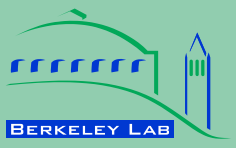

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BERKELEY NATIONAL LABORATORY

Assessment of SEAD Global Efficiency Medals for Televisions

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April 2013

This work was funded by the Bureau of Oceans and International Environmental and Scientific Affairs, U.S. Department of State, and administered by the U.S. Department of Energy in support of the Superefficient Equipment and Appliance Deployment (SEAD) Initiative through the U.S. Department of Energy under Contract No. DE-AC02-05CH11231.

Disclaimer

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Abbreviations and Acronyms

AUS	Australia
ABC	automatic brightness control
ADT	Australian Digital Testing
BAU	business as usual
CAT	commercially available technology
CCE	cost of conserved electricity (or energy)
CCFL	cold cathode fluorescent lamp
CEM	Clean Energy Ministerial
CES	Consumer Electronics Show
CLASP	Collaborative Labeling and Appliance Standards Program
CRT	cathode ray tube
EEI	Energy Efficiency Index
ET	emerging technology
EU	European Union
FPD	flat panel display
FHD	full high definition
IC	incremental cost
IND	India
IEA	International Energy Agency
kWh	kilowatt-hours
LCD	liquid crystal display
LED	light emitting diode
OLED	organic light emitting diode
p	progressive scan
PC	personal computer
PDP	plasma display panel
SEAD	Super-efficient Equipment and Appliance Deployment Initiative

TV	television
TWh	terawatt-hours
UK	United Kingdom
U.S.	United States
U.S. DOE	United States Department of Energy
W	watt(s)
W/cm^2	watts per centimeter

Executive Summary

Program Purpose and Design

The Super-efficient Equipment and Appliance Deployment (SEAD) Global Efficiency Medal competition is designed to enable the market to move toward higher efficiency by spurring innovation among manufacturers and increasing the market share of efficient products. The competition is also expected to help retailers or consumers easily identify the most efficient products across a region, and recognize these products as global leaders in energy efficiency. Through the SEAD awards program, policy makers and utilities can identify industrial potential (i.e., possible contribution from the appliance/equipment manufacturers) on energy efficiency improvement in selected product groups and design appropriate policy measures to drive the market towards greater efficiency. In addition, the SEAD awards competitions foster international government collaboration, which can strengthen the technical foundation of globalized products by supporting the harmonization of test procedures and building test lab capabilities.

With these overarching goals, the SEAD Global Efficiency Medal competition for flat-panel display televisions (FPD TVs) (hereinafter referred to as "the SEAD TV Awards") was launched in January 2012. In October 2012, SEAD awarded Samsung and LG for producing the most energy efficient FPD TVs in the world. The first competition aimed to encourage the production and sale of super-efficient TVs in three different size categories and four geographical regions (Australia, Europe, India, and North America), with an overall global winner for each size category and one global award for the most efficient emerging technology product. To ensure that the competition results in meaningful market transformation, the SEAD TV Awards competition required minimum sales thresholds. For the commercially available technology (CAT) category, applicants were required to have plans to sell at least a minimum number of units of a product model in the region of nomination.[1] The sales threshold is intended to ensure that award-winning products have a significant footprint in terms of market share, in order to maximize potential energy savings. For the emerging technology (ET) category, applicants were required to have plans for mass production within two years of the end of the competition.

Results of the SEAD TV Awards Competition

SEAD Global Efficiency Medals in the CAT category were awarded to the products in Table 1, recognizing them as the most energy efficient TVs in the four award regions. The SEAD Global Efficiency Medal in the ET category was awarded to an LG 47-inch LED backlit LCD prototype TV which consumes only about 30 W – that is approximately 59 percent more efficient than commercially available TVs with comparable technology.

[1] Australia: 5,000 units; India: 5,000 units; North America: 50,000 units; the European Region: At least 10,000 units in one country or 50,000 units across all EU27 and EFTA-countries

Table1. Award-winning Models in Commercially Available Technology Category

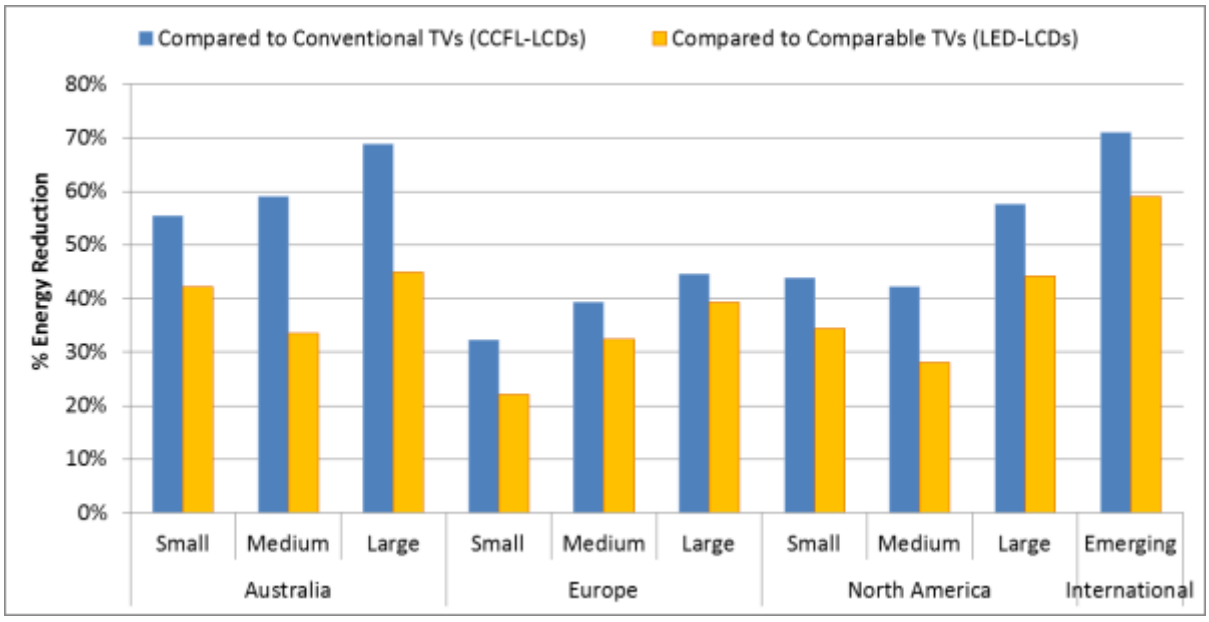
Size category	Australia	Europe	India	North America
Small	Samsung UA26EH4000M	Samsung UE26EH4000W	Samsung UA26EH4000R	Samsung UN26EH4000F*
Medium	Samsung UA40EH5306M	Samsung UE40EH5000W*	Samsung UA40EH5330R	Samsung UN40EH5000F*
Large	LG 47LM6700	LG 47LM670S*	LG 47LM6700	LG 47LM6700

* International Winners

Note: More details are available at http://www.superefficient.org/TVawards

1. Significant efficiency improvement potential - the award-winning models are 22-59% and 32-71% more efficient than TVs with comparable technology[2] and conventional technology[3], respectively.

All award-winning models are light emitting diode (LED) backlit liquid crystal display (LCD) TVs. The award-winning models in the CAT category can be regarded as most efficient existing products in the local markets. The winner in the ET category is better than the most efficient models available in the market. The international award-winning model for the ET category is about 30 percent more efficient than the winners of the large-size CAT category. The efficiency of award-winning models compared to commercially available TVs in the different regions is summarized in Figure 1.



Note: This comparison was made with TVs registered to regional databases (e.g., U.S. ENERGY STAR and Australian Energy Rating) in 2012. The majority of TV models compared with the European winning models are from the Intertek database, which can be regarded as representative of TVs sold in Europe as country-specific changes from basic models are made mostly in tuners. The dataset includes only TVs with standby power consumption less than 0.5 W and the luminance ratio between default home mode and brightest picture mode greater than 65 percent.

Fig 1. Comparison of Award-Winning Models vs. Commercially Available TVs

[2] Light Emitting Diode (LED) backlit LCD TVs

[3] Cold Cathode Fluorescent Lamp backlit (CCFL) backlit LCD TVs

2. **Manufacturers' on-going efforts at improving efficiency - manufacturers make ongoing changes (or "running changes"[4]) in efficiency improvement and cost reduction throughout the production year[5] for some models after introduction. The SEAD Global Efficiency Medal can further encourage this trend.**

The award-winning models for the CAT category have already been registered to the regional energy efficiency databases or testing lab databases, implying that they are not brand new models. The on-mode power consumption values registered in early 2012 are higher than those claimed for the SEAD TV Awards by up to 30 percent. Typically, manufacturers take into account some margin of error when reporting on-mode power consumption of their products to the regional databases. Also the on-mode power consumption is expected to decrease throughout the production year as manufacturers make running changes. LG especially has made significant improvements in energy efficiency of the large size winning model since its introduction (by approx. 30 percent). This is beyond the level typically achieved by running changes through the year. This improvement has been further encouraged by the SEAD TV Awards along with LG's own plan for efficiency improvement of their products.

3. **Energy savings potential - if all the TVs sold were as efficient as the SEAD award-winning models, more than 84 billion kilowatt-hours (or terawatt-hours [TWh]) of electricity would be saved worldwide in the year 2020. That is equivalent to 28 medium size coal-fired power plants with 500 megawatts capacity[6], or taking nearly 12.3 million cars off the road for a full year (U.S. EPA 2012).**

If all new *large* TVs (screen size equal to or larger than 42 inches) expected to be sold globally from 2013 to 2020 meet the efficiency level that the award-winning model for the ET category has achieved, it would provide *additional* annual savings in 2020 of about 12 TWh for all regions.

4. **Cost effectiveness - for the U.S. market, the CAT winners in the small and medium size categories are certainly cost effective to consumers while the winners in the large size category are also likely to be cost effective.**

For the U.S. market, CAT winners in the small and medium size categories are entry-level models and seem to be cheaper than or are similarly priced as the average market price of comparable TVs, resulting in savings of electricity costs without additional investment. The cost of conserved electricity (CCE)[7] of the CAT winning model in the large size category

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[4] A generally accepted industry term denoting "ongoing design changes made throughout the year"

[5] A typical TV product development cycle is in a range of 6 to 12 months and new models are generally released, beginning the year. Running changes to particular models are not expected to occur from one year to the next.

[6] In rough back-of-the-envelope calculations, if an efficiency technology or policy would save 3 TWh per year, it saves one 500 MW coal plant operating at 70 percent capacity factor in that year, this unit of energy savings is called one Rosenfeld (Koomey et al. 2010).

[7] CCE is a metric used to compare the cost of saving electricity to the cost of providing electricity to assess the desirability of energy efficiency measures. CCE is estimated by dividing the annualized incremental cost of the energy efficient model by annual energy savings.

with advanced features such as 3D capability and wireless network functions seems to be similar to or higher than the average residential electricity prices of many states in the U.S. All award-winning CAT models within each size category are essentially the same or very similar in product design, regardless of region. Hence, the cost effectiveness results for the U.S. market are likely to be applicable to other countries, depending on market prices and consumer electricity prices.

5. Test lab capacity building and test harmonization activity

Reliable and comparable test results are important to support a global awards program. To this end, it is critical to improve test laboratory capabilities where necessary and to harmonize testing activities among labs. The SEAD TV Awards competition used the IEC62087:2011 procedure, which is an internationally accepted test procedure for TVs and other video equipment, to verify manufacturers' energy efficiency claims. An international round-robin test across the designated test laboratories was performed to ensure comparable and transparent test results. Lastly, during this competition, SEAD assisted in improving test capabilities of the designated test laboratories in India by assessing test equipment and providing technical training for the test procedure.

The increase in the sales of internationally or regionally recognized award-winning products is expected to reduce electricity consumption in newly sold TVs that would otherwise have been less efficient. This report does not analyze the net impacts of the SEAD TV Awards as the award-winning products are still on sale and relevant marketing activities are in progress at the time of writing. However, the energy savings potential and corresponding efficiency levels of award-winning products estimated in this report can inform national and international policy measures such as regional standards, labeling programs, and incentive programs.

I. Introduction

The Super-efficient Equipment and Appliance Deployment (SEAD) Initiative of the Clean Energy Ministerial is a voluntary international government collaboration whose primary objective is to advance global market transformation for energy-efficient equipment and appliances. SEAD is a task within the International Partnership for Energy Efficiency Cooperation (IPEEC) and was launched as an initiative within the Clean Energy Ministerial[8] (CEM)'s Global Energy Efficiency Challenge in July 2010.

The SEAD Global Efficiency Medal competition has been designed to enable the market to move toward higher efficiency by

- realizing the greatest possible energy savings potential
- increasing market share of highly efficient products
- spurring innovation among manufacturers
- supporting test harmonization activity
- providing internationally comparable and transparent test results
- informing standards and labeling policies

With these overarching goals, at the second CEM in April 2011, SEAD announced plans for the first international competition to recognize the most efficient products in the world. The first round was focused on flat-panel display televisions (FPD TVs), and subsequent rounds will cover personal computer (PC) monitors and motors.[9]

The SEAD Global Efficiency Medal competition for TVs (hereinafter referred as "the SEAD TV Awards") was launched in January 2012 and recognized Samsung and LG for producing the most energy efficient FPD TVs in the world. In its first year, the competition aimed to encourage the production and sale of super-efficient TVs in three different size categories (small, medium and large) and four geographical regions (Australia, the European region[10], India and North America[11]) with an overall global winner for each size category and one global award for the most efficient emerging technology product. SEAD Global Efficiency Medals were awarded to products that demonstrate the greatest energy efficiency, in terms of watts per unit screen area. Table 2 shows the product size categories for commercially available products eligible for the SEAD TV Awards.

Table2. Size Categories for Commercially Available Products

[8] A high-level global forum to promote policies and programs that advance clean energy technology, share lessons and best practices, and encourage the transition to a global clean energy economy. At the first CEM meeting in July 2010, ministers from 14 countries pledged to carry out joint efforts to dramatically improve the energy efficiency of household appliances and other energy-consuming equipment. More details available are at www.superefficient.org and www.cleanenergyministerial.org.

[9] http://www.superefficient.org/en/Activities/Awards.aspx

[10] For the purpose of this Competition, the European Region consists of all EU 27 countries and the EFTA-countries Switzerland, Norway, Iceland and Liechtenstein.

[11] Limited to the United States and Canada

	Small	Medium	Large
Viewable Screen Area	Less than 2400 cm^2 (372 in^2)	2401 cm^2 (372 in^2) to 4800 cm^2 (744 in^2)	4801 cm^2 (744 in^2) to 6890 cm^2 (1068 in^2)
Nominal Diagonal Screen Size	Less than 29 in	29 in to less than 42 in	42 in to 50 in*

* TVs with screen larger than 6890 cm^2 (equivalent to 50 inches in diagonal) were eligible for the SEAD TV Awards, but a value of 6890cm^2 was used as the screen area in the efficiency calculation for these products.

The best performer in each size category among all of the regions was declared an "International Winner" for that size category. As the result, a total of sixteen (16) awards (12 region and 4 international winners) for the *commercially available technology* (CAT) product category were given, and one (1) award (1 international winner) for the *emerging technology* (ET) category was given (see Table 3).

Table3. 2012 SEAD TV Awards Finally Determined

		Australia	Europe	India	North America	International
Commercially Available Technology (CAT)	Small	1	1	1	1	1
	Medium	1	1	1	1	2
	Large	1	1	1	1	1
Emerging Technology (ET)		-	-	-	-	1

To ensure that the program results in meaningful market transformation, the SEAD TV Awards included the following rules:

1) TVs with screens larger than 6890 cm^2 (equivalent to 50 inches in diagonal) are eligible for the SEAD TV Awards, but a value of 6890cm^2 shall be used as the screen area in the efficiency calculation for these products in order to dis-incentivize the sale of TVs with very large screen sizes, which consume more energy than smaller products;
2) Eligible products must have displays with a minimum resolution capability of 720 progressive scan[12] [p] for the small size category and 1080p (full high definition, or full HD) for the medium and large size categories to ensure the award-winning products meet the market demand in basic performance;
3) For the CAT category, applicants must have plans to sell at least a minimum number[13] of units of a product model in the region of nomination in order to ensure that the award-winning products are commercially available and have a sizable

[12] The scanning method used mostly in old CRT TVs displays an interlaced image on the screen by scanning all odd lines first; then all even lines, i.e., using half frames per second. The term "progressive scan" refers to the scanning method used for recent FPD HDTV models wherein an image is displayed on the screen by scanning each image line in sequential order, i.e., full frames per second, resulting in less flicker and better picture quality.

[13] Australia: 5,000 units; India: 5,000 units; North America: 50,000 units; the European Region: At least 10,000 units in one country or 50,000 units across all EU27 and EFTA-countries

share in the market;

4) For the ET category, the award-winning models must be planned to be mass produced within two years of the end of the competition period; and
5) Round robin test, an inter-laboratory test performed independently with the same samples, shall be conducted before the verification process to provide internationally comparable and transparent test results for the selection of regional and international winners.

Necessity for Analysis of the SEAD TV Awards

An assessment of the SEAD TV Awards is needed for the following reasons.

1) Lessons learned from the first competition will help policy makers determine if an awards program can be an effective market transformation mechanism to promote energy efficient products. Using lessons learned from the first competition, subsequent rounds of the competition can be better designed.
2) TV screen technologies sold in different regions of the world are very similar as TV manufacturing is highly globalized. The four award regions of the SEAD TV Awards account for more than 40 percent of the global TV market. However, TVs with minor variations from the award-winning models, i.e., similarly designed TVs with similar energy consumption characteristics, are likely to be made available by the manufacturers in other regions as well. The analysis of the SEAD TV Awards is expected to enable policy makers to see how efficiency improvement of globally manufactured products can be effectively accelerated.

II. Results of the SEAD TV Awards

All the nominations, including those in the ET category, were LED-backlit LCD (LED-LCD) TVs. Table 4 summarizes the energy performance of the SEAD TV Awards nominees. *(Note that this report does not disclose any confidential information about the individual nominees, unless the nominee won an award).* SEAD Global Efficiency Medals in the CAT category were awarded to the products in Table 5, recognizing them as the most energy efficient TVs in the regions. The SEAD Global Efficiency Medal in the ET category was awarded to an LG 47-inch LED-LCD TV. The award-winning models are 22 to 59 percent more efficient than TVs with comparable technology, and 32 to 71 percent more efficient than TVs with conventional technology.[14] Figure 2 and Table 6 show the on-mode power performance comparison of the award-winning models and commercially available TVs for 2012 in the Australia, Europe and North America markets.[15]

Table4. SEAD TV Awards Nomination Results

Category	Nominal Diagonal Screen Sizes	Minimum On-mode Power Performance Claimed	Standby mode Power
unit	inches	watts/cm^2	watts
Small	22-26	0.0118-0.0157	0.1-0.3
Medium	32-40	0.0100-0.0147	0.1-0.2
Large	46-55	0.0071-0.0103*	0.1-0.3
Emerging	47-90	0.0051-0.0072*	0.1-0.2

* Note: The value (i.e., 6890cm^2) for large TVs (≥ 50") is not adjusted in this table.

Table5. Award-winning Models in Commercially Available Technology Category

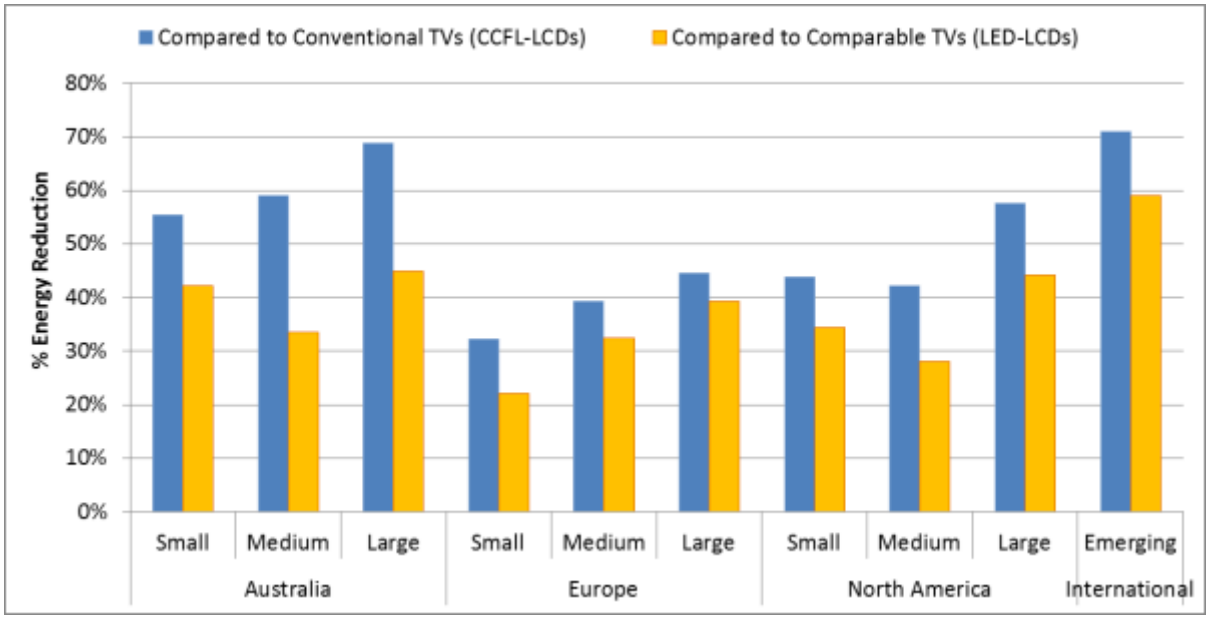
Size category	Australia	Europe	India	North America
Small	Samsung UA26EH4000M	Samsung UE26EH4000W	Samsung UA26EH4000R	Samsung UN26EH4000F*
Medium	Samsung UA40EH5306M	Samsung UE40EH5000W*	Samsung UA40EH5330R	Samsung UN40EH5000F*
Large	LG 47LM6700	LG 47LM670S*	LG 47LM6700	LG 47LM6700

* International Winners

Note: More details are available at http://superefficient.org/TVawards

[14] Comparable technology in this report is defined as LED-LCD TVs as all award-winning models are LED-LCD TVs. Conventional technology is defined as Cold Cathode Fluorescent Lamp backlit (CCFL) backlit LCD TVs which had been dominant in the global TV market, but are now being phased out. Other screen technologies such as PDP, OLED, and CRT TVs are not included in the comparison.

[15] A substantial list of commercially available TVs in India was not available to the author at the time of writing.



Note: This comparison was made with TVs registered to regional databases (e.g., ENERGY STAR and Energy Rating) in 2012. Majority of TV models compared with the European winning models are from the Intertek database, which can be regarded as representative of TVs sold in Europe as country-specific changes from basic models are made mostly in tuners. The dataset includes only TVs with standby power consumption less than 0.5 W and the luminance ratio between default home mode and brightest picture mode greater than 65 percent.

Fig 2. Comparison of Award-Winning Models vs. Commercially Available TVs

Table6. On-mode Power Performance: Award-winning Models vs. Commercially Available TVs

		Average of Commercially Available TVs		Award-winning TVs		
		On-mode power performance[a] [watts/cm^2]		On-mode power performance [watts/cm^2]		
		CCFL-LCDs (A)	LED-LCDs (B)	LED-LCDs[b] (C)	%imp (A-C)/A	%imp (B-C)/B
Australia	Small	0.0294	0.0227	0.0131	55%	42%
	Medium	0.0261	0.0161	0.0107	59%	34%
	Large	0.0228	0.0129	0.0071	69%	45%
India	Small	N/A	N/A	0.0134	-	-
	Medium	N/A	N/A	0.0107	-	-
	Large	N/A	N/A	0.0071	-	-
Europe	Small	0.0198	0.0172	0.0134	32%	22%
	Medium	0.0165	0.0148	0.0100	39%	32%
	Large	0.0128	0.0117	0.0071	45%	39%
North America	Small	0.0210	0.0180	0.0118	44%	34%
	Medium	0.0173	0.0139	0.0100	42%	28%
	Large	0.0172	0.0131	0.0073	58%	44%
International[c]	Small	0.0234	0.0193	0.0118	50%	39%
	Medium	0.0200	0.0149	0.0100	50%	33%
	Large	0.0176	0.0126	0.0071	60%	44%
	Emerging	-	-	0.0051	71%	59%

[a] Averages (not weighted by sales or shipments) of TVs registered to the above regional TV databases.
[b] All award-winning TVs are LED-LCD TVs. The market share of LED-LCD TVs in 2012 is estimated to be in a range of 41 to 74 percent, depending on region, and expected to account for more than 90 percent in 2015 for all regions (DisplaySearch 2011a).
[c] Average column is the average of all regional numbers available.
- Small size category consists of TVs with nominal screen size less than 29 inches.
- Medium size category consists of TVs with nominal screen size less than 42 inches.
- Large size category consists of TVs with nominal screen size of 42-50 inches.

As shown in Figure 3, the award-winning models in the CAT category can be regarded as the most efficient existing products in the local markets. The winner in the ET category is better than the most efficient models available in the market.[16]

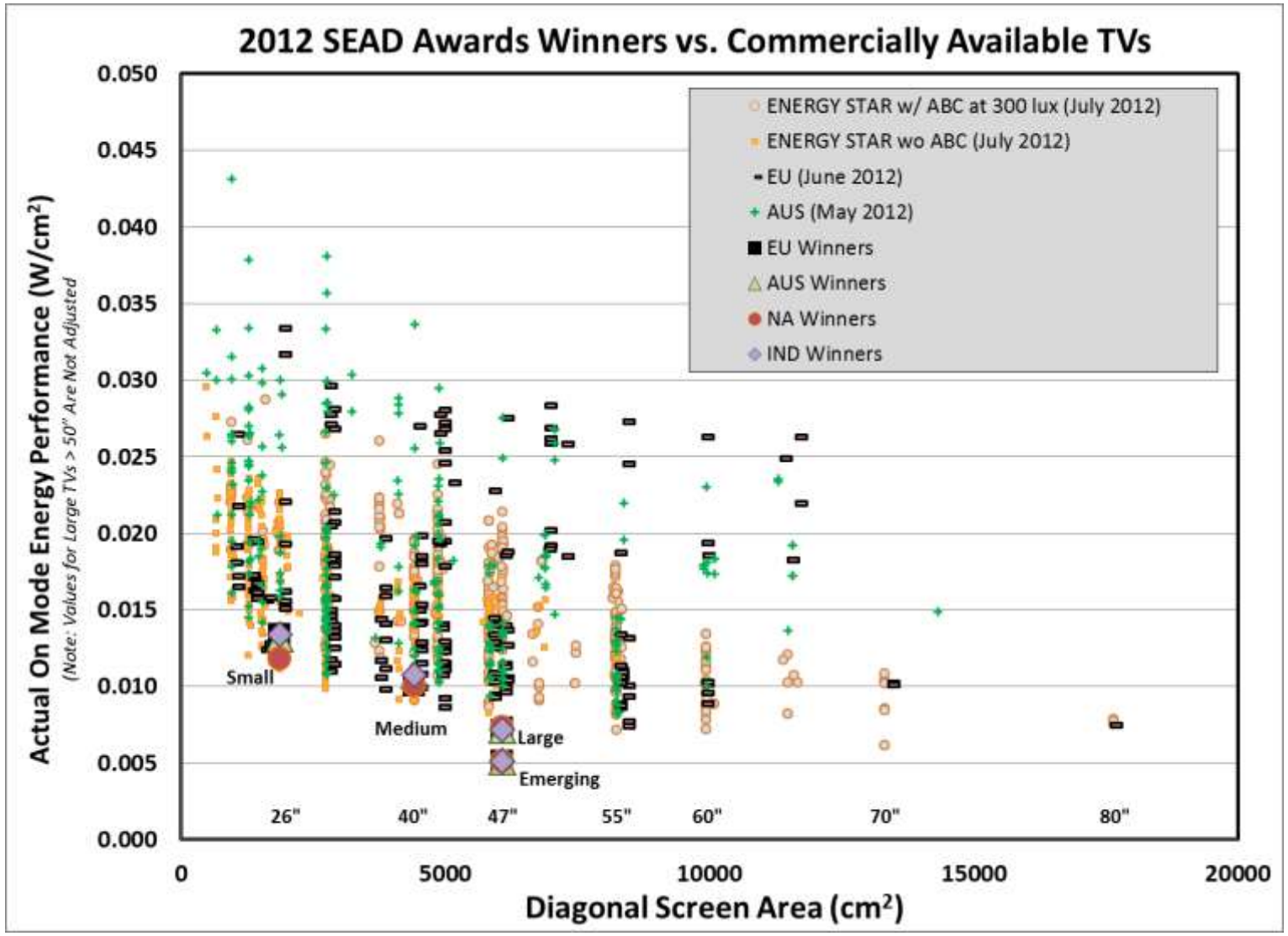
Given that a typical TV product development cycle is in a range of 6 to 12 months and that the SEAD TV Awards were publicly announced in January 2012, the applicants seem to have nominated their best performing CAT models that can meet the SEAD TV Awards requirements, rather than having newly developed higher on-mode power performance models that may not have been otherwise considered. The international award-winning model for the ET category is about 30 percent more efficient than the large-size winners of the CAT category. The ET winner is expected to be available in the market within two (2) years as per the competition's requirement.

The award-winning CAT models had already been registered to the regional energy efficiency databases or testing lab databases[17], except for India. Their on-mode power consumption registered early in 2012 is anticipated to be equal to or higher than those claimed for the SEAD TV Awards because of the timing factor (see Table 7). Specifically, this may be explained as follows: In general, manufacturers take into account some margin of error when they report on-mode power consumption of their products to the regional databases. Also, as manufacturers make running changes[18] to some of their major models, on-mode power consumption is expected to decrease. Likewise, it is also possible that manufacturers have made running changes similar to those made to the award-winning models to TV models which were not nominated to the SEAD TV Awards.

[16] This analysis finds that major manufacturers make running changes to some of their models. However, because it was not possible to track down changes in power consumption of all TVs in the market, this analysis compares the on-mode power of award-winning TVs nominated in May 2012 with those of other TVs registered to regional databases early in 2012 that might have made running changes in terms of energy efficiency throughout the first half of the year.

[17] See note on Figure 2.

[18] A generally accepted industry term denoting "ongoing design changes made throughout the year"



Note: AUS (Australia), EU (European Union), IND (India), NA (North America), ABC (Automatic Brightness Control)

Fig 3. On-mode power performance (W/cm^2) –SEAD TV Awards Winners vs. Commercially Available TVs

All winning models meet the Australian Energy Rating 8 Stars, European Energy Efficiency Index (EEI) A, India 5 Stars, or ENERGY STAR Version 6 requirements. The winners in the large size category meet Australian Energy Rating 9 Stars and European EEI A++ requirements. The on-mode power (30.9 W) of the 47-inch ET winner is only about 10 percent higher than the EEI A+++ requirement, i.e., ~28.3 W for 47-inch TVs. Table 7 and Figure 4 show on-mode power consumption of the award-winning models.

The winners in the small and medium categories are entry level TVs. Entry level TVs are not necessarily inherently inefficient compared to high-end TV models with higher resolution and higher frame rates, although high-end models may feature advanced backlight dimming or better optical components that can further reduce on-mode power consumption. In addition, since 2011 major TV manufacturers have been providing new types of LED-LCD TVs at lower prices in the market for the purpose of decreasing the price gap between conventional CRT or CCFL-LCD TVs and LED-LCD TVs. Manufacturers can accomplish this in the following ways. First, decreasing the maximum luminance level and color-reproduction capability reduces material costs as well as power consumption. For example, lower luminance allows manufacturers to use fewer LED lamps as well as low-voltage driven electronic parts in the circuitry (Park et al. 2011). Second, this trend leads to another type of affordable LED-direct[19] backlit LCD TVs, often referred to in industry parlance as "low-cost LED-direct backlighting" or "emerging market TVs", which employ about half of LEDs compared to typical LED backlights, and lower-cost optical components in the backlight system (Kim 2012, Semenza 2011). The winners in the small and medium categories are such affordable LED-LCD TVs.

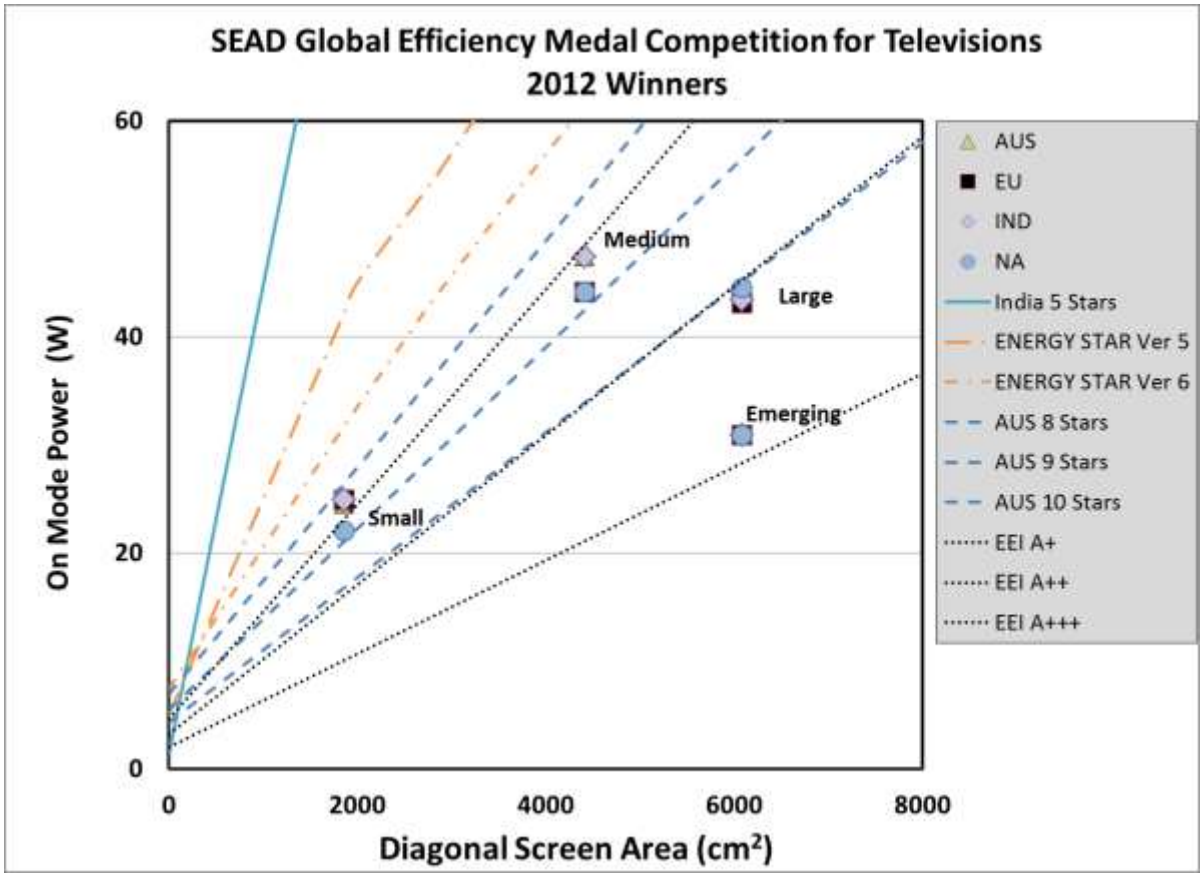
Table7. On-Mode Power Consumption of the SEAD TV Awards Winners

Region	Size	Brand	Model	Nominal Size	Registered to regional database (A)	Declared [W] (B)	(B)/(A)	Efficiency Rating
				inches	1Q 2012	2Q 2012		
Australia	S	Samsung	UA26EH4000M	26	26	24.5	0.94	8 Stars
	M	Samsung	UA40EH5306M	40	50	47.4	0.95	8 Stars
	L	LG	47LM6700	47	61.2	43.4	0.71	9 Stars
Europe	S	Samsung	UE26EH4000W	26	28	24.9	0.82	EEI A
	M	Samsung	UE40EH5000W	40	55	44.1	0.80	EEI A+
	L	LG	47LM670S	47	63	43.1	0.68	EEI A++
North America	S	Samsung	UN26EH4000F	26	23	22.0	0.96	ENERGY STAR 6
	M	Samsung	UN40EH5000F	40	44.6	44.1	0.99	ENERGY STAR 6
	L	LG	47LM6700	47	66.7	44.5	0.67	ENERGY STAR 6
India**	S	Samsung	UA26EH4000R	26	N/A	24.9	N/A	5 Stars
	M	Samsung	UA40EH5330R	40	N/A	47.4	N/A	5 Stars
	L	LG	47LM6700	47	N/A	43.4	N/A	5 Stars

* S: Small, M: Medium, L: Large,

** The award-winning products for India are not registered to the BEE Star Rating program.

[19] "LED-direct" or "LED full-array" configuration means that the LEDs are uniformly arranged behind the entire LCD panel. Unlike LED-direct models, "LED-edge" or "Edge-lit" configuration means that all of the LEDs are mounted on sides (or edges) of the display.



Note: Australia (AUS) and India (IND) star rating requirements are based on annual energy consumption in kWh per year. Assumptions applied to Figure 4 are as follows: 0.3 W of standby-mode power for both star ratings based on the nomination results; daily usage: 10 hours for AUS and 6 hours for IND

Fig 4. On-mode Power Consumption of the TV Awards Winners with Regional Standards

LG won the international award for the ET category. Luminance of the winner in the ET category is similar to the winners in the large size category, and the claimed on-mode power consumption of the ET winner is about 30 percent more efficient than that of the winners in the large size category, which misses EU's A+++ by a whisker, the most efficient level of existing categorical efficiency labels in the world.

Table8. Comparison of the Large Size Winners and the ET Winner

	Large (LG 47LM6700)		**Emerging (LG 47-inch)**	
	Model	On-mode power [W] (W/cm^2)	Model	On-mode power [W] (W/cm^2)
Australia	47LM6700	43.4 (0.0071)	N/A	30.9 (0.0051)
EU	47LM670S	43.1 (0.0071)		
North America	47LM6700	43.4 (0.0071)		
India	47LM6700	44.5 (0.0073)		

Why are they all LCD TVs?

Products eligible for the SEAD TV Awards are FPD TVs such as LCD (regardless of backlight technology), plasma display panel (PDP) and organic light emitting diode (OLED) TVs. The market share of PDP TVs is not significant at present and expected to continue to decrease (DisplaySearch 2011a). In the 2012 Consumer Electronics Show (CES) held in Las Vegas, United States (U.S.), Samsung and LG demonstrated 55-inch OLED prototype TVs, and in the 2013 CES, Sony and Panasonic demonstrated 56-inch OLED prototype TVs. LG OLED TVs would be available in the market in 2013.[20] While OLEDs are generally known to be more efficient than LCDs (Park et al. 2011), such large OLED TVs were not nominated to the SEAD TV Awards. This is mainly because, first, even though they were commercially available in 2012, they were not likely to meet the sales requirement for the CAT category in the SEAD TV Awards as their market prices at the initial stage are expected to be very high, compared to LCD TVs at the same size. Second, as the on-mode power performance (W/cm^2) of TVs larger than 50 inches is calculated using a screen size of 6,890 cm^2 (equivalent to 50 inches diagonal) instead of their actual screen area, manufacturers might have not been confident that 55-inch OLED TVs at the early stage would be competitive in the competition against LCD TVs which have been rapidly improved in energy efficiency. Third, manufacturers are extremely cautious and uncomfortable with sending products that are recent innovations with significant intellectual property under development to the testing labs in other countries to avoid revealing their cutting-edge technology. Even though OLED TVs are eligible for the ET category, OLED TV manufacturers are not likely to have their new technologies investigated by external institutions.

Standby Mode Power Consumption

Currently, a majority of TVs consume less than 1 W in standby mode, mostly passive standby[21]. U.S. ENERGY STAR requires that measured power consumption of a TV in sleep mode[22] be less than or equal to 1.0 W. In 2010-2011, the simple average of sleep mode power consumption of ENERGY STAR-qualified LCD and PDP TVs was 0.33 W, and about 70 percent of the TV models consume less than 0.5 W in sleep mode (Park et al. 2011). In 2012, TVs commercially available in the Australian and the U.S. markets consume 0.2 to 0.4 W on average in passive-standby mode. The SEAD TV Awards required a nominated model to consume less than or equal to 0.50 W in passive standby mode when measured according to the IEC 62301 test procedure. The award-winning TVs consume 0.12 to 0.20 W in passive standby mode.

[20] As of Jan 3 2013, LG retail stores in South Korea began accepting pre-orders for LG 55-inch OLED TVs. The model costs 11 million KRW, equivalent to about 10,000 USD.

[21] According to IEC 62301, "The appliance is connected to a power source, produces neither sound nor picture but can be switched into another mode with the remote control unit or an internal signal."

[22] It is sometimes the same as or a subset of standby mode. Whether this mode is "off" depends on the definition of "off mode." ENERGY STAR's TV requirements have been using "sleep mode" instead of "standby".

Table9. Standby-mode Power Consumption: Award-winning Models vs. Commercially Available TVs

		Average Power Consumption of Commercially Available TVs[a]		Power Consumption of Award-winning TVs
		Standby-mode power [W]		On-mode [W]
		CCFL-LCDs	LED-LCDs	LED-LCDs
Australia	Small	0.42	0.39	0.15
	Medium	0.38	0.27	0.15
	Large	0.36	0.22	0.20
India	Small	N/A	N/A	0.13
	Medium	N/A	N/A	0.15
	Large	N/A	N/A	0.20
Europe	Small	<0.5	<0.5	0.13
	Medium	<0.5	<0.5	0.17
	Large	<0.5	<0.5	0.20
North America	Small	0.38	0.34	0.13
	Medium	0.34	0.32	0.17
	Large	0.32	0.25	0.12
International	Small	0.40	0.37	0.13
	Medium	0.37	0.30	0.15
	Large	0.32	0.24	0.12
	Emerging	-	-	0.20

Because standby power does not depend on screen size, energy consumption in standby mode is relatively simple to estimate compared to consumption in on mode. Assuming that 1) the average standby power of all TVs across the globe is 0.3 W; and 2) the average worldwide daily on-time usage is 5 hours while the remaining 19 hours are spent in standby mode; then the total energy consumption in standby mode of new TVs to be shipped in 2013 can be estimated to be 0.54 TWh per year. If all new TVs that are expected to be sold globally from 2013 to 2020 consume 0.15 W in standby mode, the annual savings in 2020, compared to the scenario of all new TVs with no further efficiency improvement in standby mode power consumption from 2013 onward, would be about 2.5 TWh.

Recent TVs have many new features, including network connectivity, hard disks, DVD recorders, etc. TVs with these additional features are often required to have fast boot times. In particular, connected TVs (or smart TVs) are, because of their integrated features, likely to consume more energy in standby mode than current conventional TVs do, although this varies depending on manufacturers' setting (Park et al. 2011). Although the maximum power required for network connectivity and fast reactivation time, is not expected to increase because of technological improvements, the average network standby power is expected to vary depending on the power management regimes applied. In fact, the Samsung EH5300 series, which includes the winners for Australia and India in the medium size category, and the LG LM6700 series, which includes the winners in the large size category,

have added network related features (see Appendix A, B). Inclusion of network standby power in the test procedures would be necessary for the next round of the competition.

III. Savings Potential

Assumptions

The savings potential in this analysis is estimated by the difference in energy consumption between two scenarios or "cases". The result shows global electricity savings in the hypothetical future scenario where all TVs sold are as efficient as the SEAD award-winning TVs. The ***Frozen Efficiency Case*** assumes that there is a large scale transition in the TV market from traditional CCFL-LCD TVs to efficient LED-LCD TVs *with no further efficiency improvement* within each technology from 2013 onward. This scenario can be regarded as the most conservative business-as-usual (BAU) case. The baseline consumption is based on the average on-mode power performance of regional TVs. ***Super-efficiency Case*** assumes that all LCD TVs, which are expected to account for annually 60 to 98 percent of global TV shipments (in terms of total screen area) through 2020, meet the efficiency level of the award-winning models from 2013 onward. The gap between Frozen Efficiency and Super-efficiency cases includes the impact of rapidly-evolving TV technology on energy efficiency.

Savings Potential

Based on the above assumptions and the data available for this report, the savings potential contributed from annual TV shipments (for CAT winning models) are as follows:

If all new TVs (except for OLED TVs) expected to be sold globally from 2013 to 2020 meet the efficiency levels that award-winning models for the CAT category have achieved, compared to the scenario of all new TVs with *no further efficiency improvement* within each screen technology from 2013 onward, it would provide annual savings in 2020 as follows:

- 2.9 TWh in Australia (equivalent to the national annual electricity use of Botswana (IEA 2010))
- 17.2 TWh in Europe (equivalent to the national annual electricity use of Croatia (IEA 2010))
- 5.4 TWh in India (equivalent to the national annual electricity use of Bolivia)
- 18.6 TWh in North America (equivalent to the national annual electricity use of Nigeria (IEA 2010))
- 84.6 TWh, equivalent to 28 medium size coal-fired power plants with 500 megawatts capacity[23], or taking nearly 12.3 million cars off the road for a full year (U.S. EPA 2012), in all regions (more than the combined annual national electricity use of Denmark and New Zealand (IEA 2010))

[23] In rough back-of-the-envelope calculations, if an efficiency technology or policy would save 3 TWh per year, it saves one 500 MW coal plant operating at 70 percent capacity factor in that year, called one Rosenfeld (Koomey et al. 2010).

If all new *large* TVs with screen equal to or larger than 42 inches, which are expected to be sold globally from 2013 to 2020, meet the efficiency level that the award-winning model for the ***ET category*** has achieved, it would provide additional ***annual savings*** in 2020 of:

- 0.2 TWh in Australia
- 2.6 TWh in Europe
- 0.4 TWh in India
- 3.7 TWh in North America
- 12 TWh for all regions in 2020 on top of the above case.

Table10. Regional and Global Savings Potential for Efficiency Improvement in SEAD TV Awards

	Annual Savings (TWh)		Cumulative Savings (TWh)	
	in 2015	in 2020	2013-2015	2013-2020
Australia	1.2	2.9	2.5	13.7
India	2.3	5.4	4.6	25.9
Europe	7.0	17.2	14.0	81.1
North America	8.0	18.8	15.6	88.7
Global	34.8	84.6	69.8	399.6

IV. Cost Effectiveness Analysis

This section analyzes the cost-effectiveness of the regional winners in North America against similar TV models in the market. As discussed earlier, the regional winners are 25 to 51 percent more efficient than typical TVs of the same size with similar technology in the market. The regional winners in the small and medium size category are affordable entry-level models and seem to be cheaper than or similar to the average market price of comparable TVs, resulting in saving electricity costs without additional investment.

Table11. Market Prices and On-mode Power of the Regional Winners in North America and Typical TVs with Similar Technology

Regional Winners in North America			Typical TVs in the U.S. Market		
Model	Price[a]	On-mode Power Consumption	Model	Price[b]	Average On-mode Power Consumption
Samsung UN26EH4000F	$260	22.0 W	26" LED-LCD 1366×768	$278	29.2 W
Samsung UN40EH5000F	$548	44.1 W	40" LED-LCD 1920×1080	$566	64.9 W
LG 47LM6700 (3D enabled)	$919	44.5 W	47" LED-LCD 1920×1080	$845 (3D)	92.2 W

[a] www.amazon.com, www.alltimetvs.com (lowest price, as of Sep 2012)
[b] Average market price as of Q3 2012 projected by DisplaySearch in Q4 2011 (DisplaySearch 2011b)
[c] Average on-mode power consumption of Energy Star qualified TVs in the given category.

For the winner in the large size category, it is necessary to see if the investment in the model is cost effective against similar TV models in the market. Cost of Conserved Energy (CCE) is a widely used metric to compare the cost of saving electricity to the cost of electricity supply to assess the desirability of energy efficiency measures. This analysis estimates CCE considering the incremental price of adopting efficiency improvement options, i.e., purchasing the winner in the large size category LG 47LM6700.

CCE is estimated by dividing the annualized incremental cost (IC) (i.e., incremental price) of the energy efficient model by annual energy savings due to that option. For this calculation, the comparable product category is defined by screen size, backlight type and 3D capability (i.e., 47-inch 3D-capable LED-LCD TV). The CCE for the product category is calculated using annualized IC for the product category and energy savings for the product category, as follows:

$$CCE = \frac{annualized\ IC}{energy\ savings} \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (1)$$

where

$$annualized\ IC = IC\left[\frac{discount\ rate}{1-(1+discount\ rate)^{-lifetime}}\right] \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (2)$$

$$Energy\ Savings_i\left(\frac{kWh}{year}\right) = Power\ reduced\left(\frac{watts}{unit}\right) \times daily\ usage\left(\frac{hours}{day}\right) \times \frac{365\ days}{year} \times \frac{1\ kilowatts}{1000\ watts} \ldots\ldots (3)$$

, *lifetime*$_i$ is the TV economic lifetime, i.e. and *discount rate* is the discount rate of the end user.

Discount Rate

Residential and commercial sectors may use various methods to finance the purchase of TVs. The U.S. Department of Energy (DOE), in a technical support document for the energy efficiency program for consumer products analyzed that the average discount rates are 4.8 percent for residential consumers and 6.2 percent for commercial sectors (U.S. DOE 2009). This analysis provides the CCE results in range of 4 to 7 percent in Table 12 below.

Economic Lifetime

In the U.S., the average age of recently replaced TVs was about 8 years (DisplaySearch 2011c). This analysis provides the CCE results in range of 6 to 10 years in Table 12 below.

Given the on-mode power saved is 47.7 W and the incremental price is $74, compared to a typical model, the winner in the large size category (LG 47LM6700) has CCE with a range of $0.105/kWh and $0.178/kWh as described in Table 12.

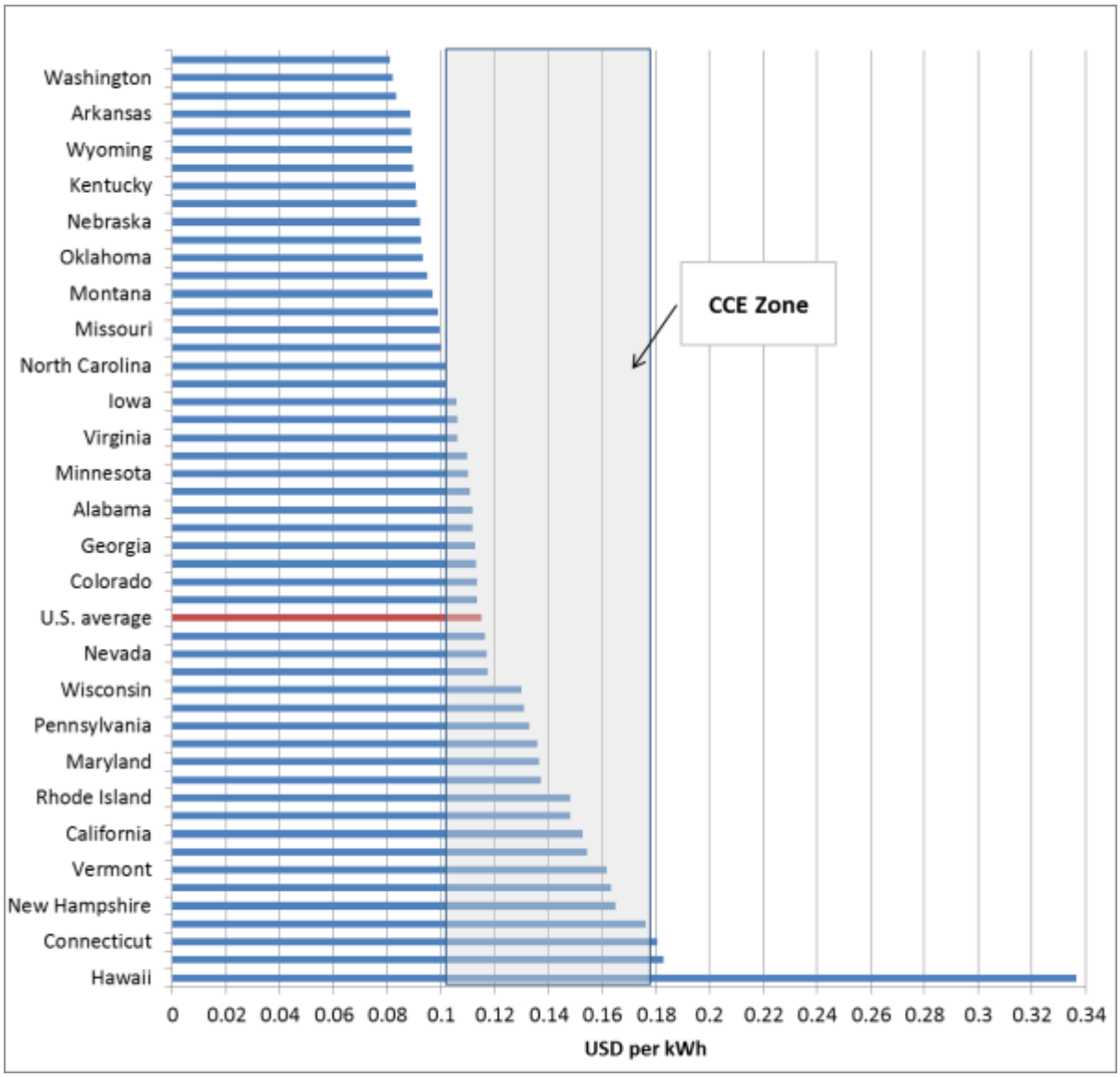
Table12. Cost of Conserved Electricity (CCE) for the Large Winner (LG 47LM6700)

USD/kWh		Economic Lifetime				
		6 years	7 years	8 years	9 years	10 years
Discount Rate	4%	0.162	0.142	0.126	0.114	0.105
	5%	0.167	0.147	0.132	0.120	0.110
	6%	0.173	0.152	0.139	0.125	0.115
	7%	0.178	0.158	0.142	0.130	0.121

* Average daily usage = 5 hours

The average electricity price of the U.S is $0.115/kWh. The CCE for the winner in the large size category appears higher than or similar to average electricity prices of many states (see Fig 5). In some regions, average residential prices (tariffs) are lower than the marginal residential tariffs (tariff for the last unit consumed which is equivalent to the reduction in consumer bill if one unit of electricity is saved). In addition, the market price of 3D capable 47-inch LED-LCD TVs was projected to come down to about $560 by the end of 2015 (DisplaySearch 2011b). Thus, the winning model in the large size category or models with equivalent power consumption can be considered to be encouraged in a cost effective manner as well, depending on situation, and are likely to become more cost effective as the market transforms.

All award-winning models within each size category are essentially the same or very similar in product design, regardless of region. Major TV manufacturers distribute similarly designed TVs across many regions. Hence, the cost effectiveness results for the U.S. market are likely to be applicable to other countries, depending on their market prices and consumer electricity prices.



Source for energy prices: ENERGY STAR 2012

Fig 5. Cost of Conserved Electricity (CCE) for the Winner in the large size category and Average Residential Energy Prices in the U.S.

Acknowledgements

Useful data and information were provided by Keith Jones at Australian Digital Testing (ADT) from Australia, Bob Harrison at Intertek from the United Kingdom, and Verena Radulovic at Environmental Protection Agency (EPA) and Matt Malinowski at ICF International from the United States. Helpful comments were provided on this report by Anna Lising and Stephen Pantano at the Collaborative Labeling and Appliance Standards Program (CLASP), and Kavita Ravi at U.S. Department of Energy. Puneeth Kalavase and Nihar Shah of Lawrence Berkeley National Laboratory provided editing support. This work was funded by the Bureau of Oceans and International Environmental and Scientific Affairs, U.S. Department of State, and administered by the U.S. Department of Energy in support of the Super-efficient Equipment and Appliance Deployment (SEAD) Initiative through the U.S. Department of Energy under Contract No. DE-AC02-05CH11231. Any errors or omissions are the author's own.

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Appendix A. 2012 Samsung LCD TV Comparison Chart (U.S. Market)

Source: http://www.samsung.com (UL: Ultimate, Inc: Included, InB: In Box)

	ES											EH								
Series	**8000**	**7550**	**7500**	**7150**	**7100**	**6900**	**6600**	**6580**	**6550**	**6500**	**6150**	**6100**	**6050**	**6030**	**6000**	**5300**	**5050**	**5000**	**4050**	**4003**	**4000**
Available Screen Sizes (inches)	65 60 55 46	 60 55 46	 60 55 46	 60 55 	65 60 55 46	 60 55 	 55 46	65 60 55 46	65 55 	65 60 55 46 40 32	65 60 55 46 40	65 60 55 46 40	65 60 55 50 	 40	65 60 55 50 46 40	 50 46 40 32	 50 46 40 	 50 46 40 37 32	 32	 32	 32 26
Resolution	1080p											720p									
Samsung Smart TV™	•	•	•	•	•	•	•	•	•	•	•	•				•					
Smart Interaction	•	•	•																		
Signature Service	•	•	•	•	•	•	•	•	•	•	•	•									
Smart Evolution	•	•	•																		
Full Web Browser	•	•	•	•	•	•	•	•	•	•	•	•				•					
3D	•	•	•	•	•	•	•	•	•	•				•							
Dual Core	•	•	•	•	•	•															
Clear Motion Rate	960	840	840	720	720	600	600	480	480	480	240	240									
Built-in WiFi	•	•	•	•	•	•	•	•	•	•	•	•		•		•					
Micro Dimming	UL	Pro	Pro	•	•	•	•														
AllShare Play™	•	•	•	•	•	•	•	•	•	•	•	•		•		•					
Skype™ Compatible	•	•	•	•	•	•	•	•	•	•	•	•				•					
Built in Camera	•	•	•					InB													
Wide Color Enhancer Plus	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•
Connect Share Movie	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•
Smart Touch Remote	•	•	•																		
Universal Remote				•	•	•	•	•		•	•	•									
Wireless Keyboard Compatible	•	Inc	•	Inc	•	•	•	•	•	•											
3D Glasses Included	4	4	4	4	4	2	2	4		2				2							
HDMI	3	3	3	3	3	3	3	3	3	3	3	3	3	3	2	2	3	2	2	2	2
USB	3	3	3	3	3	3	3	3	3	3	3	3	3	3	1	1	2	1	1	1	1
Ethernet	1	1	1	1	1	1	1	1	1	1	1	1	1		1		1				
Component	2	2	2	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1

Appendix B. 2012 LG LCD TV Comparison Chart (U.S. Market)

Source: www.lg.com

	LM							LS				CS		
Series	**9600**	**8600**	**7600**	**6700**	**G2**	**6200**	**5800**	**5700**	**4600**	**3500**	**3400**	**570**	**560**	**460**
Available Screen Sizes (inches)	55 47	55 47	55 47	55 47	55 47	65 55 47 42	55 47 42	60 55 47 42	55 47	32 26 22	42 32	47 42	42 37 32	32
Resolution	1080p									720p	1080p(42") 720p(32")	1080p	1080p	720p
LED Backlight	Full LED	LED Plus	LED Plus	LED Plus	LED	LED	LED	LED	LED	LED	LED			
Frame Rate (Hz)	480	240	240	120	120	120	120	120	120	60	60	120	60	60
Picture Engine	Triple XD Engine™													
LG Cinema 3D	●	●	●	●	●	●	●							
Dual Core Processor	●	●			●									
THX® Certified	●													
Wi-Fi	●	●	●	●	●	●		●						
LG Smart TV	●	●	●	●	Google TV	●		●						
Remote Control	Magic Remote Voice		Magic Remote		Magic Remote QWERY	Magic Remote	Standard Remote	Magic Remote	Standard Remote					
Smart Phone App	●	●	●	●	●	●		●						
Wi-Fi Direct™	●	●	●	●	●	●		●						
WiDi (Intel Wireless Display)	●	●	●	●	●	●		●						
2nd TV	●	●			●									
MHL	●	●												
Cinema Screen Design	●	●	●	●										
HDMI	4	4	4	4	4	4	3	4	3	2	2	3	2	2
USB	3	3	3	3	3	3	1	3	1	1	1	1	1	1