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Efficiency improvement opportunities in TVs: Implications for market transformation programs

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HIGHLIGHTS

- We analyze the impact of the recent TV market transition on TV energy consumption.
- We review TV technology options that could be realized in the near future.
- We assess the cost-effectiveness of selected energy-efficiency improvement options.
- We estimate global electricity savings potential in selected scenarios.
- We discuss possible directions of market transformation programs.

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ABSTRACT

Televisions (TVs) account for a significant portion of residential electricity consumption and global TV shipments are expected to continue to increase. We assess the market trends in the energy efficiency of TVs that are likely to occur without any additional policy intervention and estimate that TV efficiency will likely improve by over 60% by 2015 with savings potential of 45 terawatt-hours [TW h] per year in 2015, compared to today's technology. We discuss various energy-efficiency improvement options and evaluate the cost effectiveness of three of them. At least one of these options improves efficiency by at least 20% cost effectively beyond ongoing market trends. We provide insights for policies and programs that can be used to accelerate the adoption of efficient technologies to further capture global energy savings potential from TVs which we estimate to be up to 23 TW h per year in 2015.

1. Introduction

The total global TV electricity consumption was estimated to be more than 250 terawatt hours [TW h] in 2008, i.e., more than 5% of total global residential electricity consumption (International Energy Agency (IEA) 2009). Since the mid-2000s, the global TV market has undergone a major transition from traditional cathode ray tube (CRT) TVs to other types, particularly flat panel display (FPD) TVs such as liquid crystal display (LCD) and plasma display panel (PDP).[1] While this market transition is expected to lead to efficiency improvement of TVs, other emerging technology trends such as larger average screen size, three-dimensional (3D) video capability, and network functions, e.g., ethernet and universal serial bus (USB), are likely to increase the energy consumption of new TVs.

A global assessment of efficiency[2] improvement opportunities in TVs is needed for three reasons. *First*, policies to facilitate the adoption of cost effective[3] efficiency improvements in appliances such as TVs are necessary to correct market failures such as uncaptured economic and environmental benefits available from reduced energy consumption. Even though the market is moving to increasing efficiency on its own under a business-as-usual (BAU) case, it is not capturing all available savings from adopting cost effective technologies such as backlight diming and efficient optical films. Section 3 and 4 provide such examples. Although several other studies develop potential scenarios of TV efficiency improvement (see for example, International Energy Agency (IEA), (2009), International Energy Agency - Efficient Electrical End-Use Equipment (IEA 4E) (2010), Market Transformation Programme (MTP) (2010b)), none of these studies assess the cost-effectiveness

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[1] LCD and PDP TV shipment in 2007 accounted for about 45% of the global TV shipments, and CRT TVs accounted for about 54% (DisplaySearch, 2010).

[2] In this paper, efficiency improvement in TVs is defined as reduction in on-mode power consumption [watts, W] for a given screen size, or equivalently better on-mode power performance in terms of watts per unit of screen area [W/m^2].

[3] In this analysis, cost-effectiveness is defined as cost of conserved energy (CCE), the annualized investment in more expensive equipment or component needed to provide a unit of energy saved (kW h), less than electricity price.

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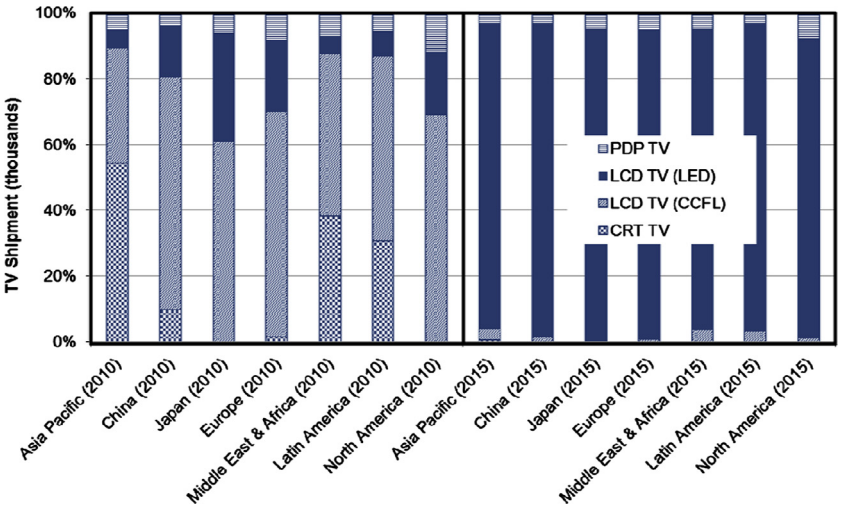

Fig. 1. Actual (2010) and Forecasted (2015) TV Market Transition by Region and Screen Technology
Source: DisplaySearch, 2011a

of efficiency improvement options in detail for TVs. Such assessment is needed for designing appropriate policies and market transformation programs[4], e.g., energy efficiency standards and financial incentive programs, to facilitate the adoption of cost effective efficiency improvements.

Second, the literature focused on TVs is limited and was published before the ongoing large scale transition from cold cathode fluorescent lamp (CCFL) backlit LCD (CCFL–LCD) TVs to light emitting diode (LED) backlit LCD (LED–LCD) TVs. LED–LCD TVs are likely to be at least 50% and 90% of the TV shipments in 2012 and 2015, respectively, (DisplaySearch, 2011a).

Third, there are only limited regional differences and global similarity in TV screen (i.e., LCDs) and LCD backlight technology (see Fig. 1), although there are regional differences in screen size preferences and market share of TVs with additional 3D or network features. Major brands distribute similarly designed TVs with similar energy consumption characteristics across many regions. For example, 98% of Samsung's flat-panel TVs on the global market, which represent the largest single share (~18%) of the market, have met the ENERGY STAR Version 4 requirements (Samsung Electronics, 2011). In addition, TV manufacturing is highly globalized and concentrated. The top six TV brands[5] produce more than 60% of TVs sold worldwide (DisplaySearch, 2011a; Morrod, 2012). Accordingly, the research presented in this paper is applicable to TVs in most countries.

This paper focuses on LCD TVs since they are expected to dominate worldwide sales, amounting to an expected 95% of global TV shipments by 2015 (DisplaySearch, 2011a). Although large Organic Light Emitting Diode (OLED) TVs (larger than 40 in.) are expected to be on the market in 2013, they are not expected to be cost competitive against LCD TVs at least until 2015. PDP TVs are expected to remain viable but to decline steeply in market share as both LCD and OLED TV production costs decline. We consider efficiency improvement options for LCD TVs that are technically feasible, practical to manufacture, and could be realized in the short term (over the next three years), as the rapid evolution of technology in the display market makes a forecast over a longer time scale highly uncertain (see Section 2 for details) and therefore less useful from a policy perspective. Instead, a short-term policy action based on more reliable analysis can make a difference given the fact that the average economic life time of TVs is about 6–10 years (DisplaySearch, 2011c; Fraunhofer IZM, 2007 Task 2, Market Transformation Programme (MTP), 2010a). In spite of questions or concerns about the potential impacts of emerging technology trends such as new displays (e.g., OLEDs), 3D capability, and the increased network connectivity on energy consumption in TVs, we see that the dominant screen technology (i.e., LCDs) and screen size are more important in terms of energy consumption and savings potential than these emerging trends which are not significant now (in terms of market share) or whose energy consumption and savings impact are still uncertain within the time horizon relevant for such a rapidly evolving market and the global scale considered in this paper (see Section 2 for details).

We obtained the data for this paper primarily from the following sources: a review of the literature including technical reports, DisplaySearch reports and data sets[6], the ENERGY STAR database for TVs that meet the Version 4 or 5 specifications, international conferences and interviews with manufacturers and experts in the field.

The remainder of this paper is organized as follows. In Section 2, we present an overview of the TV market, technology trends and energy consumption trends. In Section 3, we assess technologically feasible energy-efficiency improvement options, adoption trends of such options, and the impact of these options on the energy consumption of TVs. In Section 4 we present a cost of conserved electricity (CCE) analysis to assess the cost-effectiveness of options identified in Section 3. Section 5 offers suggestions for accelerating the adoption of efficient technologies, and in Section 6 we estimate the energy savings potential of such adoption. Section 7 presents concluding remarks.

[4] We use the definition from American Council for an Energy-efficient Economy (ACEEE). "The term market transformation is the strategic process of intervening in a market to create lasting change in market behavior by removing identified barriers or exploiting opportunities to accelerate the adoption of all cost-effective energy efficiency as a matter of standard practice."

[5] Samsung, LG, Sony, Panasonic, Toshiba, and Sharp. TCL has been recently increasing its share and ranked in the Top 5 in Q1 2012.

[6] DisplaySearch has been providing reliable information based on manufacturer surveys and analyses on the display market and related industries. Because the data sets we used do not provide country-specific TV shipment data except for China and Japan, we assume country-specific contribution to the corresponding region in accordance with indicative recommendations from DisplaySearch and TV marketing experts in the field.