

Display Energy Use in Homes

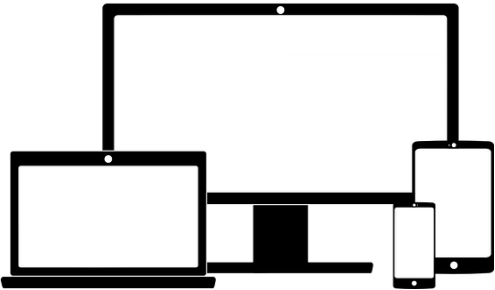
Ownership, Power, Usage, and Trends

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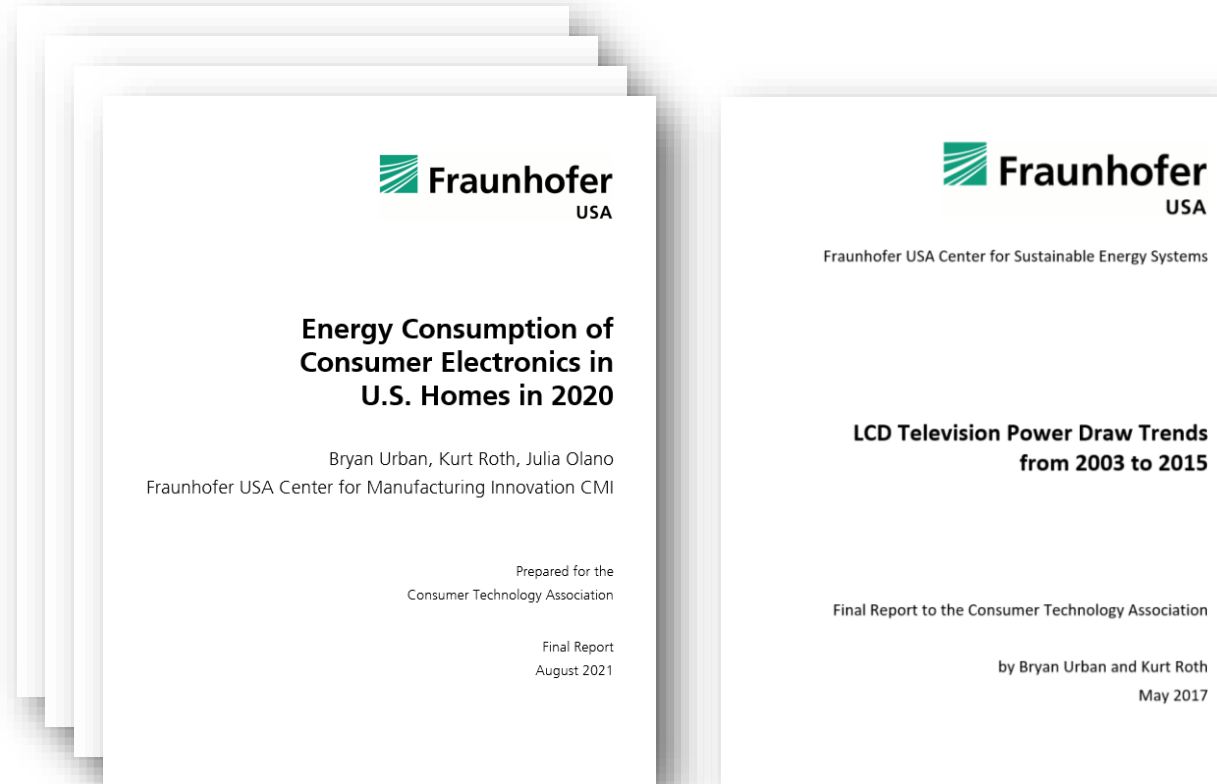
DOE SSL Workshop
Innovations in Display Architecture

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How much energy is used by consumer electronics in U.S. Homes?

Fraunhofer USA has led major studies for the Consumer Technology Association



These studies characterize **Consumer Electronics** energy consumption based on:

- Device-level energy models
- Public and industry data
- Targeted measurements
- Market research
- Usage and ownership surveys

The result is an “Energy Census” of Consumer Electronics

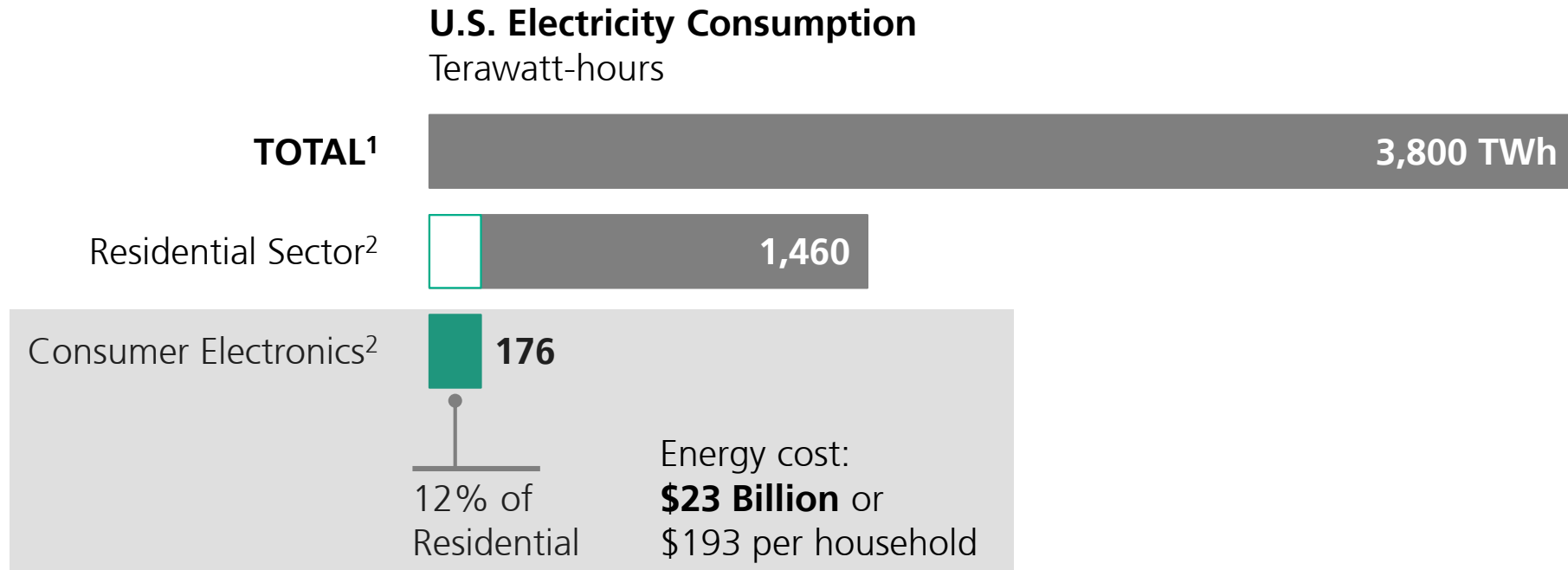
Free Download:

<https://shop.cta.tech/collections/research/products/energy-consumption-of-consumer-electronics-in-u-s-homes-in-2020>

1 Fraunhofer USA. (2021). Consumer Electronics Energy Use in U.S. Homes in 2020.
2 Fraunhofer USA. (2017). Consumer Electronics Energy Use in U.S. Homes in 2017.
3 Fraunhofer USA. (2014). Consumer Electronics Energy Use in U.S. Homes in 2013.
4 Fraunhofer USA. (2007). Consumer Electronics Energy Use in U.S. Homes in 2010.
5 Fraunhofer USA. (2017). LCD Television Power Draw Trends from 2003 to 2015.

Consumer Electronics: 4 to 5% of U.S. electricity consumption

3.3 billion devices in 120 million homes used 176 Terawatt-hours in 2020



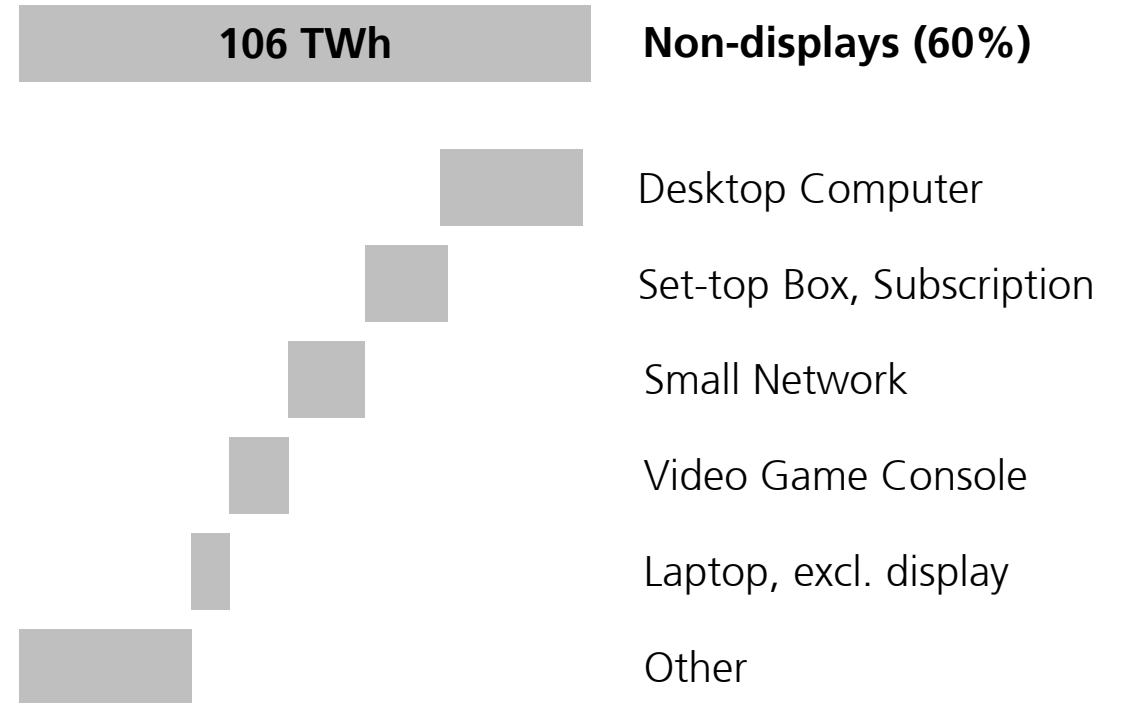
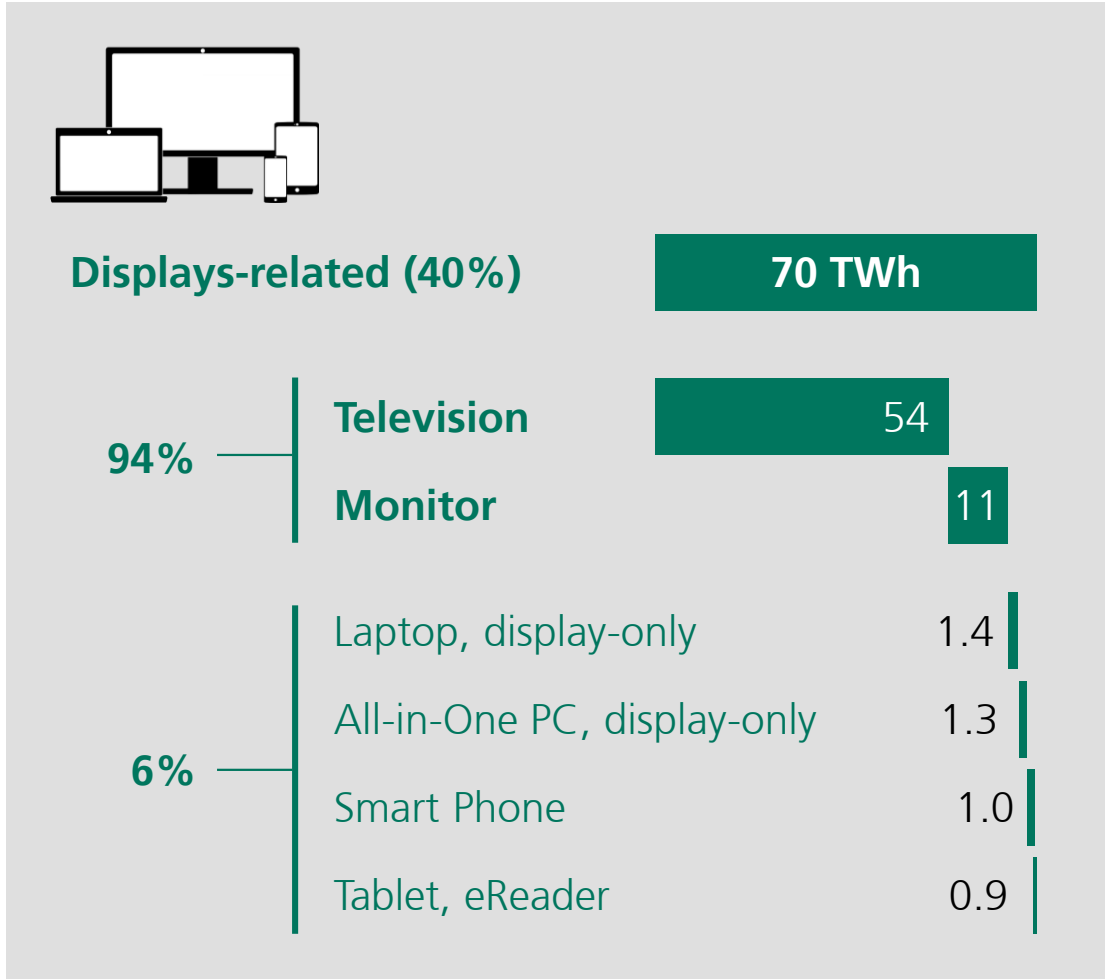
A Terawatt-hour (TWh) equals one billion kilowatt-hours

1 EIA. <https://www.eia.gov/tools/faqs/faq.php?id=97&t=3>

2 FhUSA. (2021). Consumer Electronics Energy Use in U.S. Homes in 2020.

About 40% of 2020 Consumer Electronics energy use is displays-related

Most of that comes from TVs and monitors. Portable displays use far less.

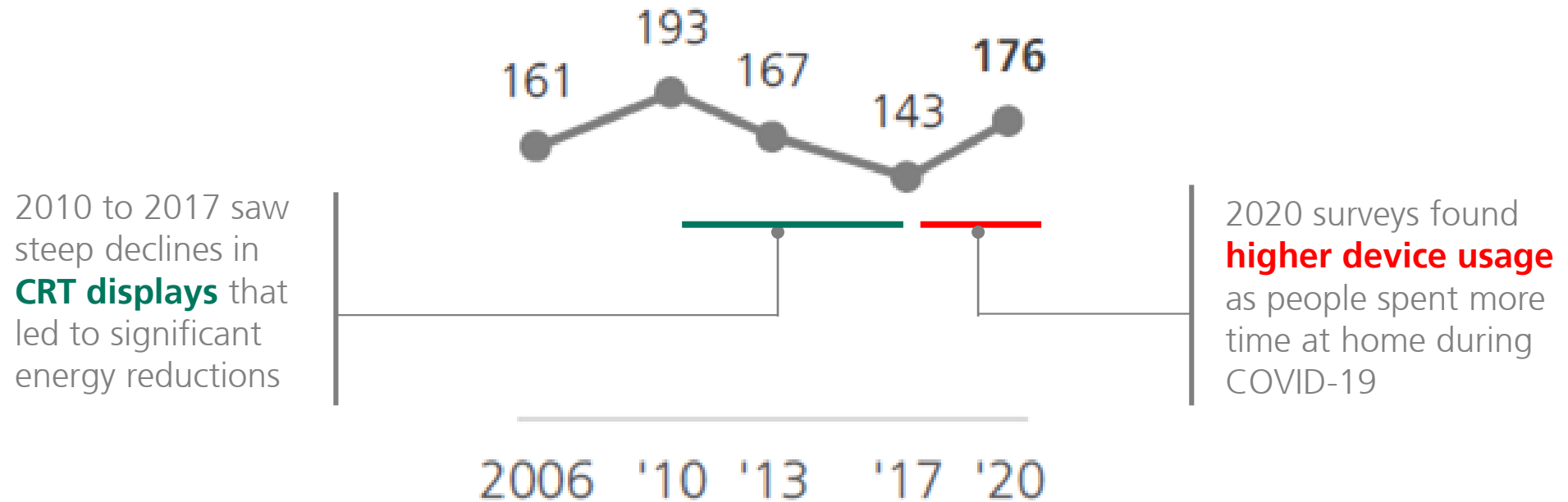


A Terawatt-hour (TWh) equals one billion kilowatt-hours
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Amid COVID-19, Consumer Electronics energy use increased by over 20%

This was driven by higher usage as people spent more time at home

Consumer Electronics Energy Use
Terawatt-hours



A Terawatt-hour (TWh) equals one billion kilowatt-hours
1 FhUSA. (2021). Consumer Electronics Energy Use in U.S. Homes in 2020.



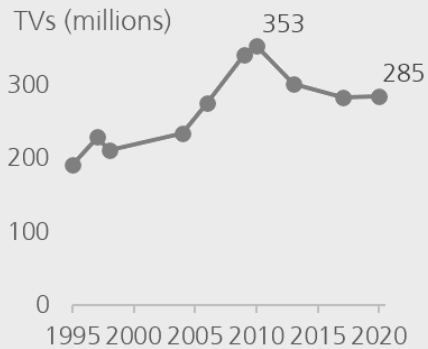
Televisions used about 54 TWh in 2020

Up 50% from 2017, mostly from increased usage

How Many

285 million TVs

- 2.4 TVs per owner household
- Similar to 2017
- Down 19% from 2010 peak



What Kind

90% LCD or LED

- CRTs mostly retired

42" Screen Avg.

- Up from 39" in 2017

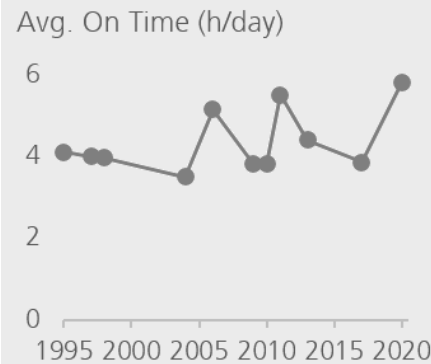
58% Smart- or Connected Capable

- 82% enabled, based on survey

Usage

5.8 hours/day per TV

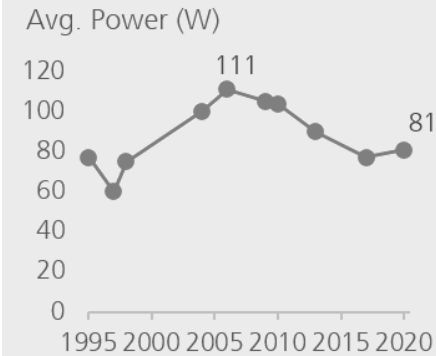
- 50% more than 2017
- More time at home amid COVID-19



Power

81 W active mode

- Similar to 2017
- Down 27% from 2005 peak

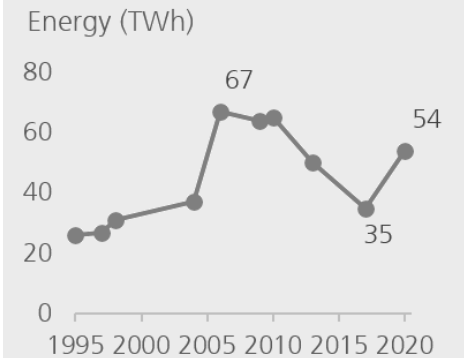


Energy

54 TWh

- Up 54% from 2017
- 188 kWh/yr per TV

92% ON mode

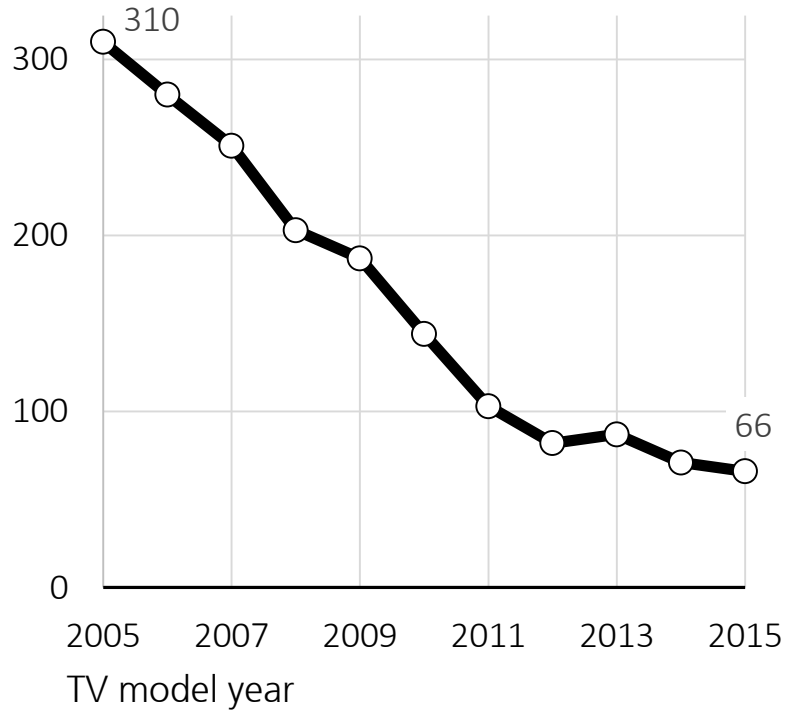


1 Consumer Electronics Usage Survey 2020. Average values and trends reflect the Installed Base.

LCD TV power draw fell steeply for all screen sizes

Meanwhile: more features, bigger screens, better resolution

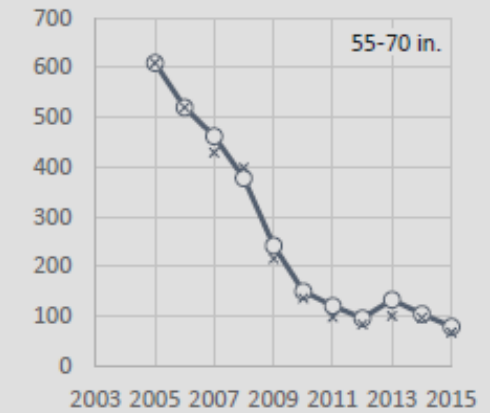
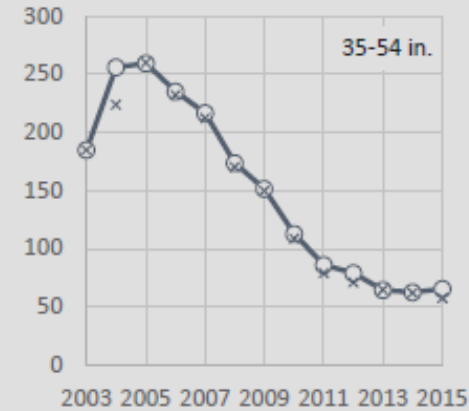
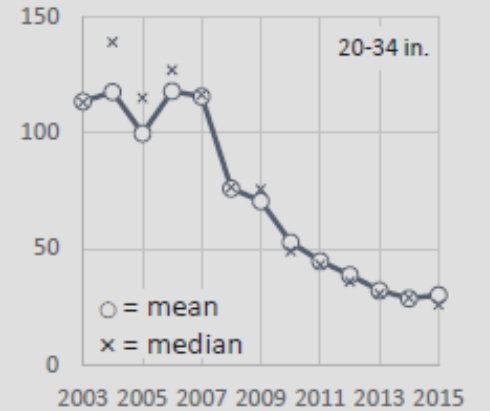
Average LCD TV Power Density
mW per square inch



- Average LCD TV power density fell by 80%
- Screen size of TV models grew by 20% from 2010 to 2016

Average LCD TV Power Draw by Screen Size
Watts

- Absolute power draw declined for all sizes

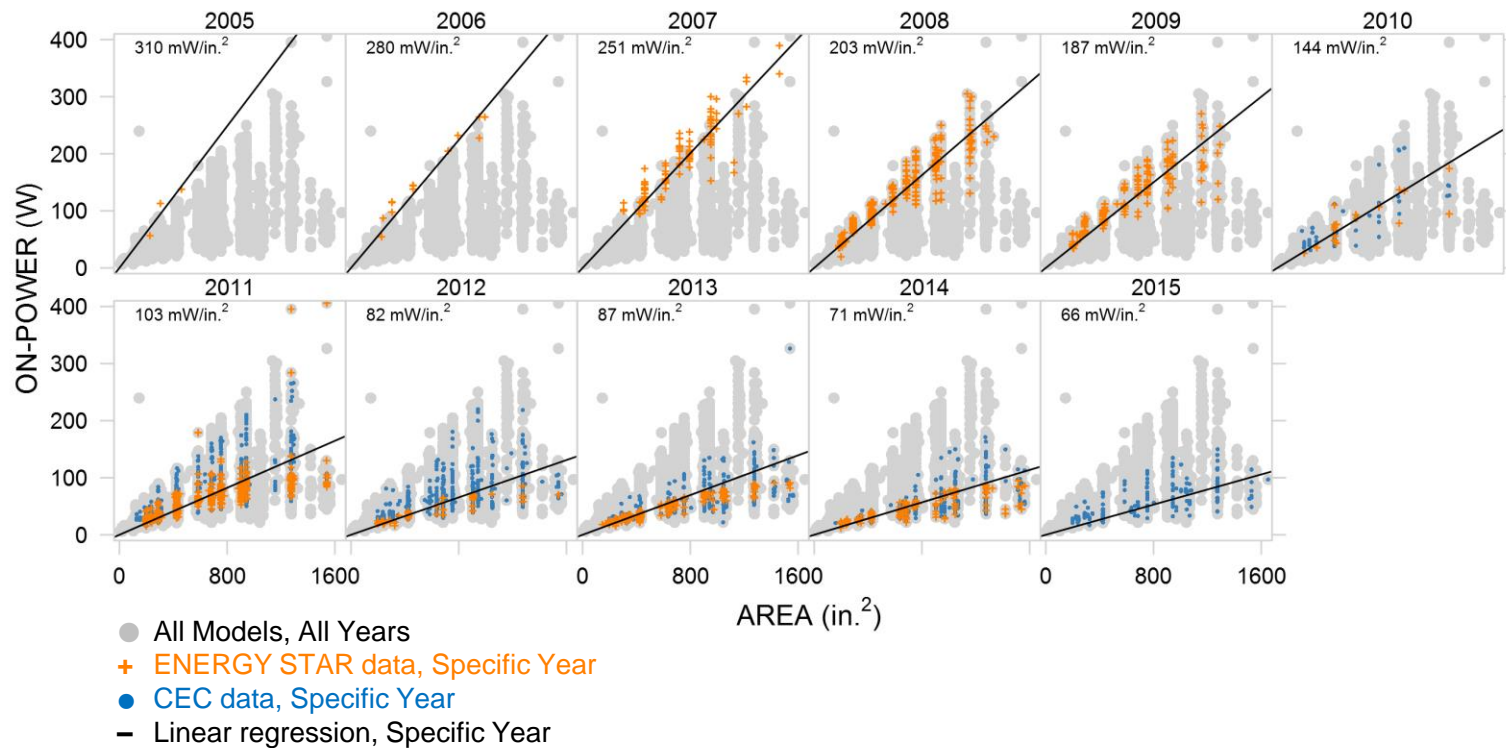


1 Fraunhofer USA. (2017). LCD Television Power Draw Trends from 2003 to 2015. Based on data from California Energy Commission and ENERGY STAR Databases. Averages calculated across 9,000+ TV models. Not sales weighted.

LCD TV active power draw varies significantly by model

Actual power draw depends on user settings...

Power density slopes have come down over time as displays became more efficient.



1 Fraunhofer USA. (2017). LCD Television Power Draw Trends from 2003 to 2015. Data from 9,000+ TV models. Colored points represent different data sources.

Influential Factors

- Brightness Settings and Picture Modes
- Automatic Brightness Control (ABC) and ambient room lighting
- Display and backlight technology
- Display resolution
- HDR capability

Brightness Settings

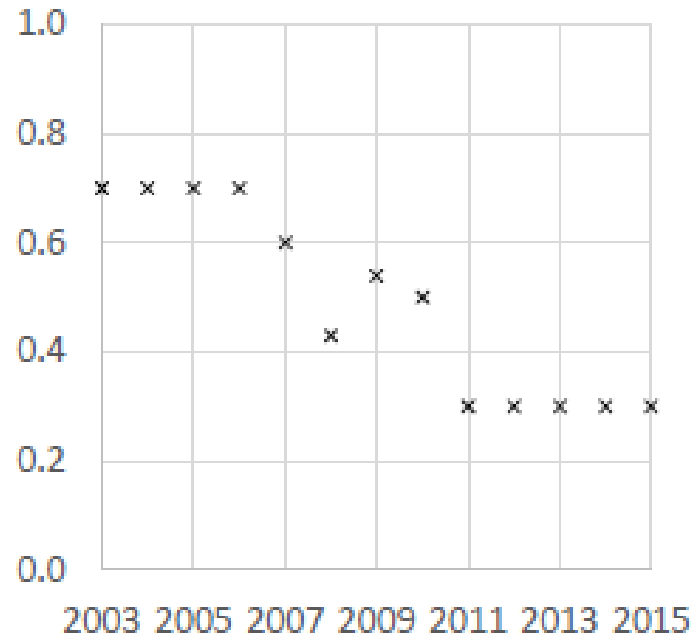
- “Retail Mode” uses about **1.3x more power** than “Default Mode” on average
- Depends on the TV

Off mode or “Passive Standby” power is generally very low

Active and networked standby modes of Smart TVs may be significantly higher

Average Passive Standby Power

Watts



Passive Standby

- Passive standby is less than 1 W for most models sold after 2008
- ENERGY STAR v7.0 in 2015 reduced passive standby limit to 0.5 W

Active Standby

- Active Standby provides network connectivity in the background.
- Some models with quick start use over 10 W. Others can provide these functions with far lower power.
- If all TVs had a 10 W standby, TV energy consumption would increase by about 30%

¹ Fraunhofer USA. (2017). LCD Television Power Draw Trends from 2003 to 2015. Based on data from California Energy Commission and ENERGY STAR Databases. Averages calculated across 9,000+ TV models. Not sales weighted.

Survey found 50% higher TV on-time in 2020 than 2017

Responders attributed most of this change to COVID-19



Average TV On Time

Hours per Day

Year	Avg. TV	Primary TV
2020	5.8	8.2
2017	3.9	6.1
2013	4.4	5.2
2010	3.8	6.5

Average self-report increase in TV on time due to COVID-19

Hours per Day

Year	Avg. TV	Primary TV
2020	+1.5	+2.5

Based on Usage Surveys from:

1 Fraunhofer USA. (2021). Consumer Electronics Energy Use in U.S. Homes in 2020.

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4 Fraunhofer USA. (2007). Consumer Electronics Energy Use in U.S. Homes in 2010.

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Computer usage was also up

Also driven by COVID-19



Average Desktop Tower Usage

Hours per Day

Year	Used
------	------

2020	5.7
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2017	5.2
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Average self-report increase in on time due to COVID-19

Hours per Day

Year	Used
------	------

2020	+1.4 (32%)
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Based on Usage Surveys from:

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2 Fraunhofer USA. (2017). Consumer Electronics Energy Use in U.S. Homes in 2017.

3 Fraunhofer USA. (2014). Consumer Electronics Energy Use in U.S. Homes in 2013.

4 Fraunhofer USA. (2007). Consumer Electronics Energy Use in U.S. Homes in 2010.

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External Monitors in homes used about 11 TWh in 2020

Desktop and laptop computers used a combined 34 TWh

How Many

123 million monitors

- Up 21% from 2017
- 70 million with desktops
- 53 million with laptops

What Kind

93% LCD or LED

- CRTs mostly retired

21" Screen Avg.

- Up slightly from 2017

Usage

9.3 hours/day active

- 38% more than 2017
- More time at home amid COVID-19
- Tightly coupled with computer power management settings

Power

25 W active mode

- Down moderately
- 31 W in 2017
- 42 W in 2006

Energy

10.8 TWh

- Up 33% from 2017
- 86 kWh/yr per monitor

98% ON mode



Laptop Displays

123 million
9.9 h/d
3.4 W
12 kWh/yr



All-in-One Displays

24 million
10.6 h/d
14 W
54 kWh

1 Consumer Electronics Usage Survey 2020.
Average values and trends reflect the Installed Base.

Conclusions

Key Findings

- **Display-related** devices used about 70 TWh or 40% of the total consumer electronics energy consumption in 2020
- Televisions and Monitors account for the vast majority (94%)
- Portable displays use relatively little energy
- TV and monitor energy use had been trending downward with the adoption of newer, more efficient displays
- TV on time estimates spiked by up to 50% due to COVID-19, driving a major uptick in consumption

Future Research Topics

- Characterize real-world display settings (brightness, picture modes) and their impact on power draw.
- Identify strategies for giving users more direct control over brightness.
- Quantify the difference between “On Time” and “Actively Used” time.

How many people leave their TVs on when not actively watching? What might be done about it?
- How are connected standby modes being used?
- Follow up on usage: Will it remain high? Increase? Return to normal?

Display Energy Use in Homes

Ownership, Power, Usage, and Trends

Contact

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- **Kurt Roth**
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Technical Reports

- B. Urban, K. Roth, and J. Olano. (2021). Energy Consumption of Consumer Electronics in U.S. Homes in 2020. *Fraunhofer USA CMI Report to the Consumer Technology Association*.

<https://shop.cta.tech/products/energy-consumption-of-consumer-electronics-in-u-s-homes-in-2020>
- B. Urban and K. Roth. (2017). LCD Television Power Draw Trends 2003-2015. *Fraunhofer USA CSE Report to the Consumer Technology Association*. Available on request.