SEAD | Super-efficient Equipment and Appliance Deployment

CLEAN ENERGY MINISTERIAL
Accelerating the Transition to Clean Energy Technologies

Super-efficient Equipment and Appliance Deployment (SEAD) Initiative:

Lessons from the Technical Analysis of Televisions

International Energy Studies Group
Lawrence Berkeley National Laboratory

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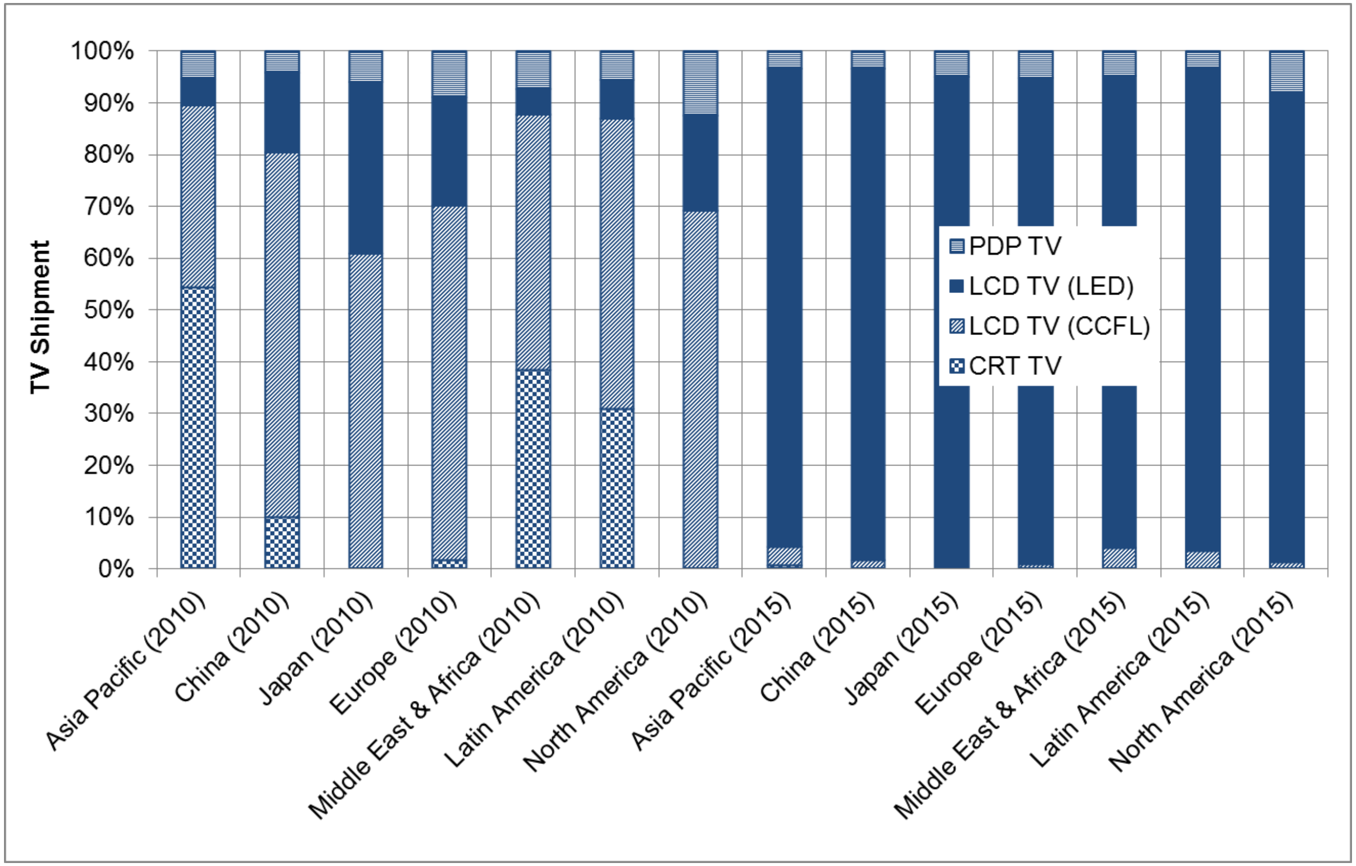
Global Market Transition: the large scale transition from CCFL to LED backlights is likely to bring substantial improvement in efficiency.



Actual (2010) and Forecasted (2015) TV Market Transition by Region and Screen Technology

Source: DisplaySearch 2011

LCD TV Efficiency Improvement Options:

Components		Improvement options	*Notes*
Backlight Unit	Backlight Source	• CCFL to LED transition	• Cost increase • Adopted by manufacturers due to improved product quality (BAU)
		• High LED efficacy	• Cost reduction in the longer term (BAU) • Technical barrier in thermal management and short term cost increase from adoption of much higher efficacy LEDs than BAU trajectory
	Optical films	• Optimized combination of films • Multi-function film	• Trade-offs in material cost, ease of manufacture, and efficiency (BAU)
		• Reflective polarizer (e.g., DBEF[a])	• Cost increase, proprietary technology
LCD Panel		• Improvement in panel transmittance by optimizing pixel design, functional layers, e.g., polarizer, color filter, and data line	• Proprietary technology • R&D investment required but driven by potential for total cost reduction.
Power management		• Brightness control (local dimming) by image signals	• Cost increase • The effect varies with backlight structure, input images, and algorithm.
		• Brightness control based on ambient light condition	• Cost increase • The effect varies with settings and ambient light condition
Other		• Power Supply Unit (PSU) Efficiency	• Trade-off between cost and efficiency
		• Color gamut (by color filter or light source)	• Trade off with efficiency

[a] Dual brightness enhancement film produced by 3M

Cost of Conserved Electricity (CCE): Energy consumption of TVs can be reduced by 20-40% cost effectively, even beyond the efficiency improvements occurring due to the technology transition.

Screen size	Backlight	$\Delta P_{on\text{-}mode}$[b] per unit (W)	ΔC_m[c] per unit ($)	CCE_m[d] ($/kW h)	ΔC_p[e] per unit ($)	CCE_p[f] ($/kW h)
32"	CCFL	12.3	6.0	0.041	17.0	$0.117
	LED	8.2	5.5	0.058	7.0	$0.072
42"	CCFL	17.9	9.9	0.047	16.0	$0.052
	LED	12.6	7.4	0.050	10.0	$0.067
Weighted	CCFL	12.9	6.4	0.042	16.4	$0.110
average	LED	9.4	6.1	0.056	7.8	$0.071

[a] Assumptions: discount rate = 5%, economic lifetime = 8 years, daily usage = 5 h.

[b] Average power saving per unit = (average on-mode power of 2012 standard models estimated by authors)–(estimated average on-mode power of 2012 models with reflective polarizer).

[c] Incremental manufacturing cost = (manufacturing cost for 2012 standard models with reflective polarizers estimated by authors)—(manufacturing cost for 2012 standard models predicted by DisplaySearch).

[d] Cost to the manufacturer of conserved energy which is calculated by Eqs. (1)–(3) at $IC = \Delta C_m$.

[e] Incremental price = (price for 2012 standard models with reflective polarizer estimated by authors)—(average market price for 2012 standard models predicted by DisplaySearch).

[f] Cost to the final user of conserved energy which is calculated by Eqs. (1)–(3) at $IC = \Delta C_p$.

Cost of conserved electricity (CCE) for reflective polarizer

Insights for Energy Efficiency Programs:

- **Standards/entry-level of labeling programs –** a level that remains technology neutral and thereby leads to additional savings.
- **Advanced levels of labeling and incentive programs –** a level that efficient units, i.e., LED-LCDs, can meet by employing cost-effective options.

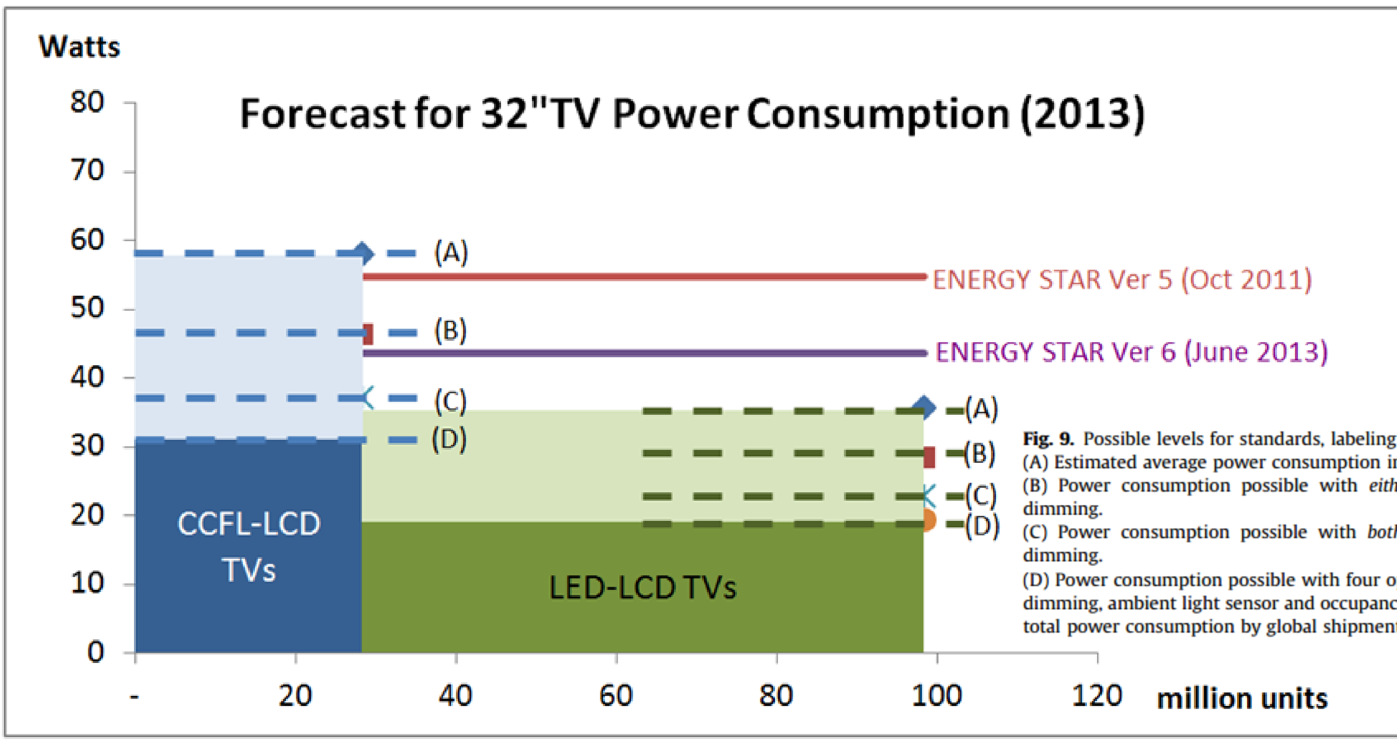
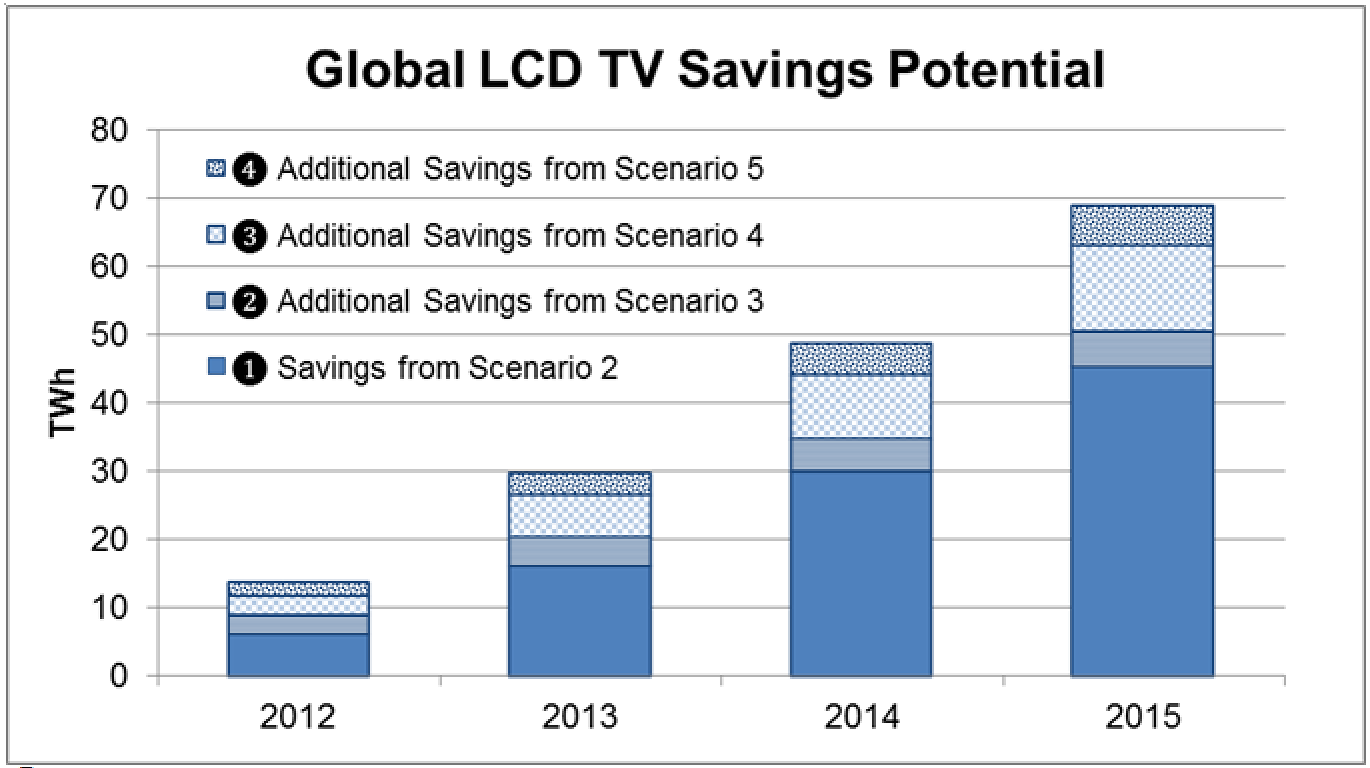


Fig. 9. Possible levels for standards, labeling and incentive programs.
(A) Estimated average power consumption in a BAU scenario.
(B) Power consumption possible with *either* reflective polarizers *or* backlight dimming.
(C) Power consumption possible with *both* reflective polarizers *and* backlight dimming.
(D) Power consumption possible with four options: reflective polarizers, backlight dimming, ambient light sensor and occupancy sensor. Each shaded area represents total power consumption by global shipments in the corresponding scenario.

Global LCD TV Savings Potential:

If in every year the efficient designs (i.e., reflective polarizers, backlight dimming, ambient light sensors) reach an average of 40-90% of the market varying by technology type and improvement option, the electricity savings potential would be up to 23.5 TWh per year in 2015.



❶: Possible savings by BAU improvement.

❷: Possible savings by standards.

❸+❹: Possible savings by incentives and labeling programs.

Conclusions:

- There will be a significant decrease in on-mode energy consumption for newly sold TVs globally, because of the large-scale transition toward LED–LCD TVs and rapid efficiency improvement in TVs, in spite of the projected growth in screen size and TV sales.

- In order to facilitate further improvement in efficiency by the adoption of cost-effective options, market transformation programs need to take into account these rapid developments and determine more stringent efficiency targets than are currently in place, as well as re-evaluate these levels as technology evolves.

- TV consumption can be cost effectively reduced further beyond the BAU improvements with a saving potential of 18.6-23.5 TWh per year in 2015.

SEAD TV Analysis (full report)

- **TV Energy Consumption Trends and Energy-Efficiency Improvement. July 2011. LBNL. Available at http://www.superefficient.org/~/media/Files/SEAD%20Televisions%20Technical%20Analysis.pdf**
- **Efficiency improvement opportunities in TVs: Implications for market transformation programs. *Energy Policy*. May 2013. Available at http://www.sciencedirect.com/science/article/pii/S0301421513002267**

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