Dovetail Partners Consuming Responsibly Report No. 12

Your Television and Energy Consumption

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Your Television and Energy Consumption

Executive Summary

Although video content is increasingly viewed on a vast array of devices, a considerable amount of time is still spent watching content on a standard television. The average U.S. household has more than one TV[1], used not only for viewing of programming and movies, but with video gaming systems and streaming music and music videos as well. The sheer number of televisions in North America and around the world add up to substantial energy consumption as well as emissions linked to electricity production. Peripheral devices used with the television (cable boxes, Blu-ray players, DVDs, DVRs) add to power consumption, and often when no picture or sound is being delivered.

Technological improvements over the past several decades have dramatically reduced power requirements of televisions, even as screen sizes have doubled and picture resolution sharpened. Energy efficiency of peripherals has also been improved. Yet, continuing pursuit of ever larger, brighter screens appears likely to reverse recent progress in reducing energy expenditure for television viewing.

In some respects, energy consumption associated with an individual TV is quite modest (for instance in comparison to a water heater). However, considered from the perspective of cumulative impact of televisions in general, consumption can be viewed as rather large. In either case, there are several things that individuals can do to reduce energy use and waste linked to television viewing.

An American Pastime

While baseball is characterized as our national pastime, watching television (a small part of which involves watching baseball) actually consumes far more of an average American's time. A 2018 Nielsen study found that American adults spend an average of 4 ¾ hours per day watching either live or recorded and/or streaming television.[2]

In 2018, 119.9 million American homes (94% of homes) had one or more televisions.[3] Their operation, including set-top boxes[4], home theater systems, DVD players, and video game consoles adds up to substantial energy consumption – 4% of residential electricity use and about 7% when energy use by peripheral devices is also considered.[5]

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[1] The terms "Television" and "TV" as used in this report specifically do not refer to computer monitors or video screens that are part of other devices.

[2] Perez (2018)

[3] Lynch (2018)

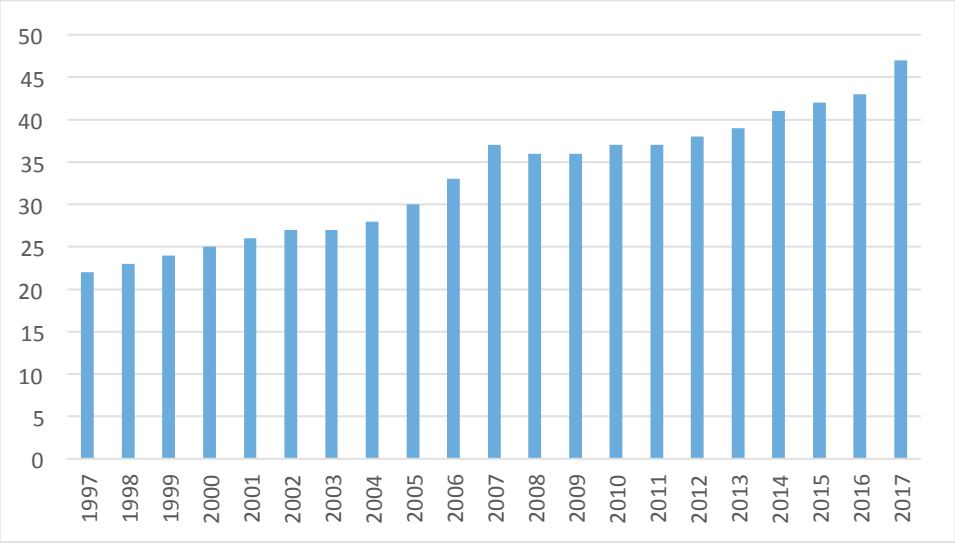
[4] The term set-top box refers to a cable box or other device that generally contains a TV-tuner input and displays output to a television set. They are used in cable television, satellite television, and over-the-air television systems, as well as other uses.

[5] EIA (2018, 2019)

There is a very good news story with respect to TV power consumption: even as picture resolution has increased, energy consumption per screen area has declined sharply in recent years. Comparing units with the same screen size shows that liquid-crystal display (LCD) TVs manufactured in 2015 use far less power than those produced one to two decades earlier.

The flip side of the good news story is that gains in TV energy efficiency have been largely offset by an ongoing trend toward ever-larger TV screens. Screen sizes are far larger than only two decades ago, with the average size rising an inch or more each year. Compared to 1997, screens were more than twice as large on average (47 inches) in 2017 (Figure 1). Several manufacturers now offer 100-inch models.

Figure 1
Average Screen Size of New Televisions Sold in the U.S. by Year, 1997-2017



Source: Statista (2019)

How much energy television consumes within a given household depends on a number of factors, all which can be controlled by members of the household. Such factors include:

- How many TVs are in the home and how often they are in use.
- Age of the TV.
- TV screen size.
- TV screen brightness.
- Number and type of peripherals.
- Management of devices to prevent vampire power losses.[6]

This report examines each of these issues and provides recommendations regarding how to minimize energy consumption linked to owning and operating televisions.

[6] Vampire power loss refers to electricity consumption that occurs when a device is in standby or off but remote-ready.

It All Adds Up

Despite gains in energy efficiency, televisions consume more energy than all other consumer electronics,[7] accounting for half of electronics power use and almost double that of home computing. Total energy consumption is significantly higher when energy use of peripheral devices is included. Overall, TV viewing in the U.S. in 2018 added up to about 62 billion kWh (62 TWh), equivalent to total energy generation from over 11 typical 500 megawatt power plants and about 43.8 million metric tons of carbon dioxide equivalent (CO_2e) emissions.

While the collective energy consumption numbers annually are impressive, energy consumed by any one of the devices individually is small as compared to energy consumption in home heating, a water heater, or the refrigerator. Because of this, some trivialize pursuit of TV related energy conservation, pointing out that potential monetary savings are minimal.[8] A very recent article, for instance, states that "Most modern TVs consume fewer than 250 watts, which adds up to just a few dollars a month per TV for even the most dedicated couch potatoes."[9] In point of fact, at current electricity rates, the cost of running such a TV an average of 5 hours a day would yield a monthly bill ranging between about $4.50 (Miami) to $9.00 (San Francisco), to most Americans, an inconsequential amount. The cost to a dedicated "couch potato" would undoubtedly be more.

Considering this same 250W television from another perspective, viewing this single device (roughly equivalent to a new 70-inch LED model) for 5 hours a day over a period of one year consumes more electricity than total annual per capita electricity consumption in more than twenty-five of the lowest income countries.[10] Whether the quantity of energy consumed is viewed as a little or a lot, there is no downside in reducing energy use and waste and associated emissions.

Spectacular Gains in Television Energy Efficiency

From CRT to Flat Screen

The record of energy efficiency improvement in televisions is impressive. Over the period 2003-2005 the average on-mode power draw of televisions decreased 76% per square inch of screen area. In addition, standby power consumption was reduced by 63%.[11] The greatest efficiency gains have come through replacement of old, bulky cathode ray tube (CRT) televisions with new flat screen models (Figures 2, 3). Whether further gains in efficiency can come close to the past record of achievement remains to be seen.

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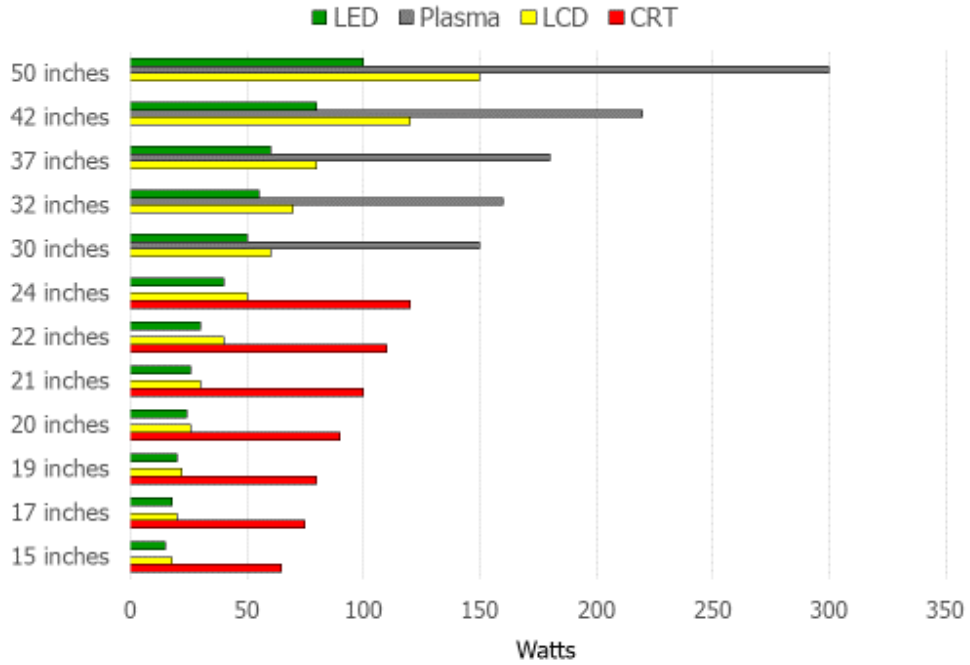
[7] Urban and Roth (2017)
[8] Katzmaier (2013)
[9] Trollinger (2019)
[10] Schlossberg (2016), World Bank (2014)
[11] Howard et al. (2012), Urban and Roth (2017)

Figure 2
CRT Television

Partially responsible for spectacular improvements is the EPA's voluntary market-driven ENERGY STAR program, which with considerable input from manufacturers, established energy efficiency standards, verification protocols, and on-product labels. The standards provided industry with benchmarks for energy efficiency, while on-product labels established standardized energy performance measures which allowed consumers to readily identify energy efficient products.

Figure 3
Power Comparison between CRT, LCD, Plasma, and LED Televisions (In watts)



Source: Energy Use Calculator (2019)

Note in Figure 3 that an LCD TV (yellow) with a screen size of 50 inches consumes 50% more energy when in operation than a comparable LED TV (green). A 50-inch plasma TV (gray) in contrast consumes twice as much energy as a comparable LCD TV and three times the energy of an LED model. Older CRT models (red) require three to four times more energy to operate newer model TVs of the same size, and in most cases significantly more than newer models with larger-screens. In all cases energy consumption rises sharply as the screen size increases.

Competing Technologies

The shift away from CRT was accompanied by development of a number of new technologies: liquid-crystal display (LCD), Plasma, light emitting diode (LED), and most recently, organic light emitting diode (OLED).

LCD (liquid-crystal display) televisions, the most prevalent type of TV sold today, use the same technology as employed for many years in display screens of calculators, digital watches, and cellphones. An LCD screen is lighted from the back by fluorescent lamps that shine through polarized glass and a matrix of tiny picture elements called pixels, each of which contain green, red, and blue sub-elements that are switched on or off as a picture is transmitted. LCD televisions are far thinner and lighter than CRT TVs.

Plasma televisions, introduced at about the same time as LCD TVs, utilize thousands of cells between layers of glass which are lit from the back to create a picture. In this case, however, each of the cells contain very hot gas – called plasma – and when an electrical charge passes through a reaction occurs and red, green or blue light is emitted depending on the current. Plasma sets have a number of advantages over LCD TVs (superior black levels, better viewing angles, and high refresh rates), but are considerably less energy efficient and prone to problems, factors that resulted in their eventual phase out.

LED TVs are similar to LCD in that light sources activate pixels. But whereas LCDs use fluorescent lights, LEDs use light emitting diodes (semiconductors) which emit light as current passes through them. This technology allows placement of the light source either behind or at the edges of the screen. This, in turn, allows thinner screens than is possible with LCDs. LED TVs also provide better picture quality than can be obtained with LCDs.[12]

The latest, and emerging, technology is OLED. These are similar to LED TVs, but do not make use of a backlight. OLED TVs make use of organic (carbon-based) plastics rather than semiconductors, allowing each pixel to be lighted individually. This technology allows extremely thin screens (as little as 1-2 mm) and consequently a host of new possibilities. For instance, screens can be curved or even rolled up. High cost is currently limiting adoption, though expectations are that costs will fall in the future.

It depends upon the type of TV and the model, but in general, LED models use less energy than LCDs, and both consume far less than plasma models (Figure 3). OLED TVs consume more energy per unit of screen area than LCD and LED TVs.

The Effect of Screen Brightness

When a television is on, the power draw typically depends strongly on screen area and screen brightness settings. Settings can often be adjusted to various preset modes – home, movie, game, vivid, eco, automatic brightness control – or users can adjust brightness independently of these modes.

Automatic Brightness Control (ABC), which adjusts screen brightness in response to indoor lighting conditions, significantly reduces power consumption. Testing of TV models equipped with ABC, and in which ABC is enabled by default, has found power

[12] How Stuff Works (2018), Bouckley (2019) Harris and Fenlon (2011), Woodford (2018)

draw to be about 25% lower than in those without. However, even models equipped with ABC that are delivered with this feature enabled by default also allow viewers to manually override this feature, sometimes without even knowing that they have done so (for instance by adjusting brightness or contrast). Switching from pre-set brightness levels to maximum brightness can, in some instances, double power consumption. [13]

Given the effect of screen brightness on energy consumption, it is important to maintain the ABC mode on units equipped with this feature, and to maintain brightness levels at 65 to 70% of maximum where brightness settings are controlled by the viewer.

As of 2015, the ABC feature was most common with larger TVs, with about half of models above 42 inches so equipped. All ENERGY STAR models have this feature. In any event, buyers should make sure that any new TV is equipped with ABC.

In 2018, Sony exhibited a prototype TV, advertised as having a screen brightness 10-15 times greater than anything on the market to date. Clarification indicated that brightness would be introduced to only strategic portions of the picture in order to increase clarity. What this means for energy consumption in the future is not clear at this point, although the potential exists for increases in power requirements as brighter screens hit the market.[14]

Peripheral Devices and Energy Consumption

All those neat gadgets that interact with your TV, from digital video disc players (DVDs) and digital video recorders (DVRs) to the cable box and game console consume energy whether in use or in a standby mode. Keeping devices in standby, rather than turned off, still consumes power, whether it be to allow reception of a signal from a remote control, perform recording functions, and/or maintain an internet connection.

In some cases, electricity consumption while in standby is almost the same as when the device is in operation. For instance, a cable box with DVR consumes 99.5% as much energy when not recording as it does when recording is in progress, and 97% of "on-recording" energy when off, but remote ready. If the connection is via a satellite box, the percentages are 90% and 89%. A cable box without a DVR does a bit better if left on, but still consumes 83% as much energy when the TV set is off as when the TV is on; if turned off, but remote ready, this setup consumes 60% as much energy as when the TV is on (Table 1). As indicated earlier, these kinds of power loss, or waste, are commonly referred to as vampire power losses.

[13] Urban and Roth (2017)
[14] Morrison (2018)

Table 1
Average Energy Consumption (Watts) by TV Peripheral Devices
in Various Modes of Operation

	Mode of Operation			
Device	Not recording, TV on	Not recording, TV off	Off by remote	--
Set-top box, digital cable with DVR	44.4	44.6	43.5	--
Set-top box, satellite with DVR	31.4	28.4	27.8	--
	On, TV on	On, TV off	Off by remote	Off by switch
Set top box, digital cable	29.6	24.7	17.8	17.5
Set-top box, satellite	16.2	16.0	15.7	15.5
	On, recording	On, not recording	Off	--
Set-top box, DVR	29.3	37.6	36.7	--
	On, playing	On, not playing	Off	--
DVD Player	9.9	7.5	1.6	--
DVD/VCR	15.3	13.5	5.0	--

Source: Lawrence Berkeley National Laboratory (2019).

Just as operating a large TV for a few hours a day results in greater energy consumption than total annual energy use by residents of a number of countries, having a digitally connected DVR that is remote ready 24/7 has a near equivalent effect. Leaving peripherals in a stand-by mode is convenient. But it is important to keep in mind that doing so impacts both the wallet and the environment.

As with TVs, there is a good news story behind peripherals energy consumption numbers. In this case, the EPA partnered with the National Consumer Technology Association to develop a voluntary agreement for ongoing improvement of set-top box energy efficiency. This agreement, signed by industry representatives in 2012, established energy efficiency goals and contained provisions protecting rapid innovation and timely introduction of new features. Over the succeeding five years, energy consumption of new DVRs was reduced by 46% in comparison to existing stock in

2012, and non-DVR equipment energy consumption had been reduced by 24%.[15] Further efficiency improvements are expected from ongoing industry efforts.

Reducing TV and Peripherals Energy Consumption

Steps that can be taken to reduce energy consumption of TVs and peripherals include the following:[16]

- Unplug devices not in use or used rarely, such as a DVR in a guest bedroom.
- Use power strips with an on-off switch for TV and peripherals, and turn off when not in use. (These can also have electricity surge protectors.)
- Disable quick start settings for TVs and inactivate the instant-on mode for game consoles.
- Turn off TV when not viewing.
- If using TV for listening to radio or music, set to black screen mode.
- Determine type and wattage of your TV and peripherals (information generally available on back of unit).
- Replace CRT and plasma units with new LED models.
- If buying new, always purchase ENERGY STAR model.
- Select a screen size no larger than needed for quality viewing.
- Make sure model selected has an ambient light sensor (ABC) and ensure this feature is enabled.
- Recycle all electronics (do not put in trash). Most electronics retailers will accept old equipment for recycling.

Summary

Improvements over the past several decades have dramatically improved the energy efficiency of televisions, reducing power requirements per unit of screen area by 75 percent or more. Energy efficiency of peripheral devices has also been improved. However, a rapid trend toward larger screen sizes has the potential to reverse recent progress in reducing the energy costs and associated environmental impacts from television viewing.

Smart consumption choices are important in moderating TV related energy demand. So too are actions on the part of device owners to reduce power consumption of presently owned equipment. Fortunately, there are several things that individuals can do to reduce energy use and waste linked to television viewing.

[15] D+R International (2018)
[16] NH Saves (2012), Gerroir (2016), HomeSelfie.com (2018)

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