-band phosphor. The action is taken by increasing the price of tri-band phosphor from US$ 40 to more than US$ 420 per kg, besides imposing export duty of around US$ 50 per kg. The price has gradually been increased @ of around US$ 50 every 15 to 20 days. India being the second largest manufacturer is hit hard because for Chinese manufacturers, there is no export duty of US$ 50 and also government gives them subsidy on exports.

For the last more than 5 months, this situation prevails and the manufacturers in India have no alternative but to increase the price of CFL. There has been increase of between Rs. 5 to Rs. 10 and another increase of around Rs. 10 to Rs. 15 is expected. Fluorescent Tubes that also use Tri-band phosphor (T5 and T8) is going to be expensive by around Rs. 30 to Rs. 40. The ripples have started appearing as many of small manufacturers have closed down unit as they are not able to match the retail prices. CFL, which is the largest energy saver in lighting in India is threatened its existence in coming future. All efforts by Industry and government are becoming futile. As the situation is, we will be back to square one, back to Incandescent Lamps soon.

II. What is required to be done:

Keeping above points in view and in order to save the Lighting Industry in India specific to products using tri-band phosphor and also to ensure that government's programs on energy conservation continue to be effective, immediate actions are required to be taken by government, both central and state. We are giving below some of the options that can be considered short term and long term implementation:

1. Take up seriously on international platform protecting interest of CFL manufacturers. United Nations Certified Emission Reduction program that promotes energy conservation through Clean Development Mechanism should be approached to take up with Chinese government. WTO can be another platform to take up with China.
2. Use diplomatic relations with Chinese government to address this issue. Government of India can negotiate with Chinese government of one time bulk purchase of tri-band phosphor of say 2000 Metric tons at a special price of say US$ 200 or less, which can be allocated to CFL and FTL manufacturers according to production capacity. This quantity will last for about 4 to 5 years.
3. Reduce duties, import, excise and VAT etc to compensate price increase in tri-band phosphor and make CFL affordable. Details of present state-wise VAT application are attached. Government can initiate to ensure that VAT is reduced to 0% all over India. This will help reduce price of lamp considerably.
4. For long run, explore and tap tri-band phosphor in India, which has about 1 to 2% of world's reserves.

Note: At present following States have reduced VAT, but it is recommended that all these States and other States who have not reduced yet, should bring the VAT to zero %

STATE	**VAT for CFLs**		**VAT for FTLs**	
	Vat	Surcharge	Vat	Surcharge
Haryana	5%	5%	12.5%	5%
Rajasthan	5%		14%	
Punjab	5%	10%	12.50%	10%
Himachal	5%		13.75%	
Chhattisgarh	5%			
Gujarat	5%			
Kerala	4%			
Delhi	5%			
Maharashtra	5%			
Goa	8%			
Chandigarh	5%			
Pondicherry	6%			

Average consumption of triband phosphor in lighting products and annual requirement

The present requirement of triband phosphor for the lighting industry in India is given below:

Light product using triband phosphor	Average Quantity triband phosphor per unit	Production units 2010	Total requirement Triband phosphor MT
CFL	600 mg	304 million	182.4
T5 tube light	3 gm	3.5 million	10.5
BEE 4/5 star rated (T8 tube light)	4.5 gm	15 million	67.5 Total 261 MT

<u>Background Notes:</u>

1. A case for CFL

The household and commercial lighting even today account for a large share of peak power demand. Nearly 12% peaking shortage in the Indian power system occurs for an hour in the evening hours. This represents the evening peak due to sudden addition of household and commercial lighting loads. This sharp evening peak for a short duration requires extra capacity of generation, transmission, and distribution infrastructure to meet the loads for few hours a day. Since this additional capacity is used only for such a short time, the peak power demand is a costly affair.

It is in such context that the National Electricity Policy notified by the Government of India mentions that:

> "*Energy efficient lighting technologies should also be adopted in industries, commercial and domestic establishments.*" (S 5.9.5)

The widespread use of incandescent (also called GLS) lamps by households and commercial users are a major area of potential efficiency gain in lighting. For example, to get the same light output, **one 60W GLS bulb can be replaced by a 15W CFL. This reduces the power demand by nearly 45W or by three fourth of the original**. Replacement of just one such GLS lamp that is operational at the peak time by every household in the country can reduce the peak power demand by over 8,000 MW! The potential saving is much larger when we consider that 25% of rural households are yet to be electrified. Under the rural electrification initiative, the government is planning to electrify the remaining households in the coming few years. This increases the **potential saving, through use of CFLs, to nearly 10,000 MW!** Hence, rapid and extensive penetration of CFLs can help us substantially mitigate the peak power shortage in the country.

2. Use of CFLs make Economic sense for Bulk Consumers and Load Management

a) Economics of CFLs for Bulk Consumers

The retail price of CFL has a wide range, but most lamps are priced between Rs 70 to Rs 150, depending on rating and manufacturer among other things. Despite this higher cost of CFL, compared to the GLS lamps; their economics is very attractive. Lower consumption of electricity and longer life of CFL make them more economical. A reasonable quality CFL, can pay back the higher initial cost of CFL, in short period of 15% to 25% of its life; depending on the electricity tariff. For the remaining 75% to 85% of CFL's life, it results in net saving for the consumer.

In other words, when the electricity tariff is Rs 3/kWh, a CFL operating for just two hours a day, saves electricity to pay back the higher initial cost in a period of eight months. For lamps operating for longer duration the payback is proportionately faster.

Table 1: Typical annual saving over the life of the CFL

Tariff (Rs/kWh)	**2**	**3**	**4**
Rs saved / Yr	99	148	197
Rs saved / CFL (over the life)	590	860	1130

Note: A 60 W incandescent lamp is considered to be replaced by a 15 W CFL having a life of 6,000 hours. The lamp usage is assumed to be 3 hours per day.

It may be concluded that the consumer will definitely benefit in the long run by shifting from ICL to CFL.

b) Economics for load management by Utilities

Since the lighting load forms a part of peak load for the utility and that too mostly by domestic users which generally receive subsidised tariffs as compared to other categories, it makes sense to reduce the peak load by use of CFL especially in domestic sector. The economics work out to be very attractive as the reduction in demand provides utility with additional capacity to supply high paying customers. In some developed countries even free distribution of CFLs by the utilities has worked very economical. **The utilities in India must exploit this opportunity offered by CFLs.**

III) Barriers for Large Scale Usage of CFLs

Newly electrified areas especially in rural India, the consumers are of very poor class. They are not able to afford CFL and generally buy only ICL. Government's efforts of providing CFL under Bachat Lamp Yojna (BLY) of BEE gives short term relief to users as when CFL ends life, he will buy ICL. Several consumers are unwilling to buy a CFL to replace much cheaper GLS, and end up paying much more for the electricity usage of the lamp. The consumers not using CFLs are faced with some barriers, which can largely be divided in three categories.

- Information barrier: A large section of consumers in urban area are now aware of the large benefits of using CFLs. The consumer awareness should be increased in newly electrified areas and other rural India through advertisement and other measures to encourage more consumers use CFLs.
- Inappropriate fitting: The consumers having lampshades or luminaries unsuitable for CFLs do not change the luminaries for using CFLs. But as smaller CFLs and decorative luminaries especially designed for CFLs are becoming more common, this barrier would diminish.
- **Pin type lamp holder: 99% of lamp sockets in India are of pin type as against screw type in most of the countries. For this reason, CFL in India is made with pin type holder. CFL is heavier than ICL due to PCB, and after adding High Power Factor of .085, it has become even heavier. CFL can be mounted only vertically for effective performance. CFL mounted in any other direction is tilted and may create sparking thus reducing the life of the lamp. Replacing 2 billion sockets with screw type is a massive job but this opens a debate on how to undertake this change. After introduction of LED Self Ballasted Lamps which are even heavier than CFL are facing the same problem. Government has to initiate some action, may be by making all new lighting points mandatory with screw type holders and give a phase out period of may be 7 to 8 years.**
- First Cost Barrier: i) Most of the government tenders are based on lowest price and unless the benefit of CFL on life cycle cost are recognised and approved it becomes difficult for the government agencies to adopt this technology.
  ii) The problem is acute for the very poor consumers. Nearly half of the residential consumers in most states have electricity usage of less than 50 kWh/month. The monthly electricity bill of these consumers is barely Rs 50 to Rs 85. These consumers are too poor to afford CFL at present prices. These would be over 50 million households. Additionally about 100 million un-electrified houses, which would be connected to the grid in the coming years, would also fall in this category.

IV) Some solutions:

a) Purchase of CFLs on life cycle cost rather than first cost basis by the government agencies. Monitoring the performance of CFLs and sharing of experiences with other departments on regular basis.

b) Considering the very large number of such houses in the country, we have to address this problem. Reduction of cost of CFLs is one method to address this problem. Bulk purchase of one or two standardised lamps, rationalisation of taxes on the CFLs and cost reduction measures by the manufacturers can help substantially help. There is a sizable scope for such cost reduction without affecting rather improving the quality of CFL.

c) If the utility has a CFL leasing program, the first cost barrier faced by consumers can be overcome. A 15-Watt CFL, which is equivalent to a 60 W bulb, would last about 6,000 hours (40 months) and may cost Rs.120. The utility can recover this cost through monthly bills at the rate of Rs.10 per month for 12 months. This is nearly a “no-cost” affair for the utility except for some modifications in the billing and accounting procedure.

d) Poor consumers with low usage are offered low electricity tariff as the lifeline tariff. In many states, the tariff paid by these consumers about Rs 1.5 / kWh. In such a case, even the cost of CFL leasing is more than the electricity saving in the initial year. Hence, it does not make economic sense for these consumers to take CFLs even through the leasing program. But in that case, their consumption remains high and the utility continues giving subsidy on their electricity use.

In addition, the utility can share part of its potential saving (due to reduced subsidy to these consumers), with such consumers to reduce the monthly instalment of CFL. The utility saving is much more than what appears to the eye, in terms of difference between average cost of supply and the tariff by the poor households. The lighting usage is peak time usage, so the saving has to be calculated considering the reduction in peak T&D losses, reduced need for peak power purchase and so on. The required contribution by utility for this is small compared to the scale of its operation.

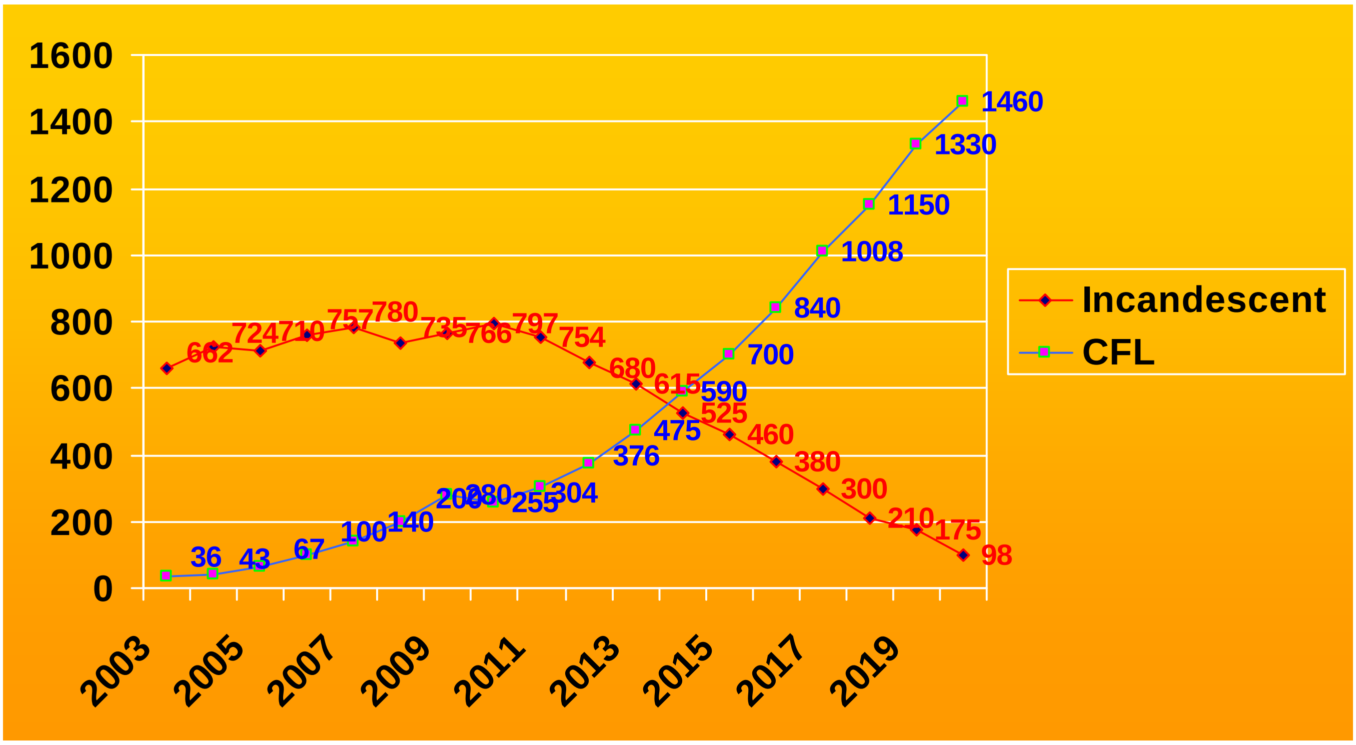
Cost Benefit Analysis for using Retrofit CFL

Savings in Electronic Retrofit CFL over a lifetime of 6000 burning hours

1	Electronic Retrofit CFL	20W	15W	11W
2	Replaces GLS	100W	75W	60W
3 -	Savings in Electricity consumption over 6000 hours (2-1) x 6000 1000	480KWH	360KWH	294KWH
4	Savings in electricity bills per lamp @Rs.3.50 per KWH	Rs.1680	Rs.1260	Rs.1029
5	Cost of Electronic Retrofit CFL	Rs.150	Rs.100	Rs.100
6	Cost of 6 GLS lamps	Rs.66	Rs.66	Rs.66
7	Net savings per GLS point (4-5+6)	Rs.1596	Rs1226	Rs.995

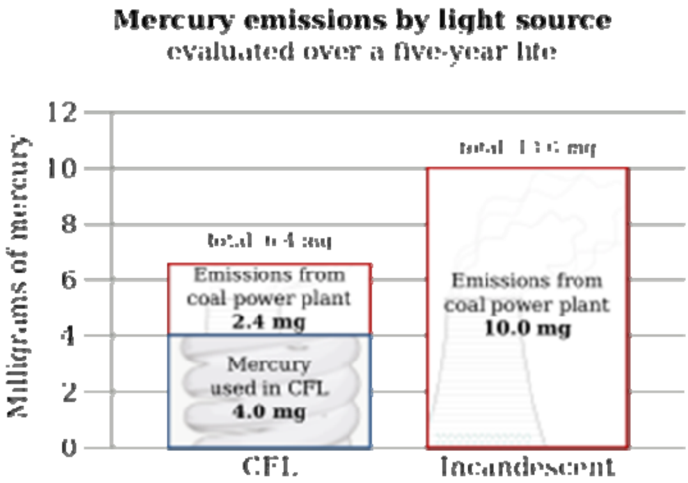
PHASEOUT PROGRAM

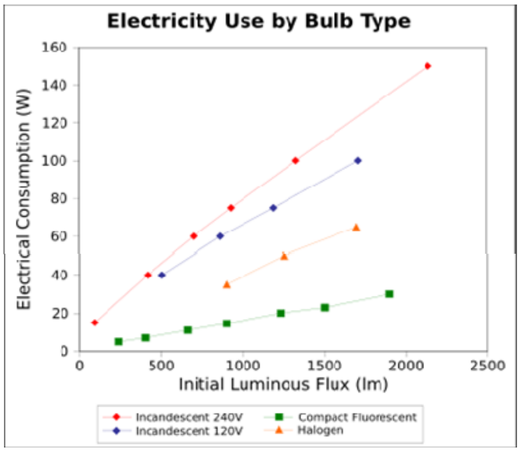
ICL being the poor man's lamp is continuing to be in demand and has not seen any decline over a long period. In spite of efforts of replacing ICL points with CFLs, new ICL demand is coming from new connections in the rural area under government's rural electrification programs. Once the electrification is 100% complete in India and the efforts of promoting CFL under various schemes like Bachat Lamp Yojna, Demand Side Management and Clean development Mechanism, it is expected that ICL will start showing decline. A wishful plan is prepared to ensure that the efforts bring in positive results and the scenario will look as shown in table below. By year 2020, it is expected that ICL will almost be eliminated from Indian market provided efforts are continued in promoting CFL and by removing any bottlenecks or barriers, as it is being faced now



The figure below shows that CFL is more environment friendly as compare to Incandescent Lamp. Electricity generated that ICL uses emits about 10 mg of mercury in the atmosphere whereas when Electricity generated for CFL emits only 2.4 mg of mercury into the atmosphere. Even if we account that CFL uses about 4 to 5 mg of mercury for its operation, still it is at least 3 to 4 mg less than

Bulb vs. CFL
Impact on Environment





Annexure:
What is tri-band phosphor

A **phosphor,** most generally, is a substance that exhibits the phenomenon of **luminescence.** Somewhat confusingly, this includes both phosphorescent materials, which show a slow decay in brightness (>1ms), and fluorescent materials, where the emission decay takes place over tens of nanoseconds. Phosphorescent materials are known for their use in radar screens and glow-in-the-dark toys, whereas fluorescent materials are common in CRT and plasma video display screens, fluorescent lamps, sensors, and white LEDs.

Phosphors are transition metal compounds or rare earth compounds of various types. The most common uses of phosphors are in CRT displays and fluorescent lights. CRT phosphors were standardized beginning around World War II and designated by the letter "P" followed by a number.

Phosphorus, the chemical element named for its light-emitting behavior, emits light due to chemiluminescence, not phosphorescence.[1]

Phospher Materials

Phosphors are usually made from a suitable host material with an added activator. The best known type is a copper-activated zinc sulfide and the silver-activated zinc sulfide (*zinc sulfide silver*).

The host materials are typically oxides, nitrides and oxynitrides,[9] sulfides, selenides, halides or silicates of zinc, cadmium, manganese, aluminium, silicon, or various rare earth metals. The activators prolong the emission time (afterglow). In turn, other materials (such as nickel) can be used to quench the afterglow and shorten the decay part of the phosphor emission characteristics.

Many phosphor powders are produced in low-temperature processes, such as sol-gel and usually require post-annealing at temperatures of ~1000 °C, which is undesirable for many applications. However, proper optimization of the growth process allows to avoid the annealing.[10]

Phosphors used for fluorescent lamps require a multi-step production process, with details that vary depending on the particular phosphor. Bulk material must be milled to obtain a desired particle size range, since large particles produce a poor quality lamp coating and small particles produce less light and degrade more quickly. During the firing of the phosphor, process conditions must be controlled to prevent oxidation of the phosphor activators or contamination from the process vessels. After milling the phosphor may be washed to remove minor excess of activator elements. Volatile elements must not be allowed to escape during processing. Lamp manufacturers have changed composition of phosphors to eliminate some toxic elements, such as beryllium, cadmium, or thallium, formerly used.[11]

The commonly quoted parameters for phosphors are the wavelength of emission maximum (in nanometers, or alternatively color temperature in kelvins for white blends), the peak width (in nanometers at 50% of intensity), and decay time (in seconds).

Applications in Lighting

Phosphor layers provide most of the light produced by fluorescent lamps, and are also used to improve the balance of light produced by metal halide lamps. Various neon signs use phosphor layers to produce different colors of light. Electroluminescent displays found, for example, in aircraft instrument panels, use a phosphor layer to produce glare-free illumination or as numeric and graphic display devices.

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