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# Consumer Electronics in U.S. Homes Energy Use in 2017



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Fraunhofer USA Center for Sustainable Energy Systems

EEDAL 2017, Irvine, CA  
Sept. 13-15, 2017

## Fourth Study in a Series



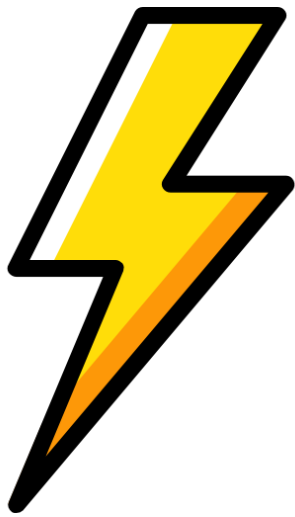
### GOAL

**Quantify the energy use  
of Consumer Electronics  
installed in U.S. Homes**

Urban, B., K. Roth, M. Singh, and D. Howes. (2017). Consumer Electronics Energy Use in U.S. Homes in 2017. *Fraunhofer Center for Sustainable Energy Systems Report to the Consumer Technology Association*. In Preparation.

**WHY CONSUMER  
ELECTRONICS?**

# U.S. Electricity Use (2016)



**11% of  
Residential**

**3,700** TOTAL TWh\*

**1,400** Residential

**148** Consumer  
Electronics

\*1 TWh = 1 Billion kWh

# Consumer Electronics



**3.5 billion devices**

**119 million homes**

**148,000,000,000 kWh/yr**

**\$16 billion  
energy cost**

# Per Household

30 devices

44 kWh/device

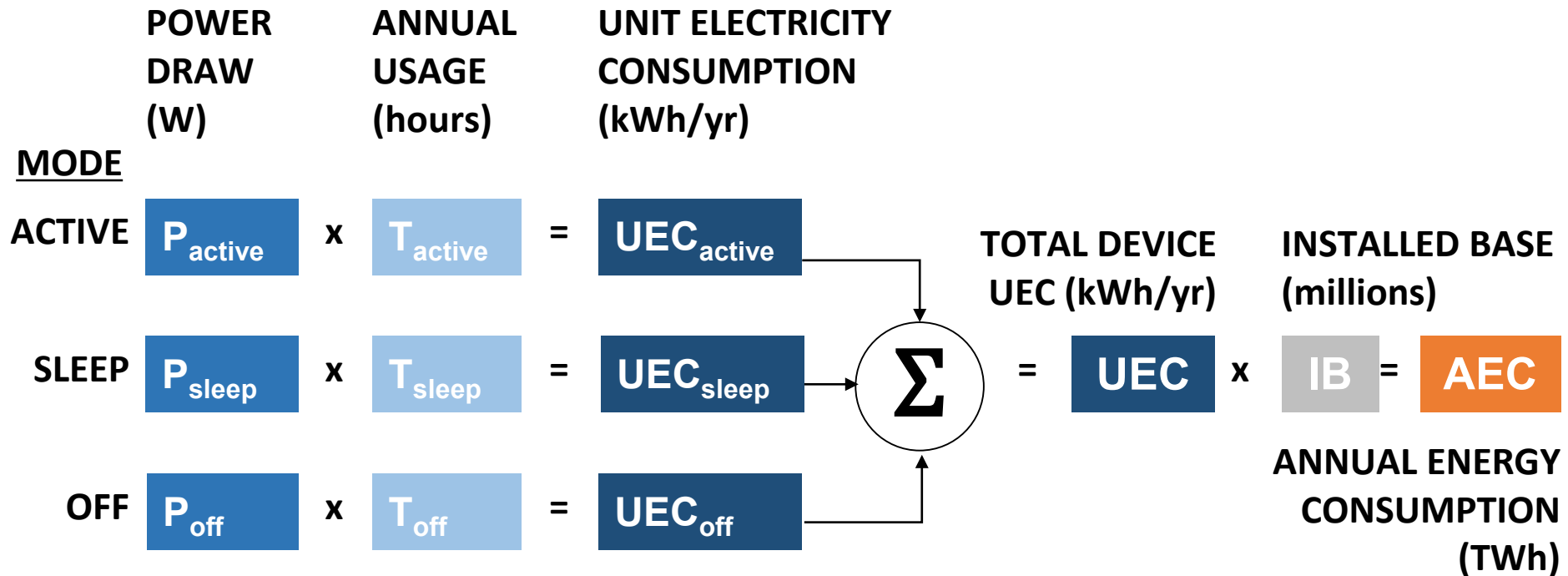
**1,300 kWh/yr**

**\$150 per year**



# **METHOD**

# Bottom-up Calculations





# Consumer Electronics Usage Surveys



**1,000 households\***

**How many devices were plugged last month?**

**How were they used?**

**\*500 landline/500 cell phone**

# Voluntary Energy Efficiency Agreements

**Set-Top Box**

**Small Network Equipment**

**>90% of purchased products met these standards**

See: <http://www.energy-efficiency.us>

Industry stakeholder commitment to energy efficiency goals for newly shipped products.

Third-party auditing: measurement, testing, reporting.

Reports indicate sales-weighted power draw of new equipment.

# Device Categories Studied in Depth

Televisions

Computers

Set-Top Boxes

Monitors

Sound Bars

Network Equipment

Video Game  
Consoles

## 80/30 RULE

These **1.1 billion** devices account for about **80%** of the total energy consumption.

# Device Categories Studied in Depth

**Televisions**

**Computers**

**Set-Top Boxes**

Monitors

Sound Bars

Network Equipment

Video Game  
Consoles

These **0.7 billion devices** account for about **60%** of the total energy consumption.

# Other Devices (Less Depth)

## AUDIO

AV Receiver w/ Surround  
Computer Speakers  
Home Theater In-a-Box  
Radio + Clock Radio  
Shelf Stereo + Compact Audio  
Speaker Dock

## DISC PLAYER

Blu-ray Player  
CD player, standalone  
DVD Player

## SET-TOP BOX (Standalone)

DVR  
Over-the-air DTA  
Digital Media Streaming  
VCR

## VIDEO

Digital Picture Frame  
Video Projector  
Web Camera

## INFO-TECH

External Storage Drive  
Printer + Multi-function

## PHONE

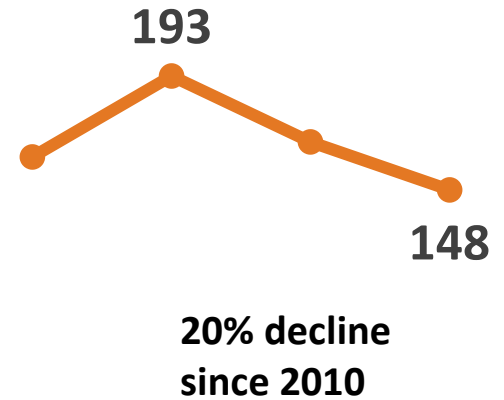
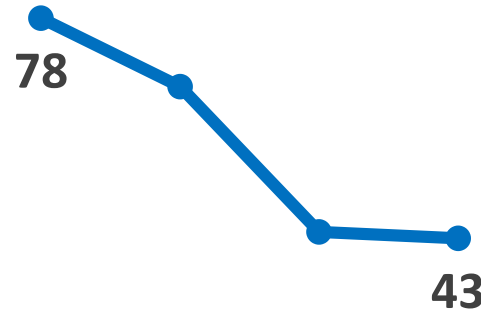
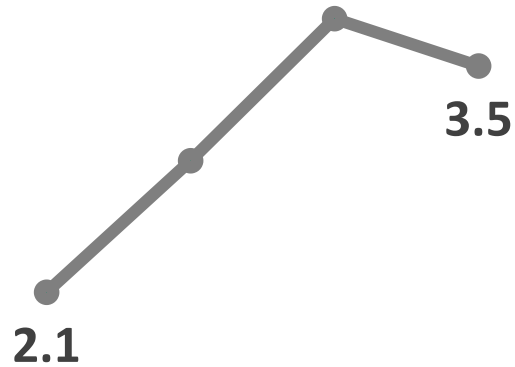
Cordless Phone  
Internet-based Phone  
Telephone Answering Device

## PORTABLE DEVICES

Bluetooth Headset  
Wireless Speaker  
DVD or Blu-ray Player  
Media player, MP3+CD  
eReader  
GPS, handheld  
Smart Watch + Wearable  
Tablet Computer  
Mobile Non-Smart Phone  
Mobile Smart Phone  
Camcorder  
Digital Camera  
Video Game Console

These **2.4 billion** devices account for about **20%** of the total energy consumption.

# MACRO TRENDS



2006 2010 2013 2017

2006 2010 2013 2017

2006 2010 2013 2017

**billion  
units**

**X**

**kWh per  
device /yr**

**=**

**TWh**

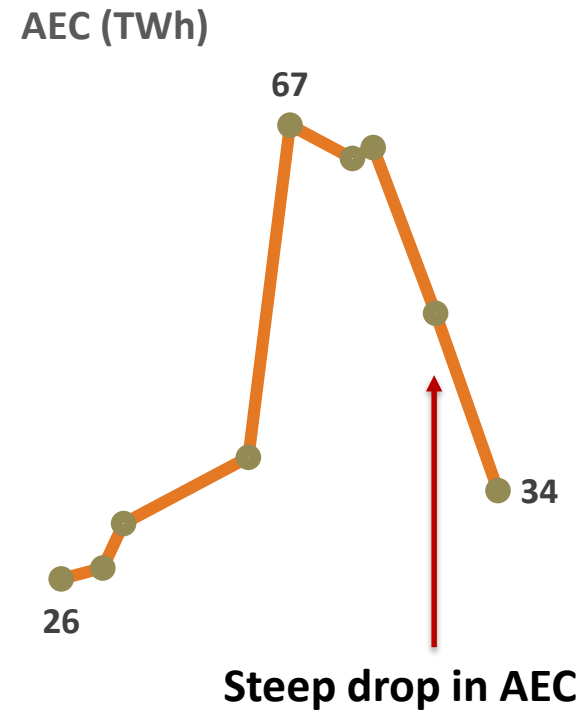
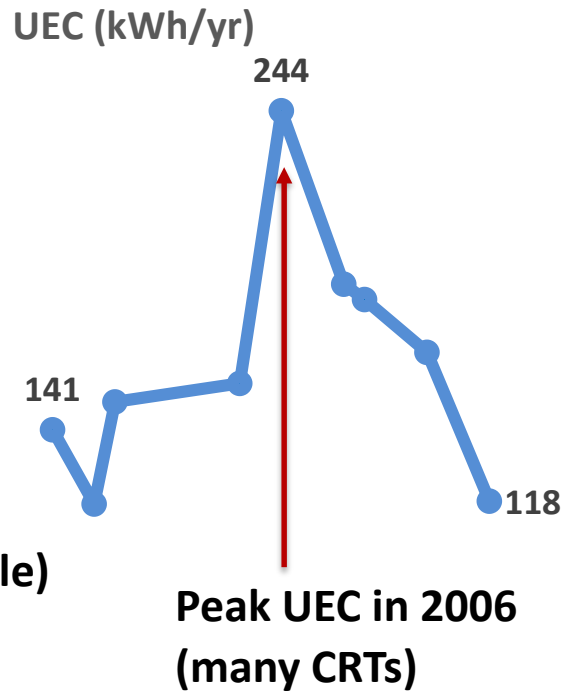
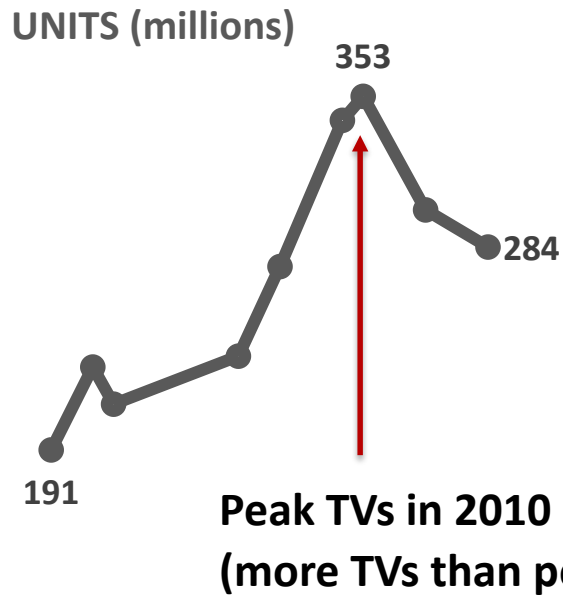
# HIGHLIGHTS

# TELEVISIONS





# TV Trends



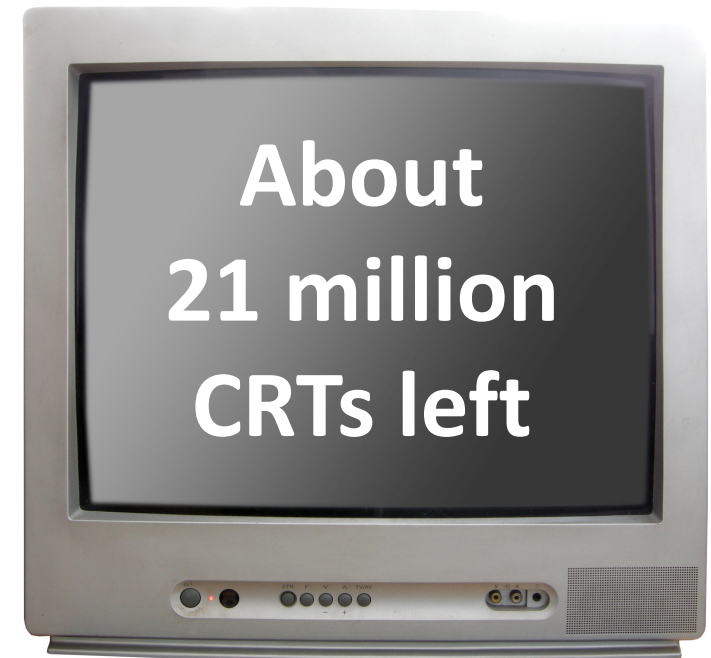
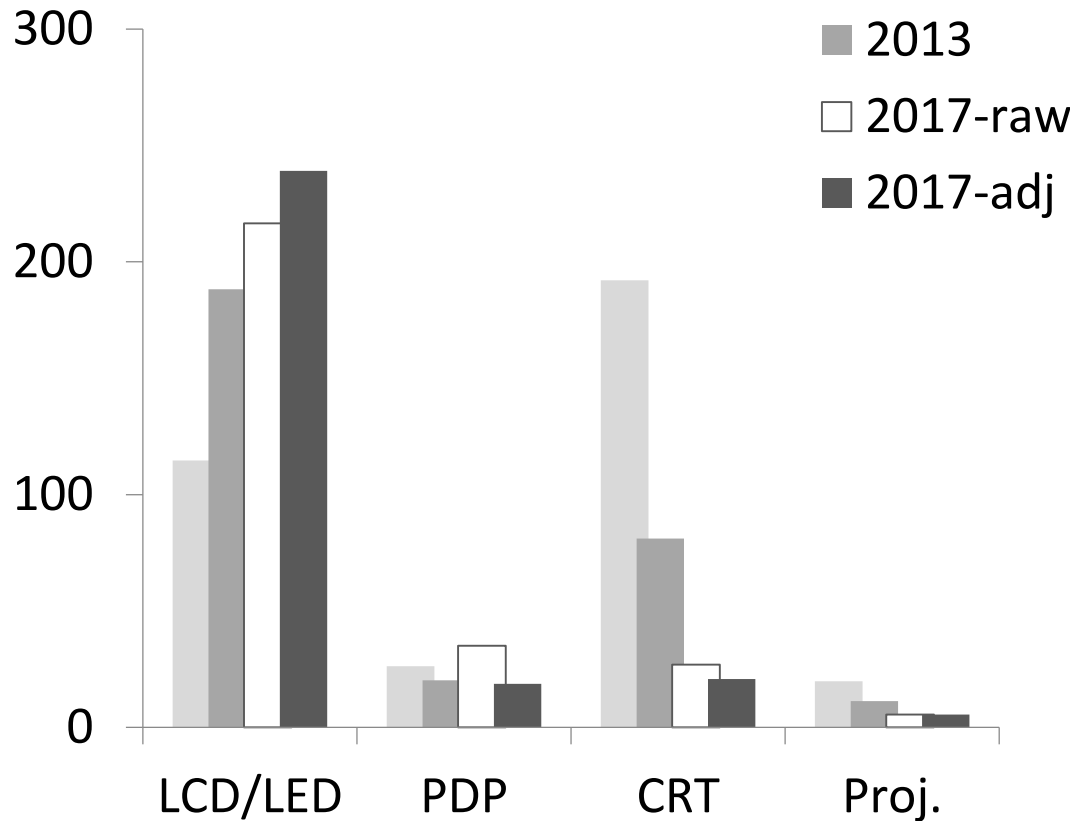
1995 2005 2015

1995 2005 2015

1995 2005 2015

# CRTs give way for LCDs...

TVs (millions)





**308 million TVs  
owned**

**284 million TVs  
plugged in**



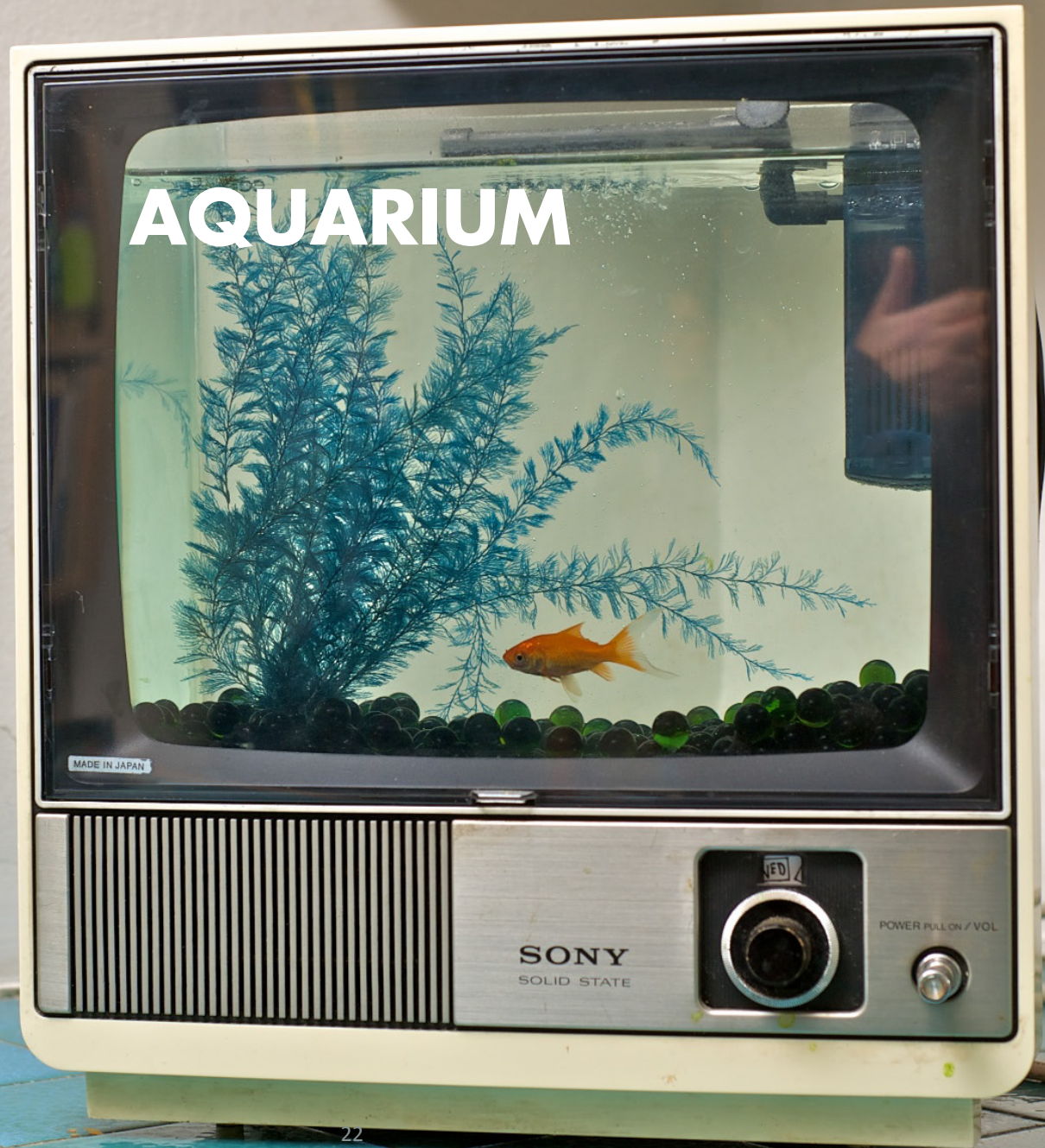
**Where Are  
They Now?**



**TERRARIUM**

ADMIRAL

# AQUARIUM



# MINIBAR



# Usage is Still High...

**3.9 hours/day  
per TV**


**5 hours/day  
per person**

**Usage may have decreased slightly,  
competition from other screens.**





# TV Power Draw Trends



Fraunhofer USA Center for Sustainable Energy Systems

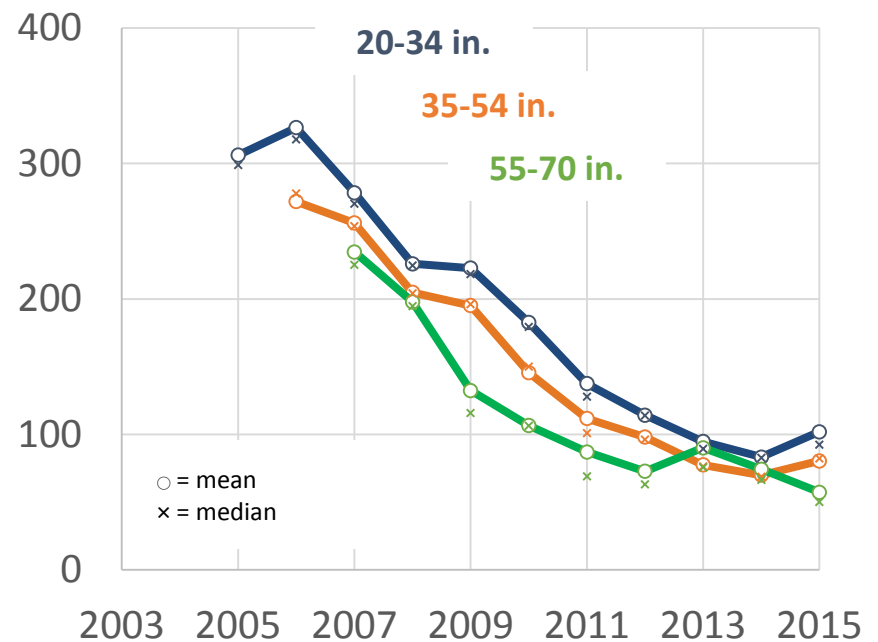
**LCD Television Power Draw Trends  
from 2003 to 2015**

Final Report to the Consumer Technology Association

by Bryan Urban and Kurt Roth  
May 2017

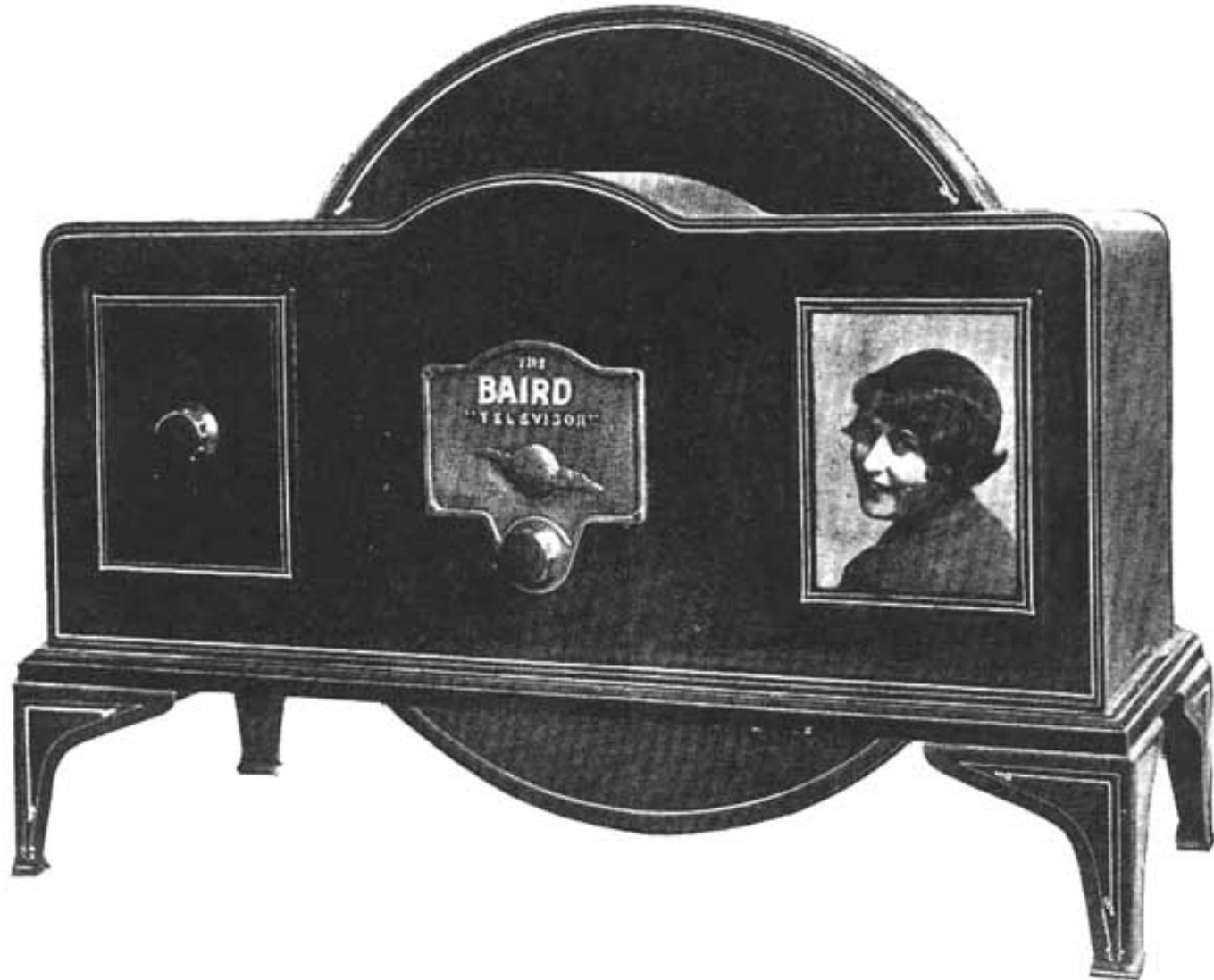
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LCD TV On-mode Power Density (mW/in.<sup>2</sup>)



Urban, B. and K. Roth. (2017). LCD Television Power Draw Trends from 2003 to 2015. *Fraunhofer Center for Sustainable Energy Systems Report to the Consumer Technology Association*. May.

# Mechanical Scanning TV (1920s)

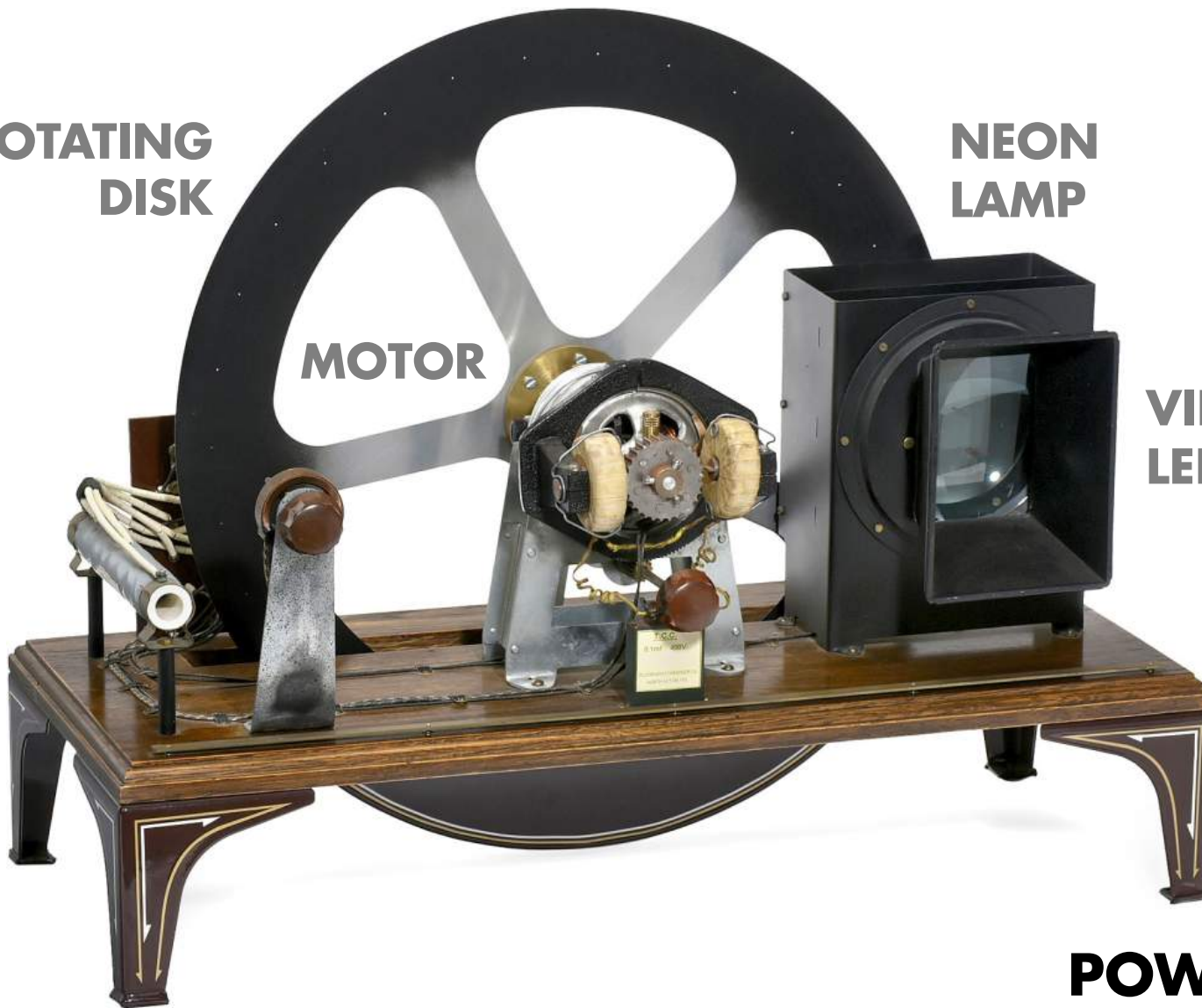


**ROTATING  
DISK**

**NEON  
LAMP**

**MOTOR**

**VIEWING  
LENS (1.5 in<sup>2</sup>)**

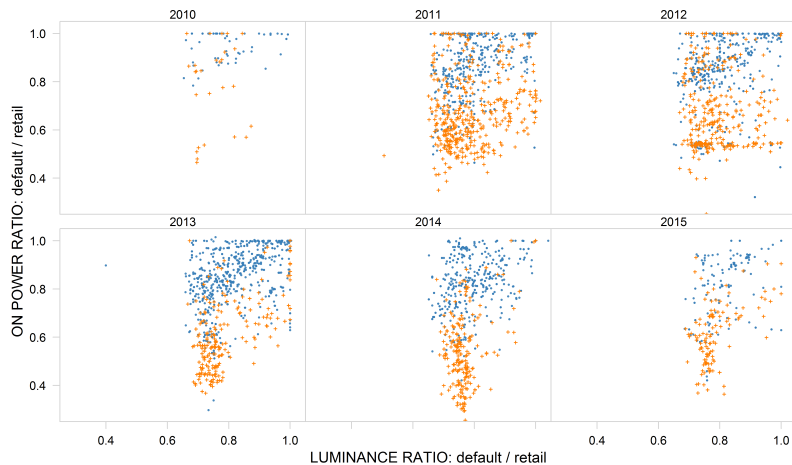


**POWER DENSITY:  
5 W (?) = 3,000 mW/in<sup>2</sup>  
> 10x higher than LCD**

# Picture Settings

## Brightness Settings and Viewing Modes

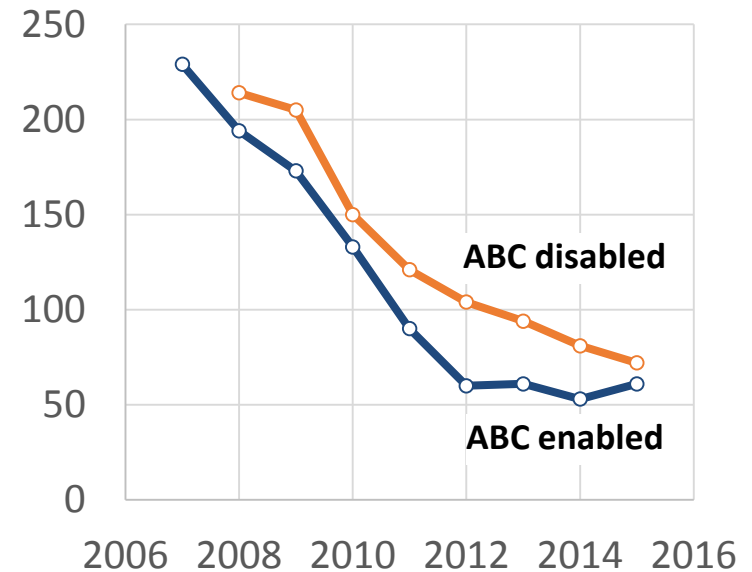
Default Mode: Retail Mode = 0.85 on average.



Further study needed to determine what settings people actually use.

## Automatic Brightness Control

POWER DENSITY (mW/in.<sup>2</sup>)



# Passive Standby



$< 1 \text{ W}$   
for most TVs

# Smart TVs and Connected Standby



About **HALF** of homes have **at least one** Smart TV.

About **27%** of homes had at least one Smart TV enabled.

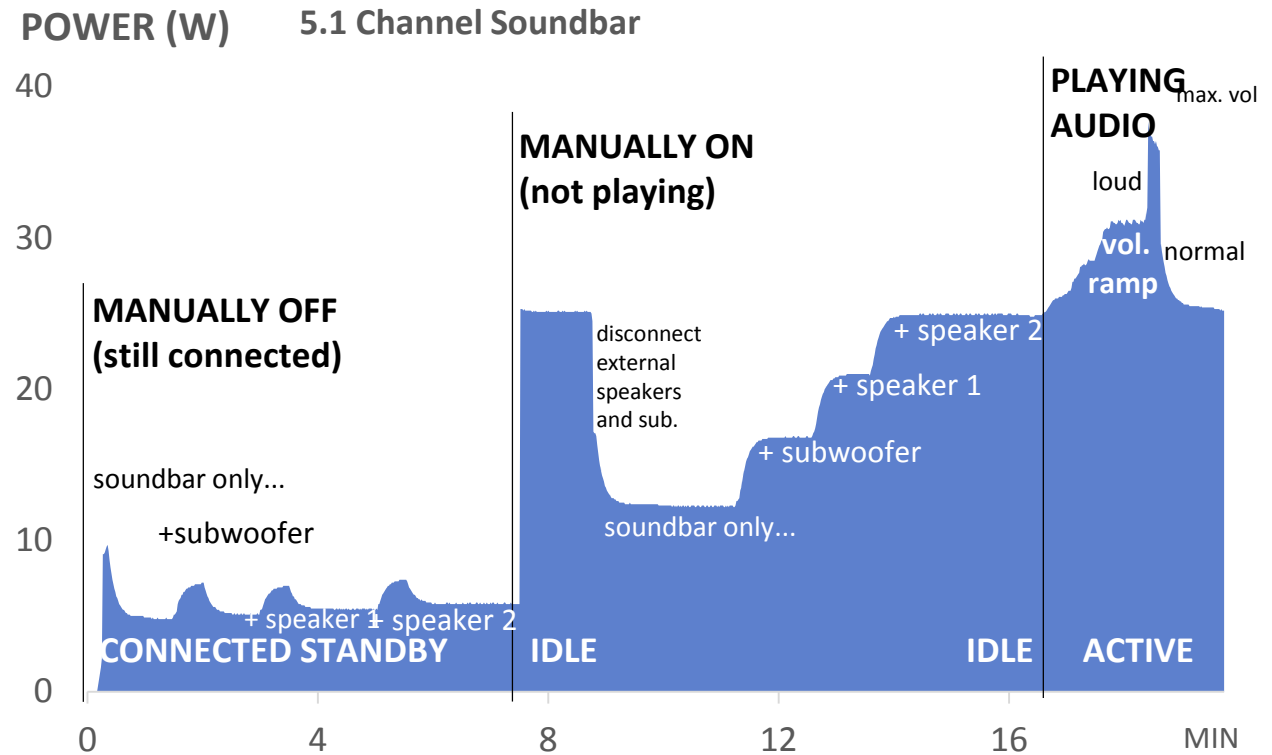
Passive Standby:  
Fleet average of about **1 W**

Active Standby could be about **10 W** for Smart TVs with this feature enabled.

# Soundbars

**Newer category  
with rapid growth**

**20 million units**  
**65 kWh/year**  
**1 TWh**







# SET-TOP BOXES (SUBSCRIPTION)



# Set-top Box Trends

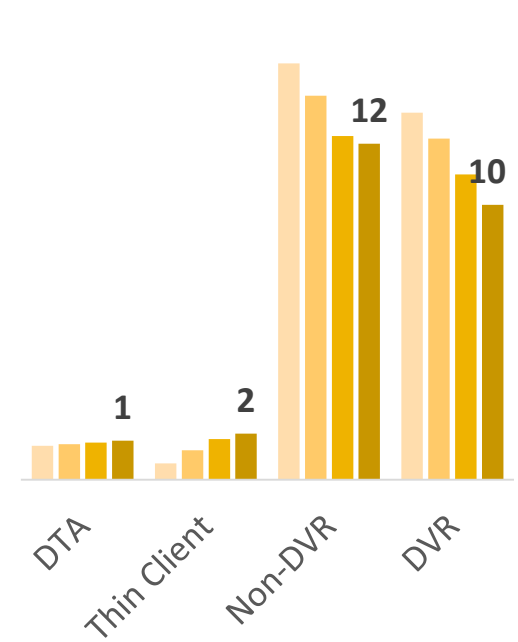
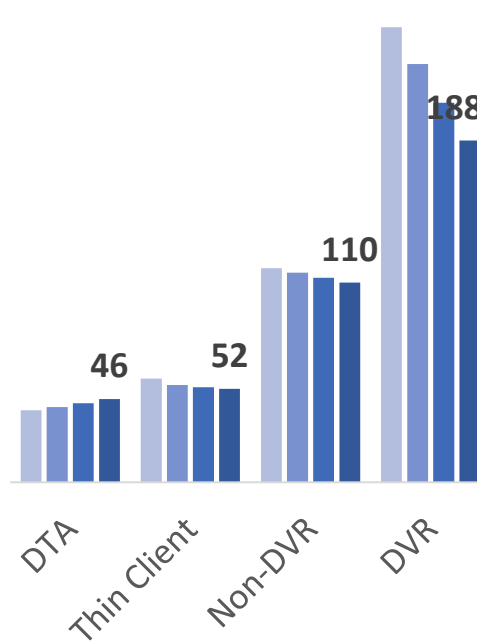
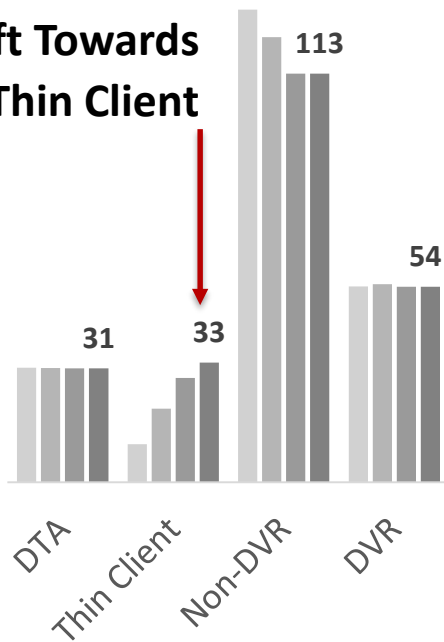
UNITS (millions)

UEC (kWh/yr)

AEC (TWh)

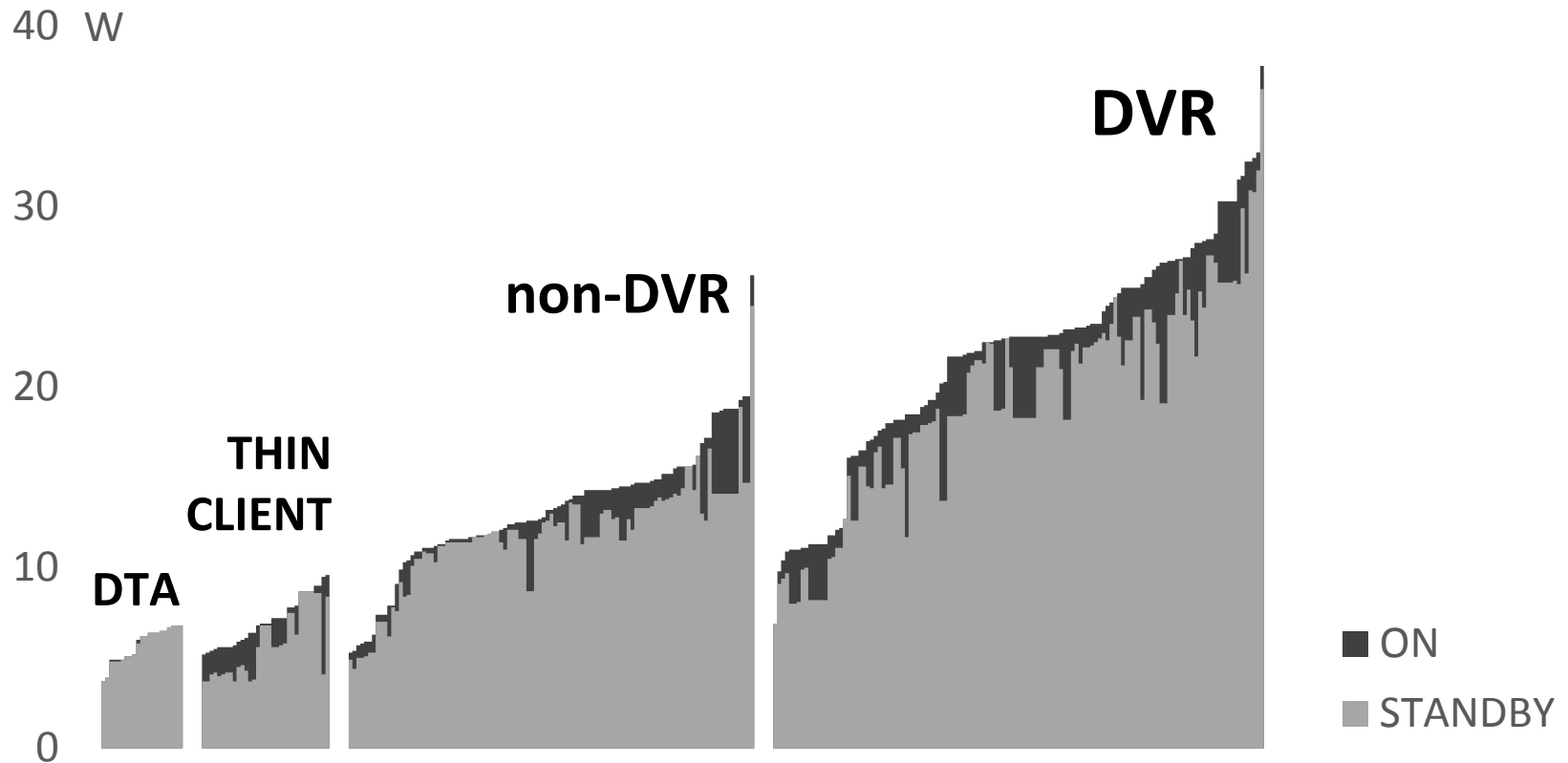
2013 2014 2015 2016p

Shift Towards  
Thin Client

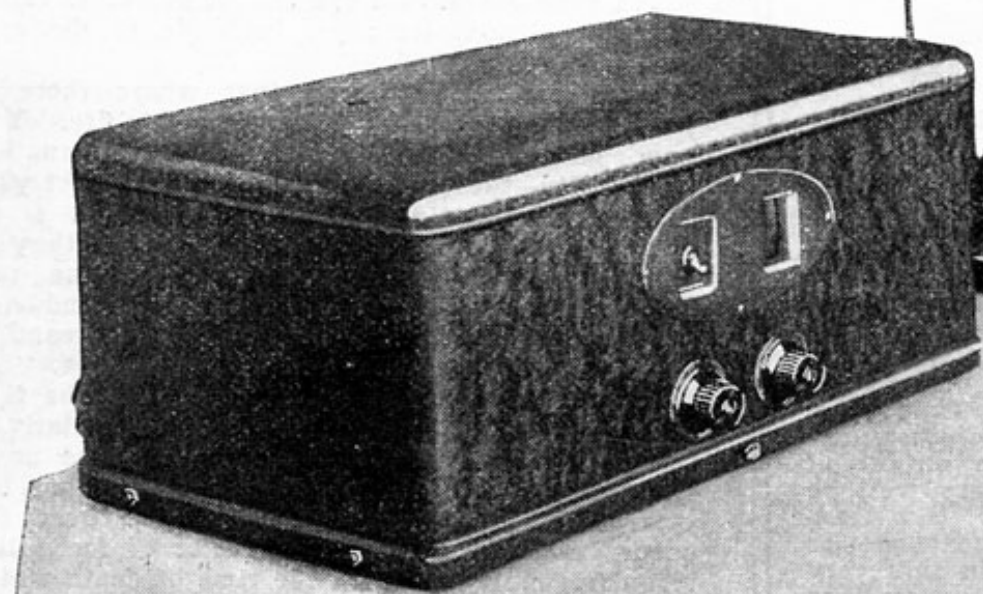


# Set-top Box Power Draw

## High Variability Among Devices



# How To Build The S & I TELEVISION RECEIVER



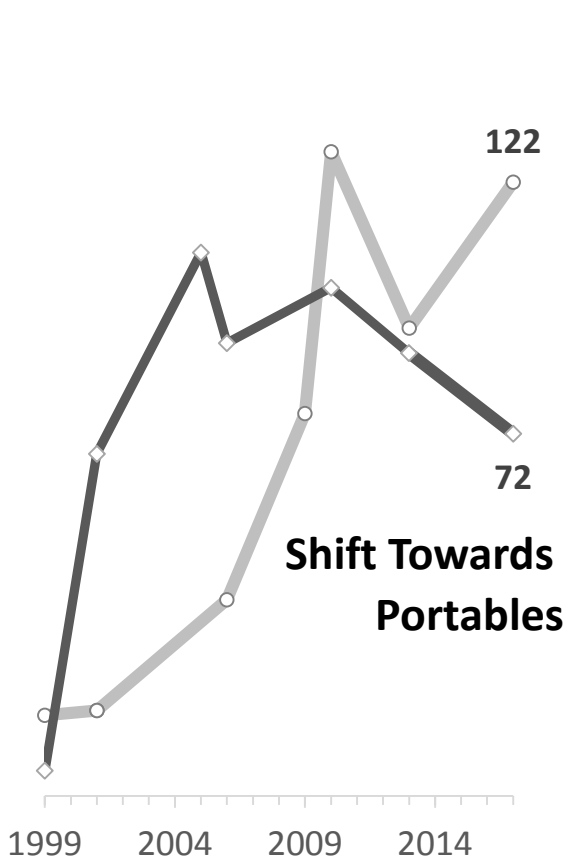


# COMPUTERS

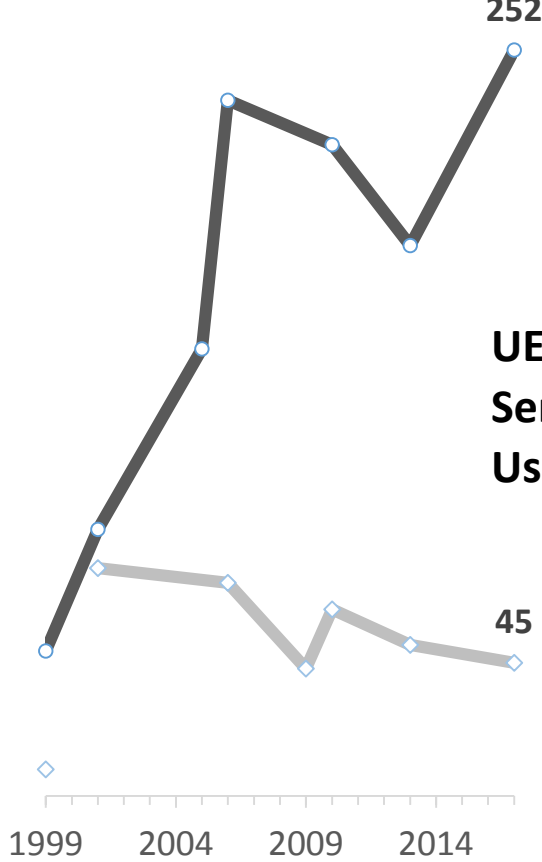


# Computer Trends

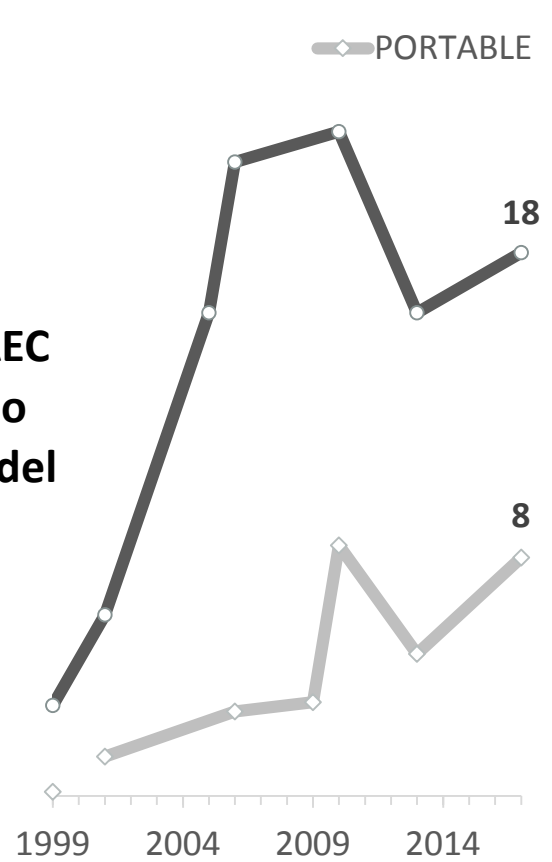
UNITS (millions)



UEC (kWh/yr)



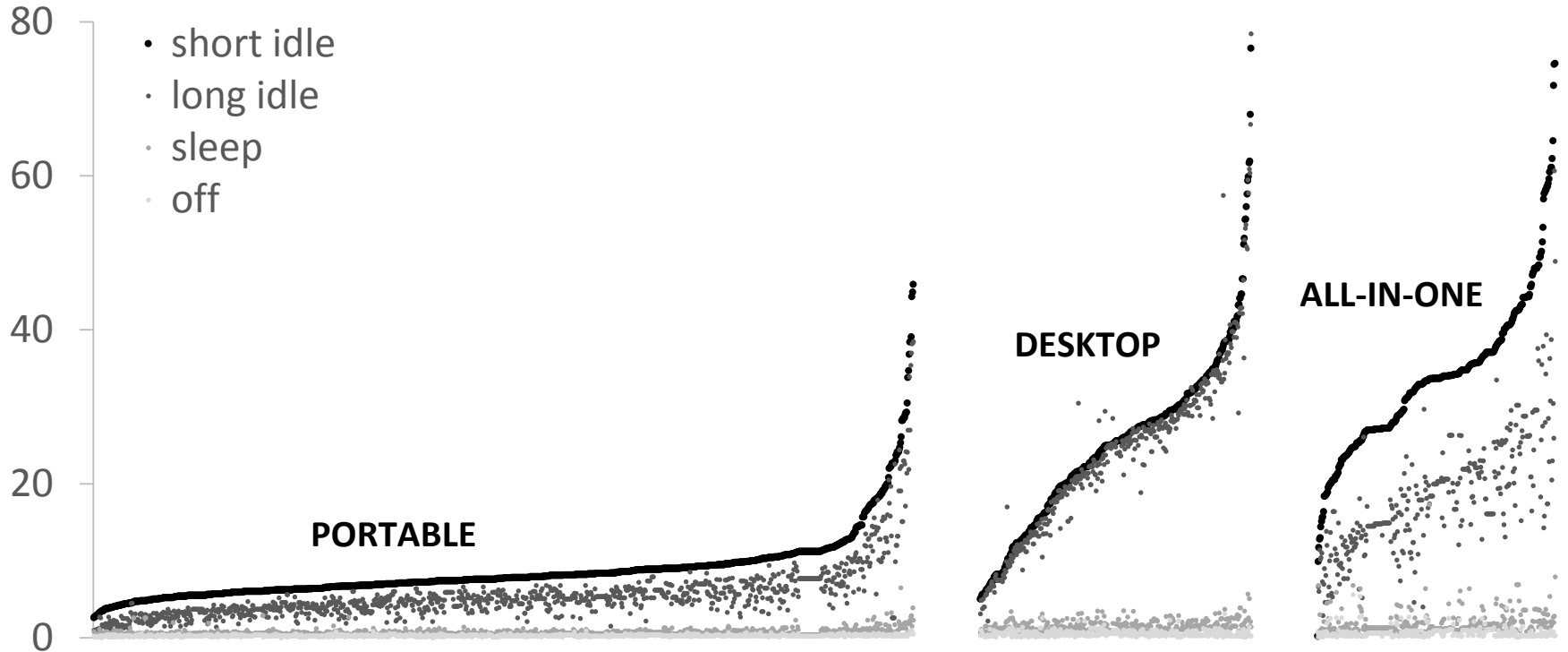
AEC (TWh)



UEC and AEC Sensitive to Usage Model

# Computer Power Draw

POWER (W)

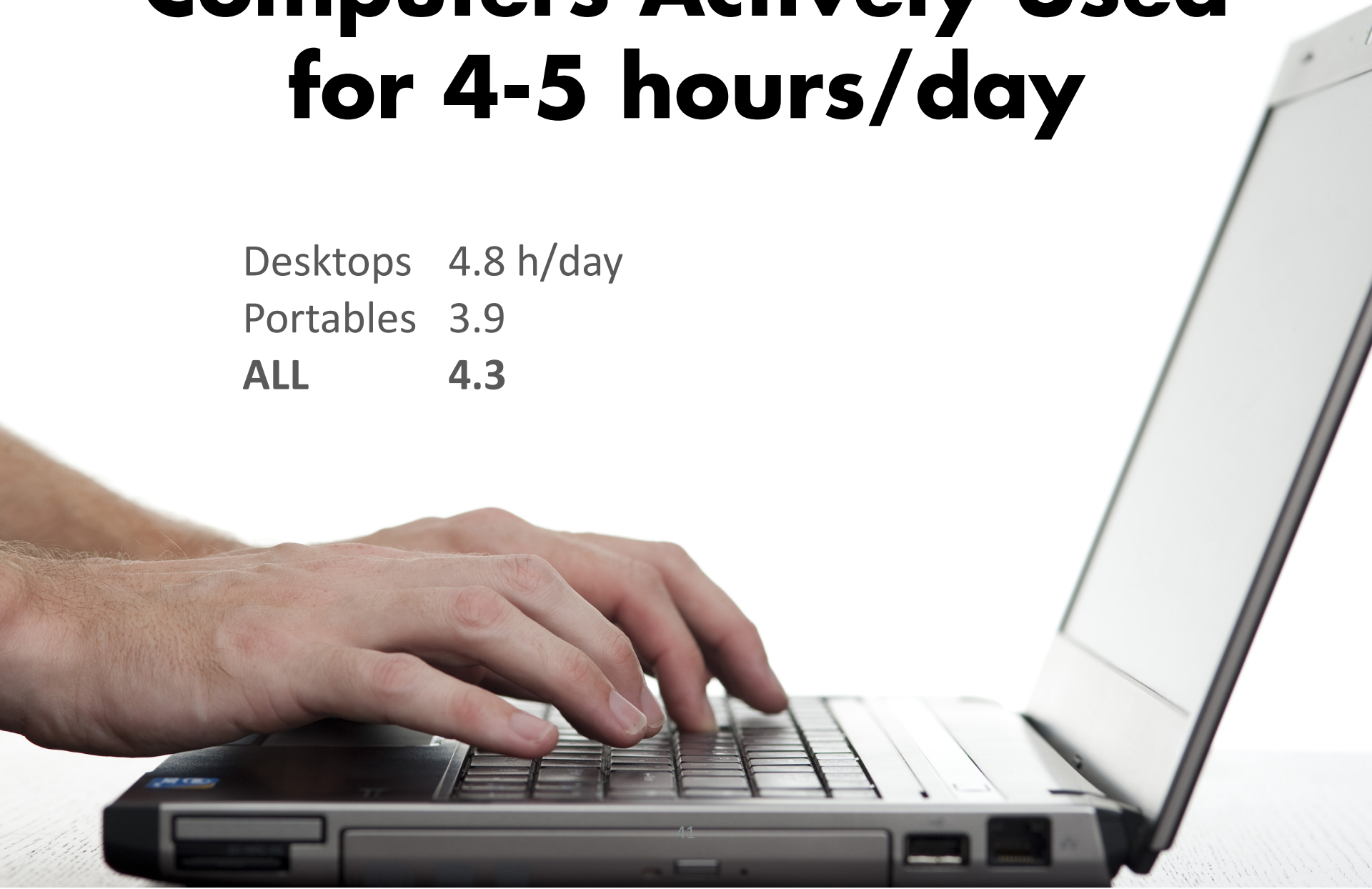


Based on ENERGY STAR qualified models 2013-2017.



# Computers Actively Used for 4-5 hours/day

Desktops	4.8 h/day
Portables	3.9
<b>ALL</b>	<b>4.3</b>



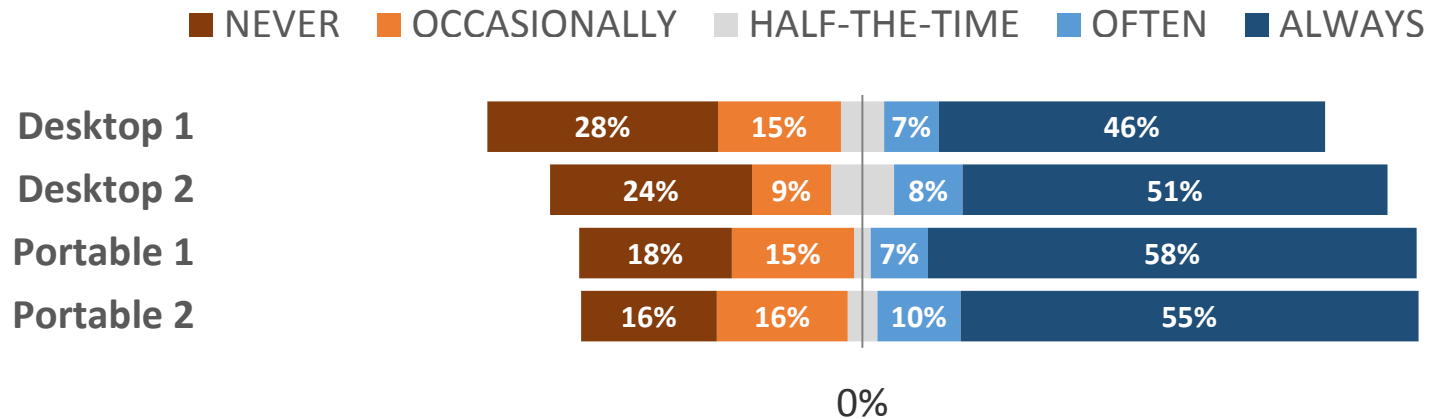
# Manual Power Management Rates Reasonably High

## DAYTIME

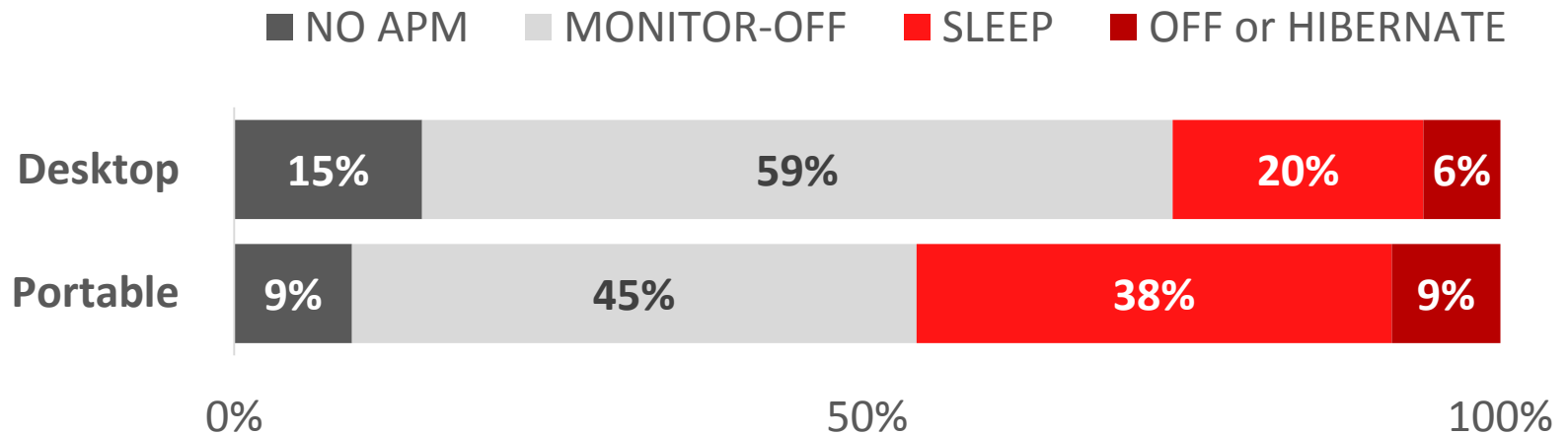
1/3 report shutting down  
1/3 report sleep or standby

## NIGHT

About half shut down  
(Fig. below)



# Automatic Power Management Rates



**Based on people who always leave their computer on overnight.**

# Gaming PCs

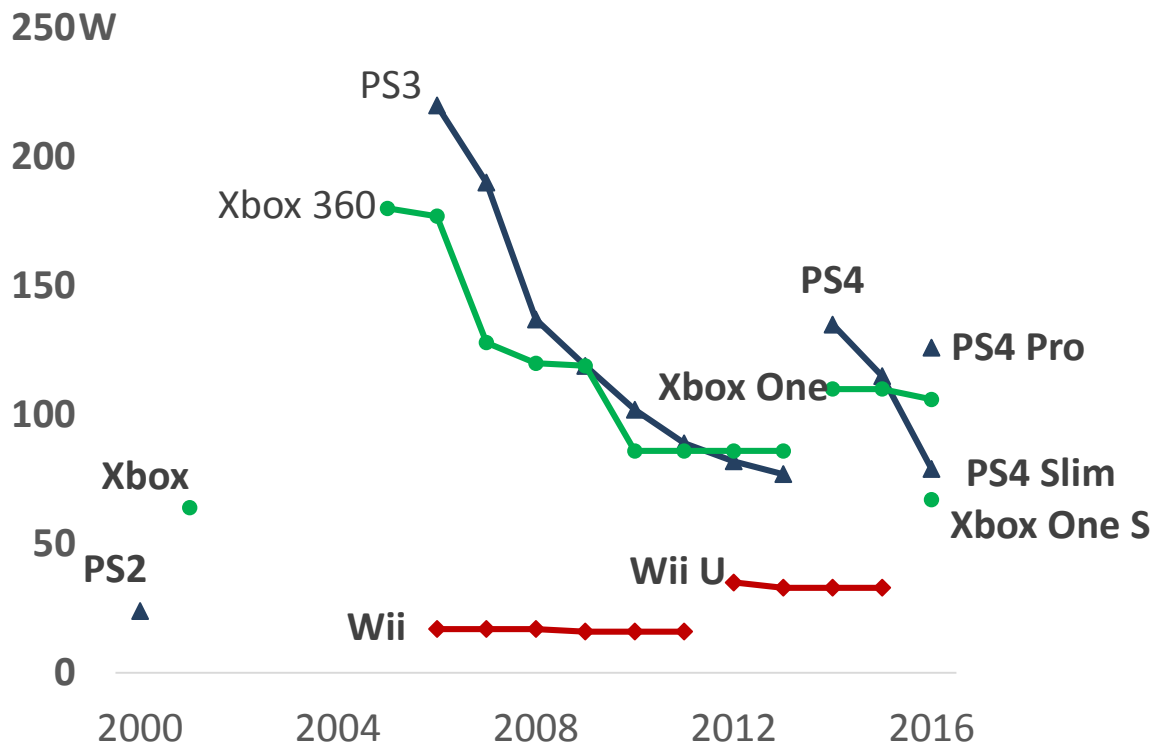
**Wildcard subcategory.**

**Enthusiast gaming computers can use much more energy.**

**Gaming power draw can add 100+ W to active mode.**

**Primarily due to dedicated graphics processing units (GPUs).**

# Video Game Console Power Draw



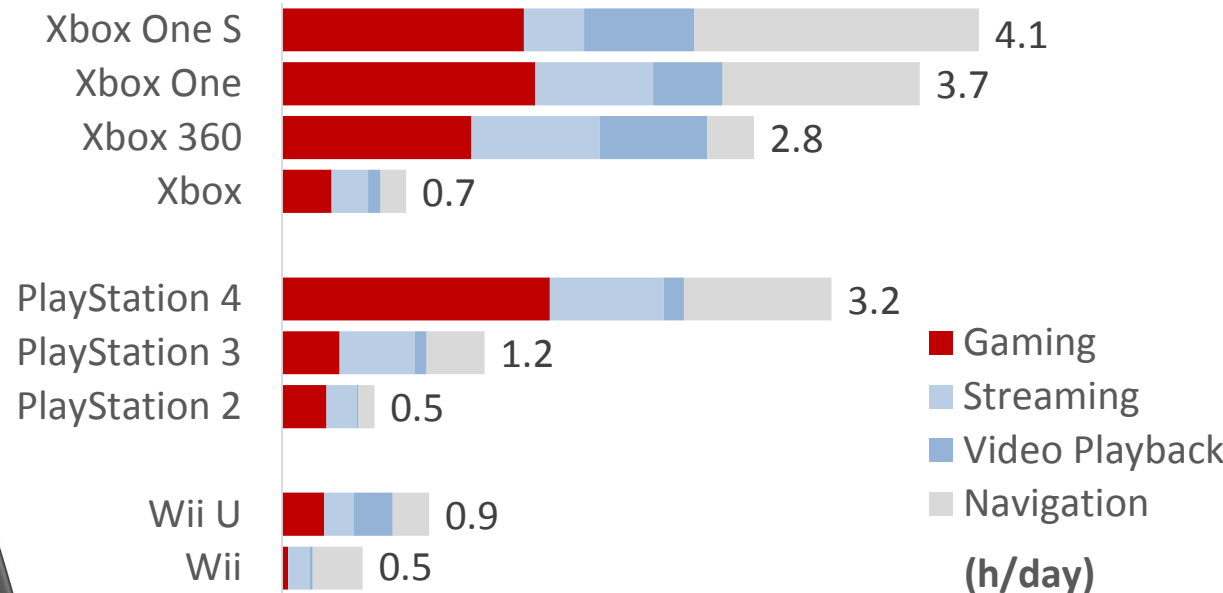
**Varies by console.**

**Changes with new hardware releases.**

# Video Game Consoles

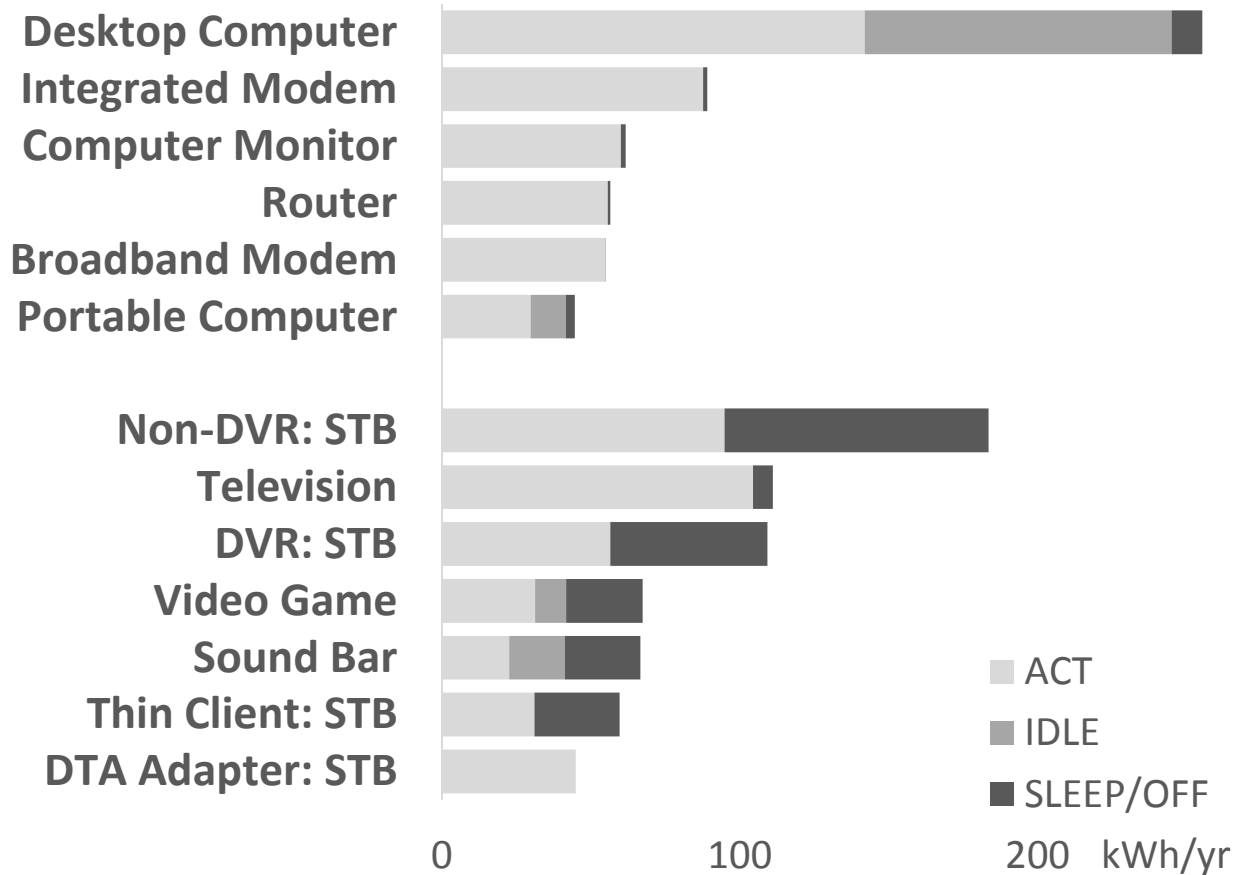
In Active Modes for  
0.5 to 4 hours Per Day

Crossover video usage...  
DVD and Blu-ray  
Video Streaming



# CONCLUSIONS

# Unit Energy Consumption

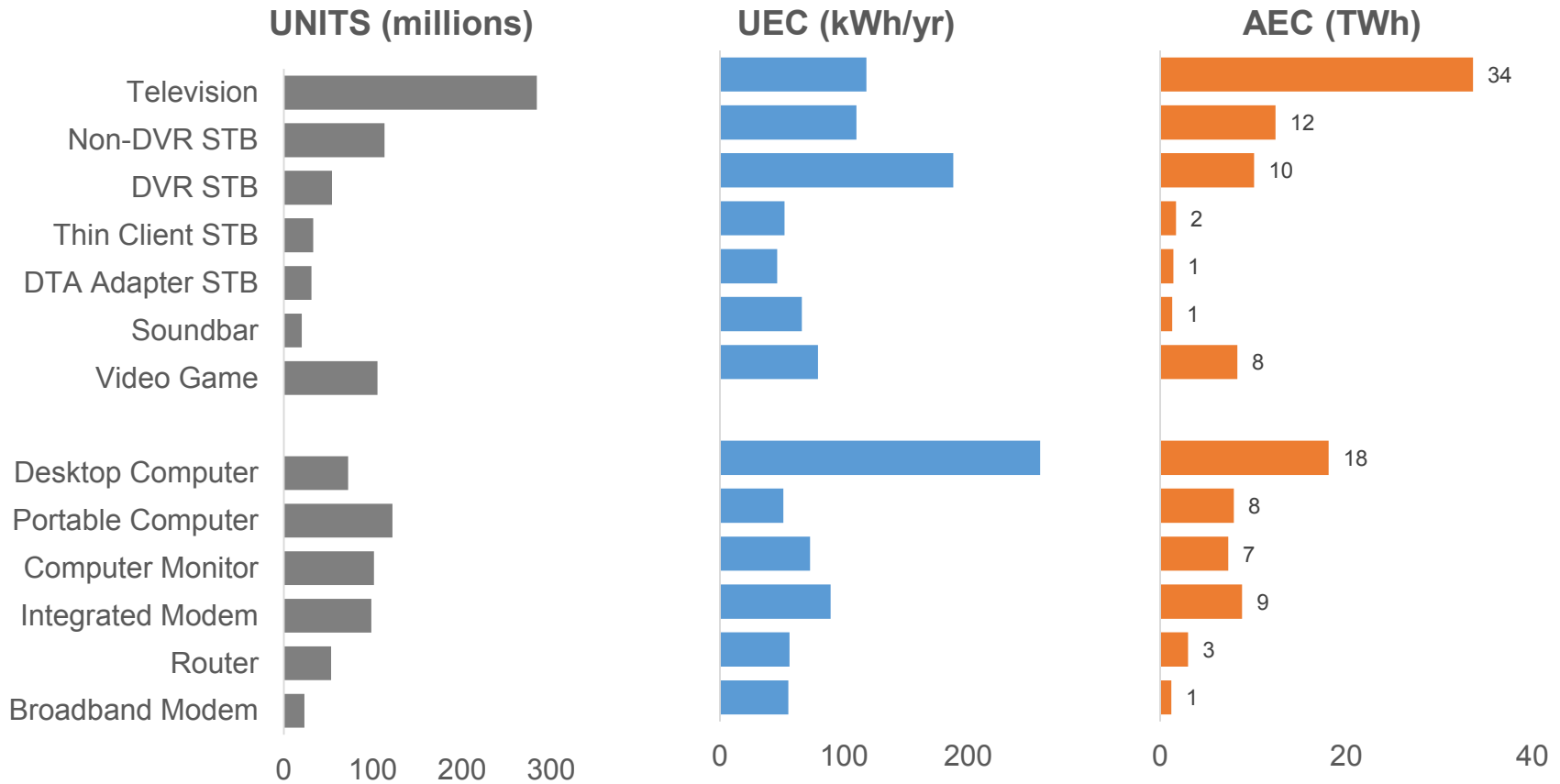


45-200+ kWh/yr  
per device

Most consumption in  
active modes, with  
some exceptions.



# Results



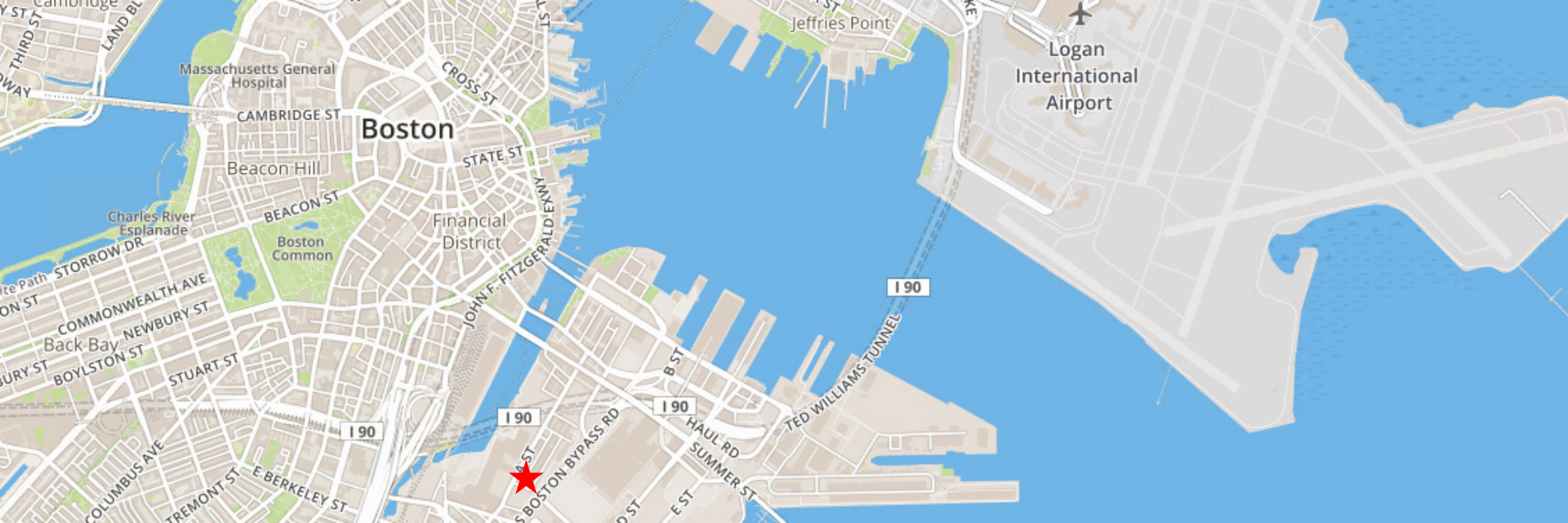
# Key Takeaways for 2017

**3.5 billion** devices used **148 TWh**  
(20% less than in 2010)

Driven largely by new, more-efficient devices displacing older devices.  
Especially TVs.

TVs and Set-top Boxes now use similar amounts of energy (~35 TWh).

# Stay Tuned for the Final Report



## Contact

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