Comments on Draft 1 Version 3.0 ENERGY STAR TV Products Specification

Submitted by:

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Abstract
I have reviewed the policy proposed in this EPA Draft document and believe it to have a fundamental flaw that in practice will work against the admirable goal of reducing the energy consumption of flat-panel TV sets as much as could be possible in the long run. An alternate proposal is provided that will better achieve the EPA long term goals.

Who is Larry Weber?
Before I explain my reasoning, I would like to introduce myself for those who do not know me. I have worked on flat-panel displays for 38 years, starting in the late 60s as a student of the inventors of the plasma display panel at the University of Illinois at Urbana-Champaign. I have spent much of this 38 years devoted to reducing the energy consumption of plasma displays. As a professor at the University of Illinois, I invented the energy recovery sustain circuit which is used in all plasma TV sets today and reduces the power by 100 to 300 Watts depending on display area. In 1987, I started a company, that I named Plasmaco, which manufactured plasma displays. Plasmaco was the first company in the world to manufacture plasma displays using my energy recovery sustain circuit invention. I became President of Plasmaco in 1993 and led it to develop a prototype full color plasma display TV display which had the lowest power per unit area of any other plasma display of that era. In 1996 I sold Plasmaco to Panasonic which then used the Plasmaco technology to become the largest plasma TV manufacturer in the world. I continued on as Plasmaco President under Panasonic's ownership for 8 years until I retired in 2004.

In retirement, I now serve in a voluntary capacity as the President of the Society for Information Display (SID). I am also the Liaison Officer of IEC Technical Committee 110 (Flat-Panel Displays) to the IEC 62087 Ed 2.0 Maintenance Team. In this capacity I served IEC as the principle architect of the TV set energy measuring method now being proposed in the new draft standard of IEC 62087 Ed 2.0. I was also the editor of the 10 minute video test clip now being tested by interested stakeholders for the EPA. I do not now work or consult for pay for any commercial organization or company. In addition to my volunteer work for SID and IEC, I am currently conducting personally funded research on advanced methods to dramatically reduce the power consumption of plasma displays by as much as a factor of 40.

I am a Fellow of the SID and the IEEE and I have received many awards for my work on displays. In September 2007 I will receive the prestigious IEC "1906 Award" for my work on the IEC 62087 Ed 2.0 TV energy measuring method standard.

I have not been solicited to prepare these comments by any person, company or organization. The views presented here are simply my own opinion as an individual with considerable experience in the display industry and who has a sincere interest in reducing the long term energy consumption of TV sets.

Why is this EPA Draft Policy Flawed?
The major problem with this EPA Draft is that it proposes a single On Mode Power criterion (straight-line equation: Y = 0.245X + 11) that would apply to all the different types of display technology. In other words, all display technologies: LCD, Plasma, Projection, CRT, OLED, FED, SED etc will be given Energy Stars based on a single criterion. I believe this policy would adversely impact the long term goal of reducing the TV set energy consumption in the best way. A policy that gives Energy Stars based of the lowest energy TV sets of a given display technology would in the long term reduce the TV set energy consumption considerably greater than the proposal of the EPA Draft. In other words a much better policy would be for LCDs to have one energy usage criterion, Plasma another and Projection a third, etc.

The TV display market is currently in a very dynamic and sometimes chaotic state. The flat-panel displays such as LCD and Plasma are displacing the traditional CRT TVs. The LCD and Plasma are in a very tough battle to see who will dominate in the TV market and so their prices are dropping dramatically. New technologies such as OLED, FED and SED are promising to lower energy consumption, even more than the current LCDs and Plasmas, but these new technologies will have a very difficult time overcoming the market lead of LCD and Plasma. Each of these many TV display technologies (except the CRT) is in a relatively immature state and so we can expect great improvements in the future as they all strive to achieve market dominance.

Each of the display technologies I have mentioned here has a very good story on how it will ultimately reduce its On Mode Power consumption more than the others. I have covered these stories in my lecture entitled “The Race for TVs with Higher Luminous Efficiency” which I have presented at many international display conferences. I have attached the text that accompanies this lecture. Also the PowerPoint slides are available at ftp.sidchapters.org In this lecture I analyze the strategies of each of the TV display technologies, including LCD, Plasma, Projection, CRT, FED, SED, and OLED. My conclusion is that no individual or institution can currently predict which technology will win this race. We can only predict that each technology will work very hard on energy efficiency since it is the key factor that impacts the viability of a given display technology. Manufacturers are focused on energy efficiency because displays with better energy efficiency will have lower manufacturing costs and will then be more competitive in the market.

I have called this a “Race” because it is indeed very much like a horse race. At any given time there is a leader of the race (except for the beginning) but as the initially immature technologies develop, new leaders will temporarily pull ahead of others. The winner of the race cannot be determined until the race is over which in the case of TV displays will be when the various technologies mature.

One problem with this “Race” situation is that like a horse race, the early leader in the race is frequently not the winner of the race. An example of this is the recent Kentucky Derby where the horse that won by a wide margin started the race in 19th place and was in the rear half of the pack of horses for most of the race. This has relevance to the race for higher efficiency TVs. In my lecture, I present figure 1 which was derived from data compiled by a Japanese environmental group in 2005. This shows that in 2005 the LCD, Plasma and CRT TVs took the same power per unit area of 580 watts per meter squared, independent of size. However the data presented in the EPA Draft shows that LCDs have reduced their power more than Plasma by 2007. So the LCD horse has pulled ahead of the Plasma horse in 2007 whereas both technologies were neck-and-neck in 2005. LCD has done this by dynamically dimming the backlight as I explain in my lecture. However, this current LCD lead is a poor indicator of which technology will be the ultimate long term winner.

A major flaw of the EPA Draft is that it sets the On Mode Power criteria for all technologies based on the average performance of all technologies. This causes some peculiar results. Taking a look at the Charts_6_29_07.pdf TV On Mode Power By Type provided with the EPA Draft shows that according to the EPA Draft criteria shown by the red dashed line, all of the Rear Projection TVs would get Energy Stars but perhaps only one of the many Plasma TVs would get an Energy

Star. Are Projection TVs inherently more efficient? As explained in my lecture, the projection displays are all limited to a power of roughly 200 watts independent of Screen Area because of a technical limitation of the projection lamp technology that is available for these displays. In other words all of the Projection TVs must limit their luminance in order to comply with this lamp limitation. This means that Projection TVs with larger Screen Area will have significantly lower luminance than Projection TVs with smaller Screen Area. Since all of the manufacturers of Projection Displays are limited by the same lamp technology they all take roughly the same power, independent of Screen Area as shown in Charts_6_29_07.pdf.

Projection Display manufacturers do not purposely limit their power in order to save energy but instead they have lower power because the lamp technology limitation does not allow them to increase the power. Clearly if this lamp technology limitation did not exist, the Projection Display manufacturers would increase the power of the larger Screen Area displays in order have higher luminance and become more competitive with the LCD and Plasma TVs which are currently taking market share from the Projection Displays. The EPA Draft equation Y = 0.245X + 11 does a very poor job of characterizing the projection displays. A much better approximation of the Projection Display power is the simple equation Y = 200. LCD and Plasma TVs increase their power in proportion to Screen Area because in order to compete in the market place they need to provide a display with roughly the same luminance for all Screen Areas. An equation that makes Power be proportional to Screen Area is a reasonable approximation for LCD and Plasma but is unreasonable for Projection. A big problem with the EPA Draft equation is that it has a significantly lower slope of 0.245 because of the inclusion of the Projection Displays in the average. This lower slope would cause virtually none of the Plasma TVs to receive Energy Stars while all of the Projection Displays would receive Energy Stars. This situation is due to the lamp technology limitation of the Projection Displays. This is a fundamentally unfair situation that rewards Projection because of this lamp technology limitation and penalizes Plasma because of the improper method of averaging of the screen-area-independent Projection power data with Power data of LCDs, Plasma and CRTs which have a Power proportional to Screen Area.

If virtually none of the Plasma TVs receive Energy Stars then most of the lower power Plasma TVs will not be rewarded as they should be so as to encourage other Plasma TV manufacturers to lower their power. Some may argue that Plasma TVs deserve this treatment because they are “power hogs”. This could be reasonable except for the fact that the EPA Draft equation slope was improperly lowered due to the Projection lamp technology limitation. If the lamp technology limitation did not exist, the Projection power would be considerably higher which would increase the equation slope and allow more of the Plasma TVs to receive Energy Stars.

A policy that keeps virtually all Plasma TVs from receiving Energy Stars while roughly half of the LCDs receive Energy Stars will have a significantly adverse effect on sales of Plasma Displays. Currently Plasma Displays are experiencing significant competition from LCDs and there are many forecasts that LCDs will take most of the market share of Plasma Displays. The strong imbalance of Energy Stars between these two highly competitive technologies could cause a very significantly decline in sales of Plasma TVs. While some may feel that this is the desired result since Plasma TVs are “power hogs”, this is indeed a short sighted view that will not serve the long term goals of the Energy Star program. This is because the horse race is not yet over. The temporary situation of LCD taking lower Power per unit Screen Area than Plasma in 2007 is not likely to last forever. Plasma has a greater opportunity than LCDs to lower power in the future. It will not serve the long term Energy Star goals to kill off Plasma TVs because they are less efficient than LCDs in 2007!

I have been conducting a personally funded research program to dramatically improve the luminous efficiency of Plasma TVs by as much as 40 times. I am very optimistic that this can be achieved. A Plasma Display is basically a million or so small fluorescent lamps. The common fluorescent lamp easily achieves luminous efficiencies of 80 lumens per watt. On the other hand, the best Plasma Displays in today’s TVs only achieve 2 lumens per watt. I have been researching Plasma Displays to determine if there is some fundamental reason why the 1 meter

long fluorescent lamp is 40 times more efficient than the small plasma display pixel which is slightly less than 1 millimeter in length. My research has shown that there are no fundamental physical reasons why this factor of 40 should exist. This means that the appropriate engineering should be able to make the Plasma Displays of the future be as much as 40 times more efficient. I plan to continue research work on this very exciting opportunity. I will soon apply for patents and then publish the results widely. My goal is to teach this technology to all of the world's plasma display experts and manufacturers so that they can rapidly bring this energy efficient idea to production.

One may think that such a factor of 40 is not very likely to be achieved. Consider the history of LEDs. Just 15 years ago typical LEDs would achieve 1 or 2 lumens per watt. Today, commercially available LEDs achieve 40 or 50 lumens per watt and research LEDs achieve in excess of 100 lumens per watt. This dramatic improvement in LEDs was caused by the good ideas of a very small number of individuals. The exact same thing can easily happen with plasma displays.

LCDs are less likely to achieve this large factor of 40 improvement once they mature. LCDs typically use fluorescent lamp backlights with 80 lumens per watt but they only transmit about 5% of the light and so the usable luminous efficiency is by a simple calculation 80*5% = 4 lumens per watt. In practice today's typical LCDs achieve only 2.5 lumens per watt. It is possible for the LCD to increase its efficiency by increasing its light transmission. This might be done by eliminating the color filters that reduce the transmission by a factor of 3. However additional improvement in transmission beyond 15% will be difficult since the LCD has many layers of materials between the fluorescent backlight and the viewer that lose light. Many of these materials are currently near their limit of perfection. More details of this can be found in my lecture.

We can expect that OLED TVs will come to the market sometime in the near future. OLEDs are much more energy efficient than the current LCD and Plasma TVs as I discuss in my lecture. If we have a single criterion for all technologies, then all of the OLEDs will receive Energy Stars and a lower percentage of Energy Stars will go to other technologies such as LCD and Plasma. The problem with this is that OLED TVs will likely have a severe burn-in problem when used as TVs. LCD and Plasma TVs currently guarantee 60,000 hours half-luminance lifetime and in practice do much better. The best OLEDs are achieving only 25,000 hours for some but not all of the colors and so they are currently restricted to applications like cell phones which have intermittent use and are replaced by the user every year or two. So it is possible that in the future many of the Energy Stars would be given to a new energy efficient technology which is not very suitable for practical television displays and which will not survive in the marketplace. If this new technology does not survive in the end, then the single criterion policy will have needlessly hurt the surviving practical TV technologies. The current status of TV display technology is too immature and the various technologies operate much too differently for a single criterion policy to operate optimally.

Proposed Solution

The long term goals of the Energy Star program can better be achieved by having an independent On Power criterion for each display technology. As described above, Projection is much different than the other technologies and should be treated differently. All projection displays do not deserve Energy Stars simply because they have a projection lamp power limitation.

If we eliminate Projection and use a single On Power criterion for all the other technologies we still have the problem that in a given year some technologies will have advances that will temporarily put them ahead in the race over other technologies. These temporary leads are a poor indicator of the final winner. It is not wise to reward one technology over another since this may decrease the chances that the best technology would win in the future. Clearly the recent winner of the Kentucky Derby would not have had a fair chance of winning if we made a rule that horses that are far back in the pack would have to carry additional weight because they got a slow start and are seemingly not as good as the temporary leaders. The Derby winner was the

best horse even while he was only running in the 19th position. We should not make Plasma TVs carry the additional burden of receiving virtually no Energy Stars and being declared an "energy hog" simply because in the past two years, the LCDs have nosed ahead.

What is needed is a separate On Power equation for each technology. This would allow the lowest power TVs of each display technology to be appropriately rewarded with Energy Stars. These individual technology equations should be revised periodically as the technologies mature and the average On Power decreases. As technological breakthroughs occur that significantly lower On Power in a given technology, the Energy Star criteria would follow these advances. This would award Energy Stars to only the desired percentage of the total product population in a given technology. Having a different equation for each technology will not diminish the activity of manufacturers to work toward lower energy consumption; in fact it will more evenly promote it. The manufacturers in a given technology will still seek to be better than its competitors and will work hard to reduce the On Power. As an example, the proposed single equation in the EPA Draft will very significantly decrease the incentive of Projection to reduce its On Power. This is because the EPA Draft criterion insures that all Projection TVs will receive Energy Stars even if they do nothing to improve On Power. On the other hand, if the Projection TVs had their own individual criterion equation, then we would likely see more improvement since the Projection products not receiving Energy Stars would be pressured to improve.

The EPA Draft criterion would be appropriate if TV display technology was at a relatively mature state of development. However since it is clearly not, there will most likely be significant yearly changes in the On Power of one technology relative to another as we have just witnessed in the difference between the 2005 data shown in figure 1 of my lecture and the 2007 data shown in Charts_6_29_07.pdf. A uniform criterion for all technologies reduces the incentive of the technologies that are temporarily ahead. The EPA Draft criterion would then unfortunately reduce the rate of advance of the technologies with the lowest power. This is inconsistent with the EPA goal of reducing the On Power of TV sets in the shortest possible time since the most advanced technologies will get most of the Energy Stars and will not work as hard to improve further.

Summary

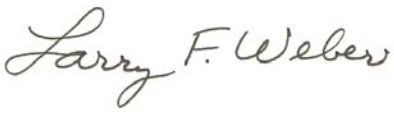
1. The EPA Draft proposal of a single On Power criterion for all display technologies does not optimize the incentive for all technologies to increase power efficiency because of the current immature state and the very significant technical differences of the display technologies.
2. A single On Power criterion for all display technologies would be very appropriate if all of the display technologies were at a mature state of On Power efficiency development. However some of the display technologies can expect a factor of ten or greater improvement in the future and so we are far from maturity.
3. Each display technology is likely to have its On Power efficiency breakthroughs at different times in the future. A single On Power criterion for all technologies will provide less incentive for improvement by the technologies that have the lowest power in a given year.
4. A single On Power criterion for all technologies will significantly hurt the technologies that temporarily have the highest power. Because of the very competitive nature of the display business, this additional burden could drive these technologies out of the business. This would not be a desirable result if these technologies are the ones that could, with the appropriate breakthroughs in the future, have the lowest power of all technologies in the long run.
5. Energy Star should encourage power efficiency for the various display technologies and should not be in the business of selecting winning display technologies. That is the function of the free market. The EPA Draft proposal will award Energy Stars to all TV sets of one display technology but virtually none to another. This will improperly interfere with the function of the free market to select TV set display technologies.
6. This commentary recommends that each display technology have its own On Power criterion that is independent of the other display technology criteria. These criteria would

be periodically adjusted so that the desired percentage of the product population in a given display technology would receive Energy Stars.

7. An independent criterion for each display technology would continue to provide the desired incentive for improvement that would cause manufacturers to lower the On Power.
8. An independent criterion for each display technology will optimize the incentive for all technologies to save our precious energy supplies and will work well in the long term to allow the lowest power display technology to achieve maturity.

I would be happy to have further discussions with the EPA officials on these comments.

Respectfully submitted,



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