

What Do We Know Now About the Energy Use of 4K/Ultra High Definition (UHD) and “Smart TVs”?

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Presentation at ENERGY STAR Partner Meeting
October 2015



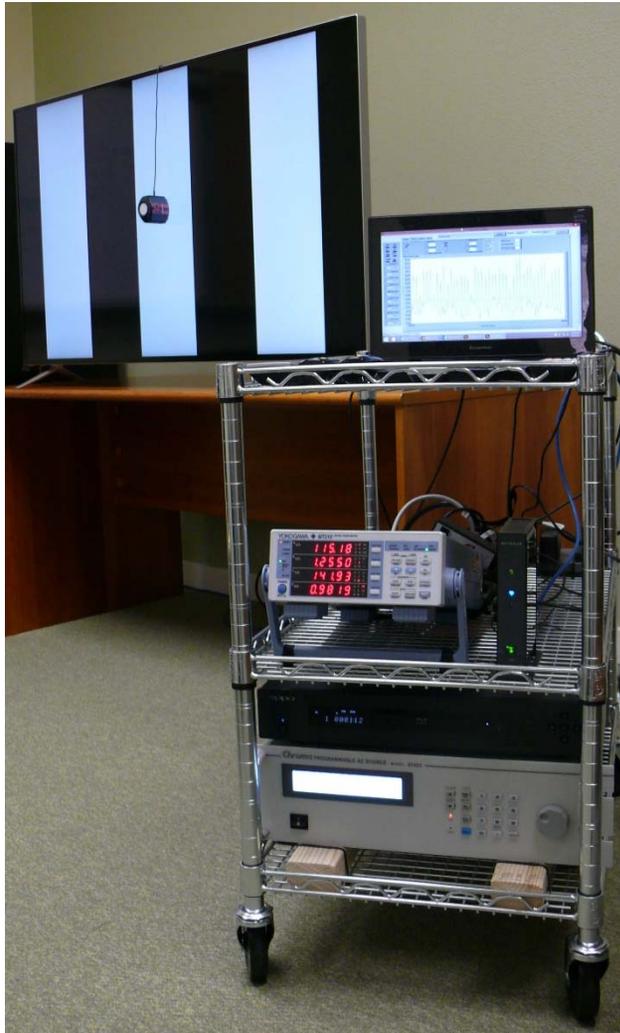
Questions we tried to answer?

- What is the difference in On mode power use between HD and 4K TVs?
- What is the spread in On mode power use of similar sized 4K TVs?
- What impact does automatic brightness control (ABC) have on UHD On mode power use?
- Smart TVs – what is the power use and reboot time for TVs with Quick Start off and on? How does it vary between brands?

Research Questions (cont.)

- What impact does playing 4K content with HDR have?
- Test Method - any improvements needed?
- What is the national energy and environmental impact of shift from HD to UHD TVs (work in progress -- analysis not yet completed)?

How we did our study



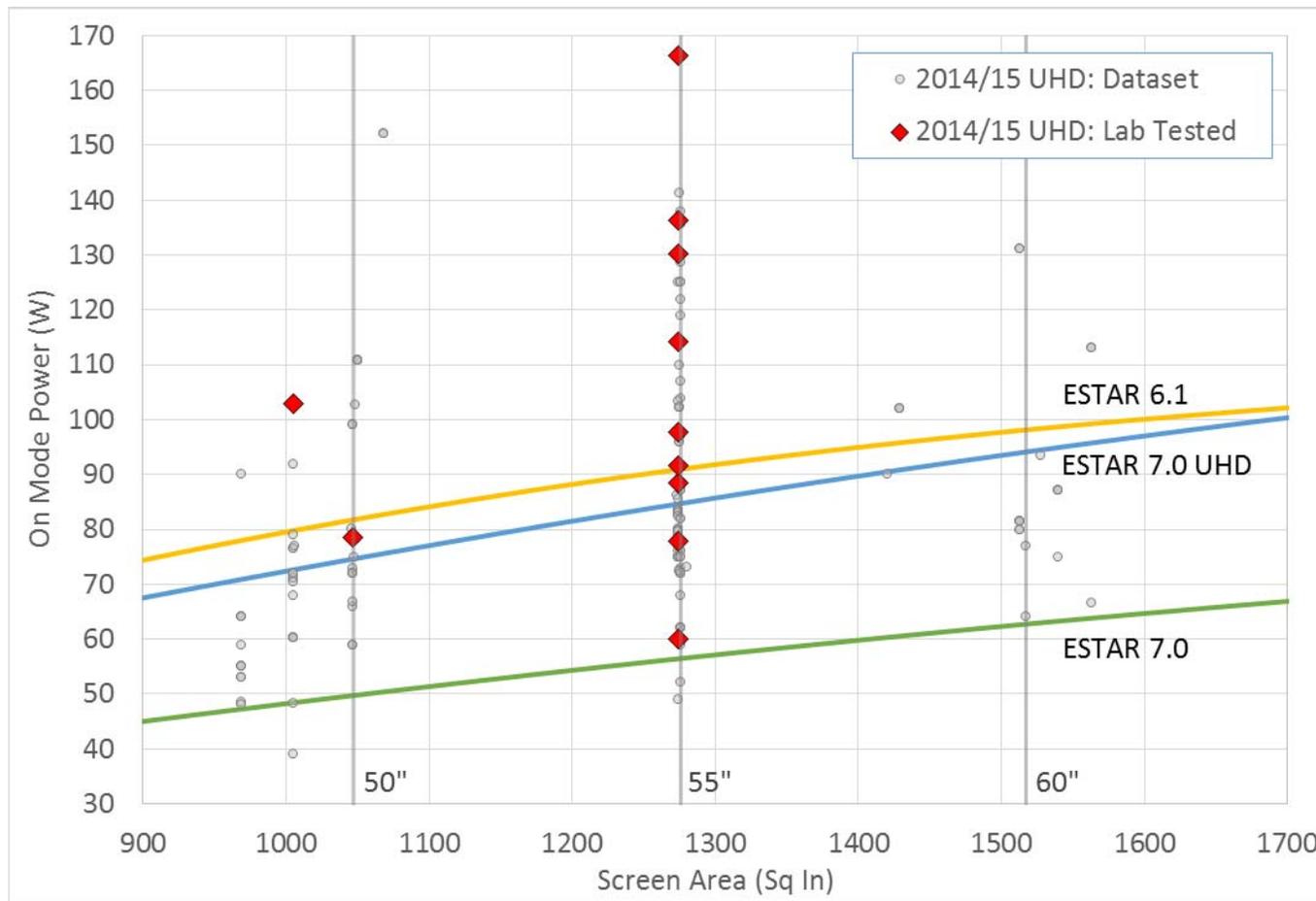
- On behalf of NRDC, Ecos Research tested 10 TVs in a store with ABC off, and 11 in lab with ABC on and off
- Measured on and standby power using calibrated lab equipment
- Tested mostly 55" TVs -- the sweet spot of today's UHD TV market
- Used DOE test method (uses 10 minute DVD test clip from IEC for on mode power)
- Also analyzed public databases of TV on mode power use

Summary of TVs We Tested in the Lab

- Focused on 55 inch TVs; cross section of models, operating systems and price points

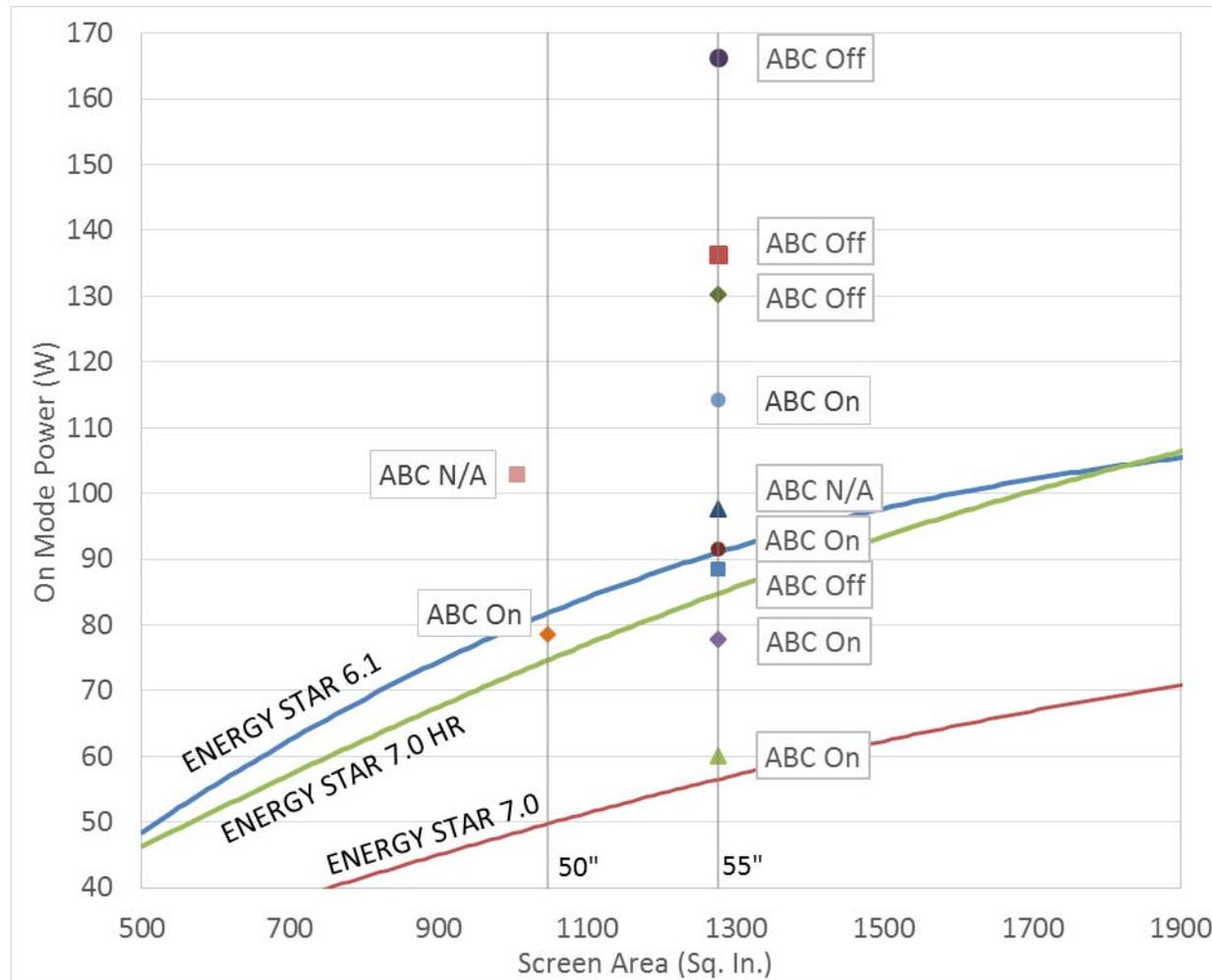
MFG	Manufacturer 1	Manufacturer 2	Manufacturer 2	Manufacturer 3	Manufacturer 4	Manufacturer 4	Manufacturer 5	Manufacturer 6	Manufacturer 7	Manufacturer 8	Manufacturer 8
Year	2015	2015	2015	2015	2015	2015	2015	2015	2015	2015	2014
Screen Size	49.5	54.6	54.6	54.6	54.6	54.6	48.5	54.6	54.6	55	54.64
Verital Resolution	2160	2160	2160	2160	2160	2160	2160	2160	2160	2160	2160
Price (Amazon)	\$598	\$5,499	\$1,399	\$2,999	\$2,497	\$1,597	\$520	\$999	\$1,599	\$999	\$999
Backlight	LED Edge Lit	N/A	LED Edge Lit	LED Full Array	LED Edge Lit	LED Full Array	LED Full Array				
Panel Technology	-----	OLED	IPS	-----	Quantum Dot	-----	-----	-----	Quantum Dot	-----	IPS
Processor	-----	Quad-core	Quad-core	Quad-core	Octa-core	Quad-core	-----	Quad-core	-----	Dual-core CPU	Dual-core CPU
OS	Opera	webOS	webOS	Firefox OS	Tizen	Tizen	Proprietary	SmartCentral	Android TV	Proprietary	Proprietary
Voice Interaction	No	Yes	Yes	Yes	Yes	Yes	No	No	Yes	No	No
ABC Sensor	Yes	Yes	Yes	Yes	Yes	Yes	No	No	Yes	Yes	Yes
Quickstart Option	No	No	No	No	Yes	Yes	No	Yes	No	No	No
On Mode Power (ABC On) Measured Value (watts)	78.62	108.67	48.26	114.14	77.79	60.08	N/A	N/A	91.57	67.66	107.42
On Mode Power (ABC Off) Measured Value (watts)	94.64	136.32	88.47	152.00	125.00	99.94	97.12	97.71	107.57	130.25	166.32

UHD TVs spanned a wide range of efficiency levels: On-mode power use of lab-tested models varied by >2.5x.



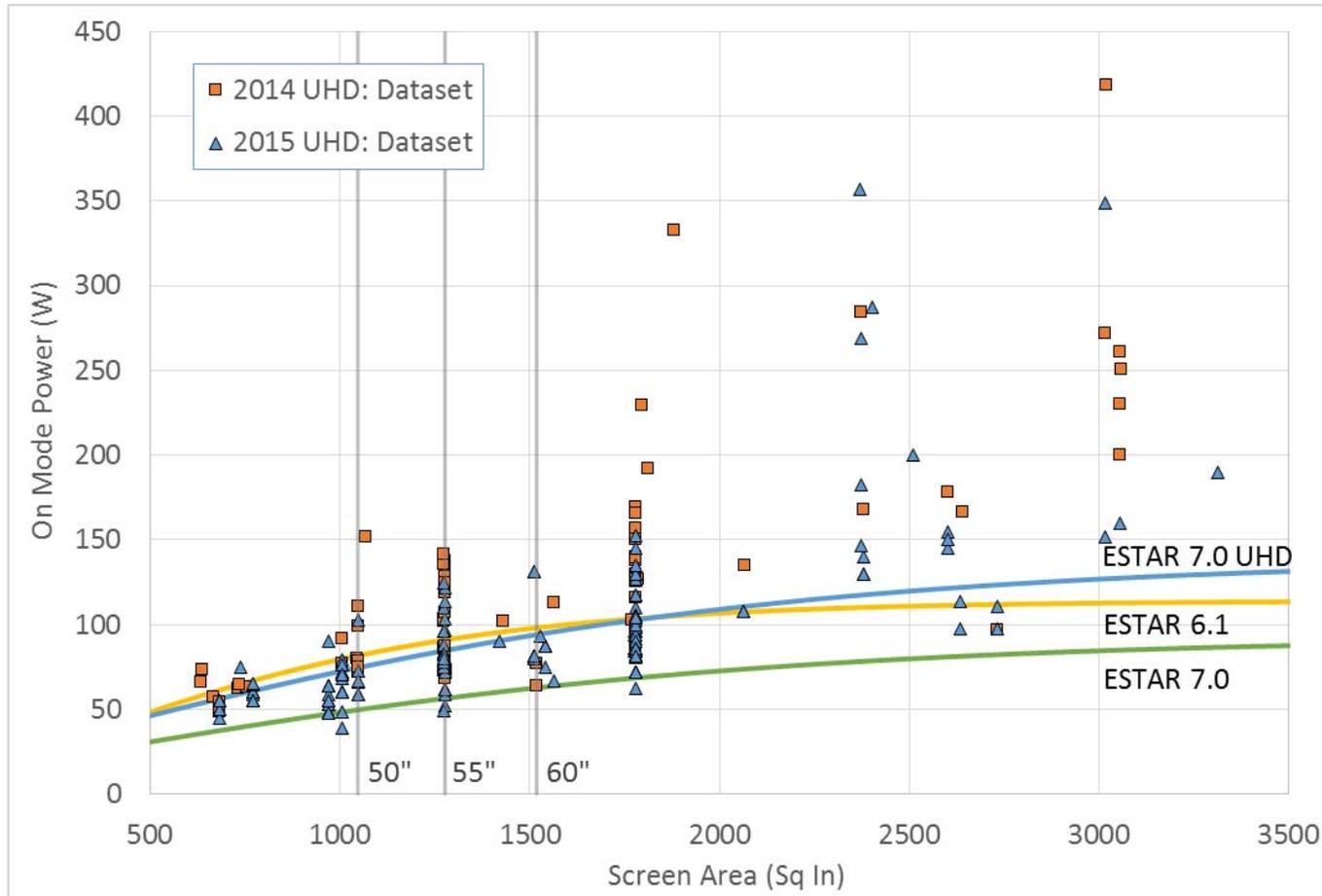
- Parameters:
- EPA, CEC, DOE data from July 2015
 - Duplicates removed when possible
 - All brands and sizes

Spread of UHD On Mode Power Levels for Models We Tested and Comparison to ENERGY STAR



- Parameters:
- Lab Testing (DOE final rule)
 - ABC configured per the DOE test method

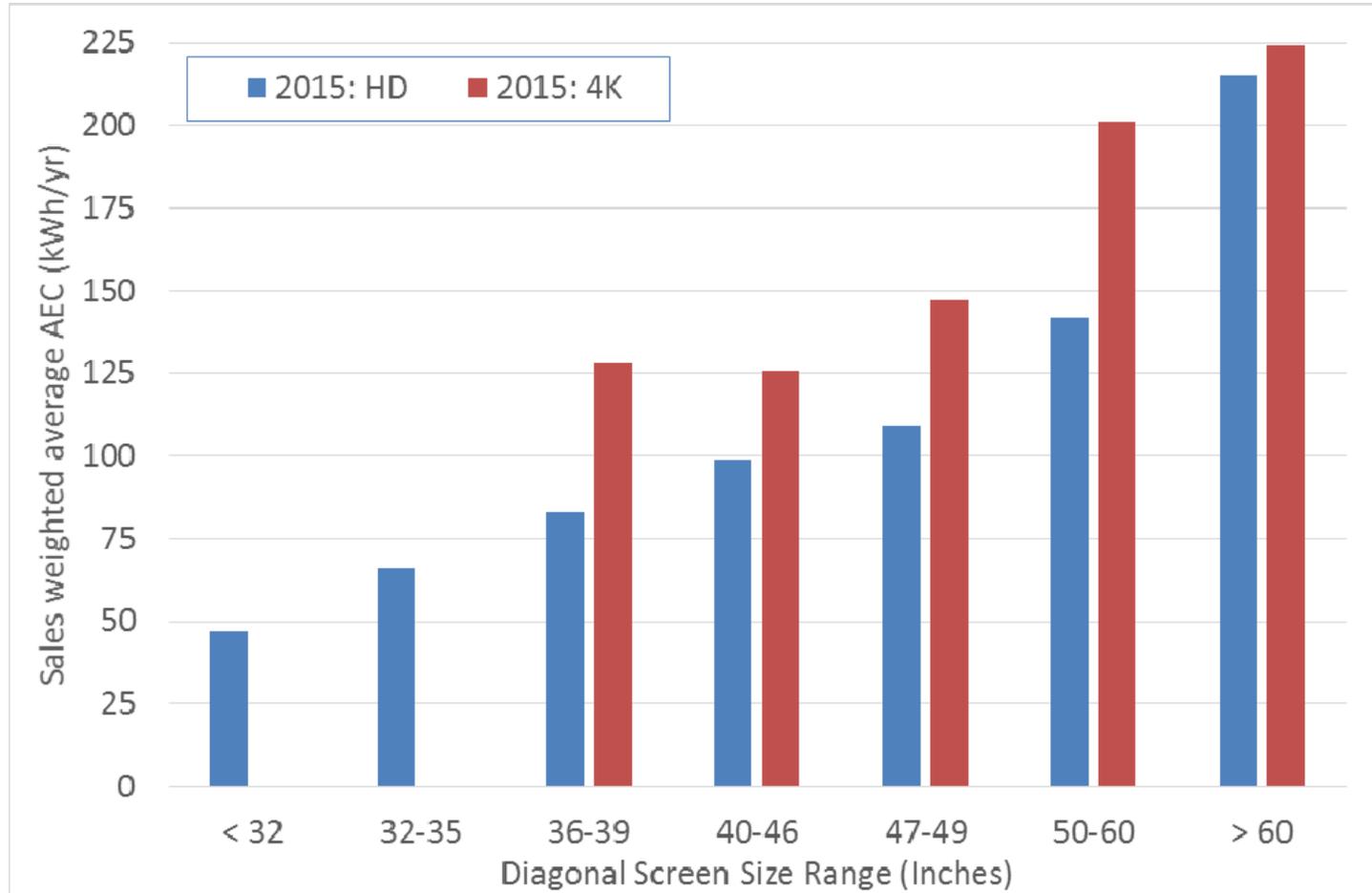
Past 60", reported UHD power use rises rapidly for least efficient models (275W @ 5 hours/day → 500 kWh/yr.)



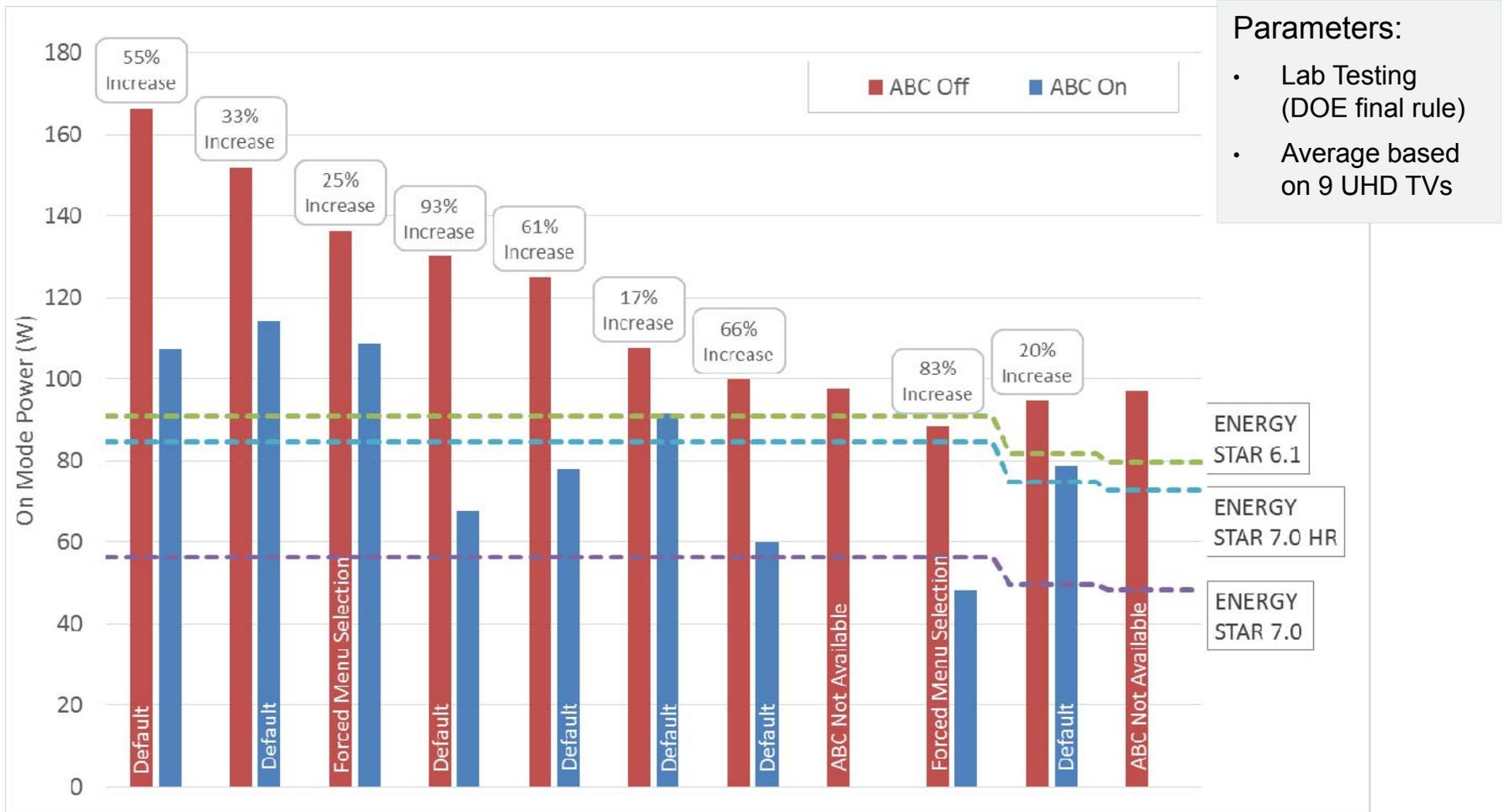
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Energy impact HD → 4K is around 30%

“Developed by Energy Solutions on behalf of NEEA using the NPD Group/Retail Tracking Service”

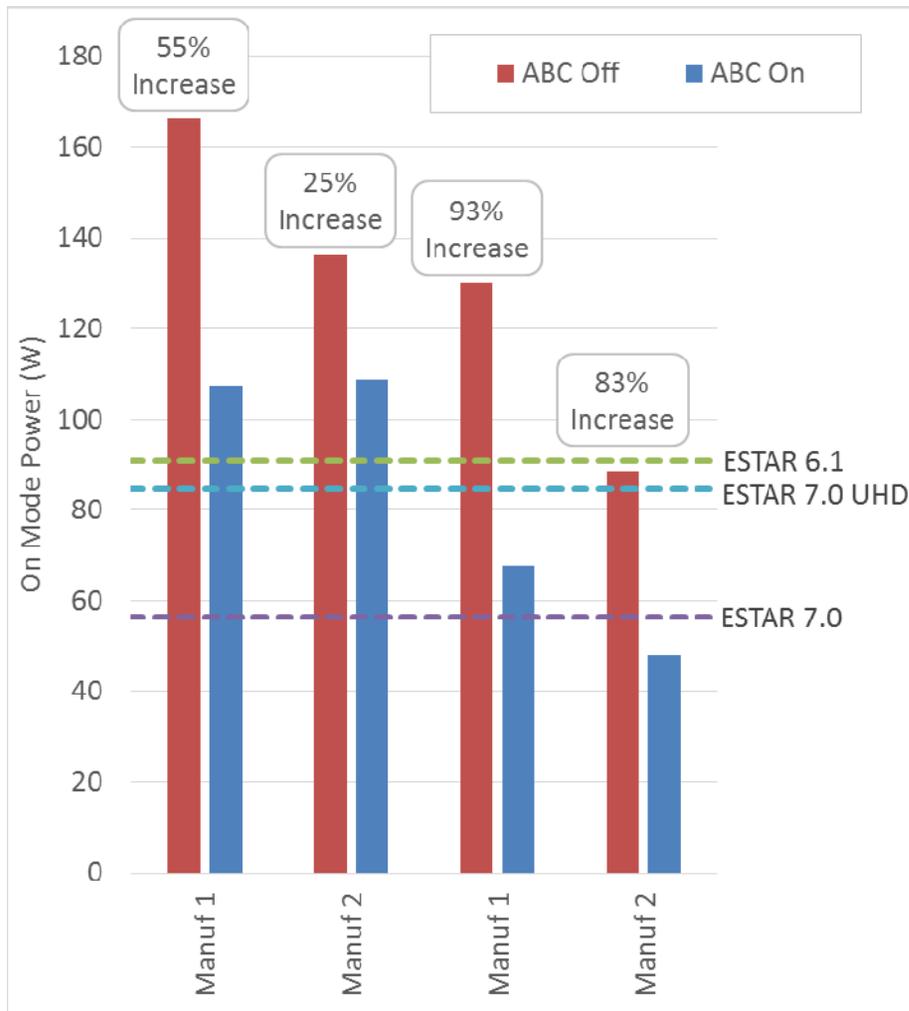


On average, 50-55" sized 4K TVs we tested use 50% more power with ABC off



UHDs average 64% more power use with ABC off for these two manufacturers

(“Manufacturers should ship TVs defaulted to **ABC On** and help consumers save a lot of energy”)



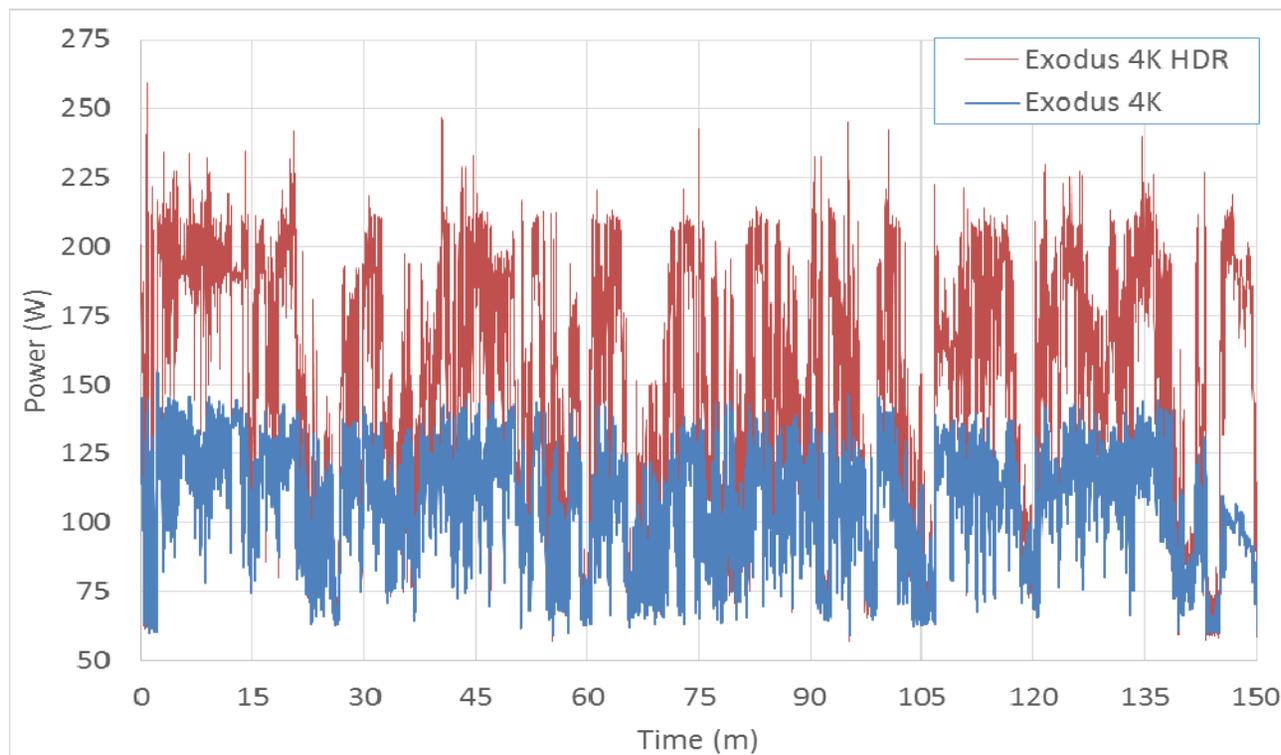
- DOE method requires these 4 TVs to be tested with ABC off
 - Manuf 1: ABC defaults to off
 - Manuf 2: ABC choice is presented in forced menu

Parameters:

- Lab Testing
- Average based on 4 2015 UHD models

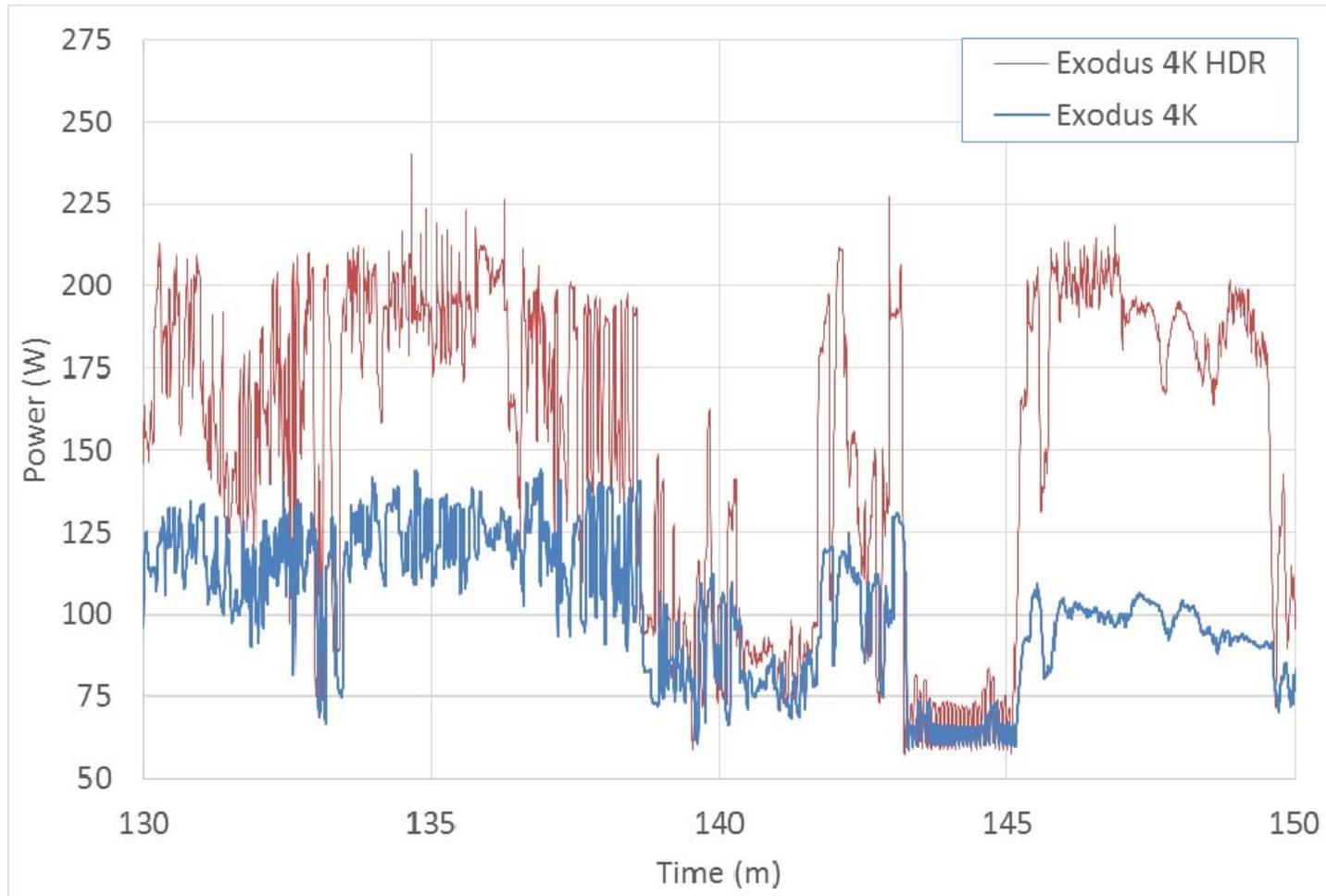
Results of Testing with Native HDR Content on a 2015 HDR-Capable 4K TV

- Exodus HDR uses 40% more power; Maze Runner HDR uses 54% more power. Avg of two films = 47%
 - Exodus: Gods and Kings 4K: 106.9W, 4K HDR: 149.4W;
 - Maze Runner 4K: 94.2W, 4K HDR: 145.4W



HDR Results- time slice of Exodus: Gods and Kings

Note: when you measure really matters; power Δ is smaller in dark scenes



Smart TV: Start Time and Standby Power Testing – some brands are nailing it and others not even close

- Tested TVs with Quick Start Off and On
- Found two of the biggest manufs provide very low standby power (<0.3W) and quick reboot times (5 -10 seconds)
- 3rd manuf – also low standby power (0.2W) but slightly longer reboot time (15 seconds) and no quick start option
- ***Two other manufs have very high standby power levels (see next few slides)***

Long start times for some brands could lead users to select higher power Quick Start mode

- Leading brands have effective standby implementations
- Other brands are getting better

Year	4K Model	OS	Quick start Off		Quick start On	
			Standby Power (W)	Boot Time (s)	Standby Power (W)	Boot Time (s)
2015	Model 1	Opera	0.26	13.30	N/A	N/A
2014	Model 2	webOS	0.10	9.0	N/A	N/A
2015	Model 3	webOS	0.13	9.7	N/A	N/A
2015	Model 4	webOS	0.17	6.7	N/A	N/A
2015	Model 5	Firefox	0.24	8.38	N/A	N/A
2015	Model 6	Tizen	0.15	6.4	0.24	5.4
2015	Model 7	Tizen	0.07	6.2	0.20	4.5
2015	Model 8	Tizen	0.11	6.9	0.22	5.1
2015	Model 9	Tizen	0.18	6.6	0.28	5.0
2015	Model 10	Tizen	0.07	6.1	0.20	4.7
2015	Model 11	Proprietary	0.25	16.10	N/A	N/A
2014	Model 12	Proprietary	0.16	19.5	25.21	8.9
2015	Model 13	Proprietary	0.25	17.9	9.03	5.7
2014	Model 14	Proprietary	0.09	12.5	34.42(**)	5.6
2014	Model 15	Proprietary	0.02	11.0	37.54(**)	4.0
2015	Model 16	Android TV	0.29/22.1(*)	8.2	N/A	N/A
2015	Model 17	Proprietary	0.20	15.3	N/A	N/A
2014	Model 18	Proprietary	0.20	15.7	N/A	N/A

Parameters:

- Lab & Retail test results
- Default values shaded in light blue
- N/A indicates Quick Start feature not available
- LAN not WAN connection

64% less QS standby power than 2014 model

Manuf eliminated QS in 2015

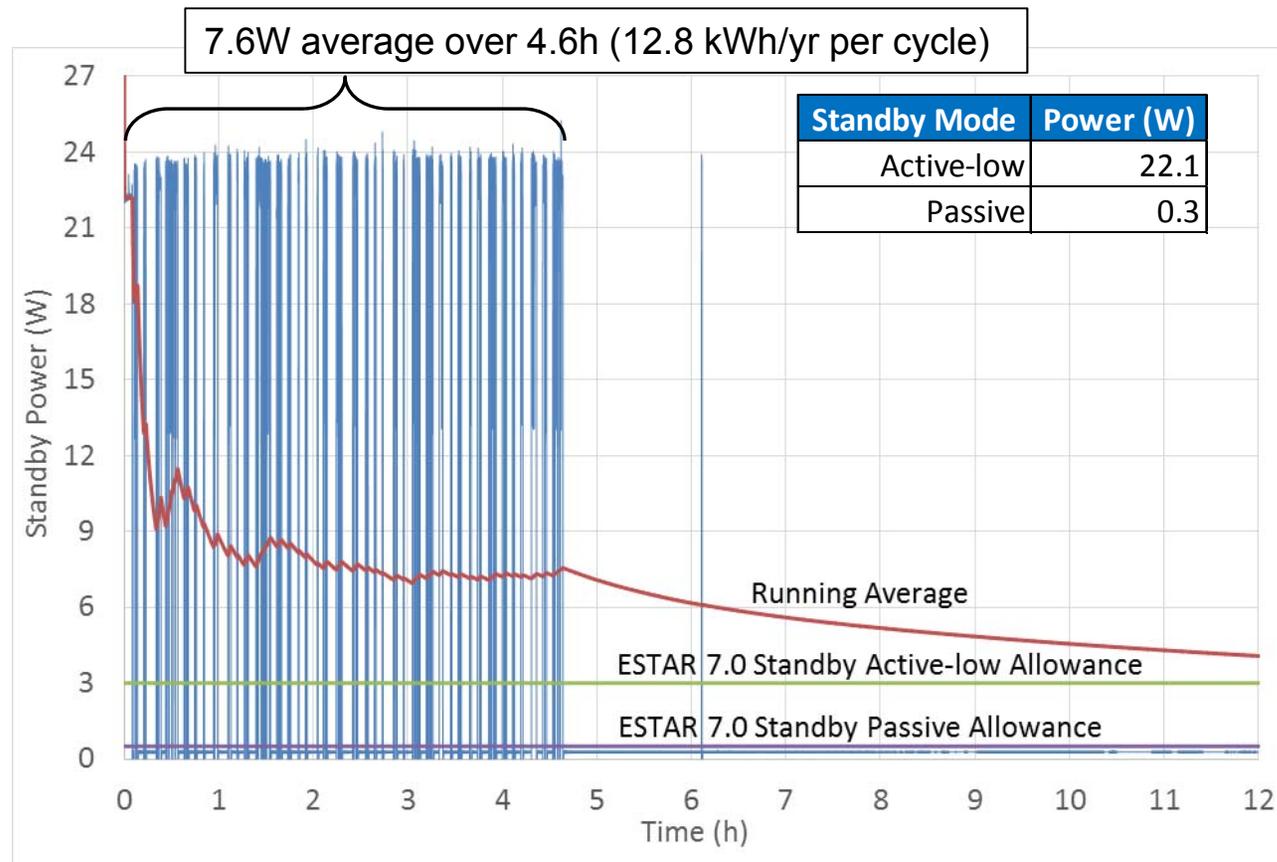
(*) Fluctuates between Standby passive (0.29W) and active-low (22.1W)

(**) Programmable quick start up to 6 hours per day or auto settings

A 2015 Model with Android OS draws a lot of power intermittently after each time you switch it off

Is this a problem with all Android TVs? Could have large energy consequence

- The fluctuation between standby active-low and passive modes creates challenges for DOE testing and ESTAR certification



Parameters:

- Lab Test

Definitions:

- Standby Active-low: Device is discoverable on the network
- Standby Passive: Device is not discoverable on the network

Main Findings

1. Main TV screen size increasing dramatically. 50 inches and above now almost a third of the market.
2. Big spread in On mode power use for 4K TVs. Can be 2.5x or greater.
3. 4K TVs used around 30% more energy use than HD TVs.
4. ABC can have a big difference in TV power use. Encourage all manufacturers to ship it enabled.
5. HDR – only tested one TV but had a 47% increase over 4K. More testing needed. Could have HUGE impact on future national energy use.
6. Test method needs to be updated – new test clips, clarify standby power, etc.

NRDC's Recommendations

Consumers	TV Manufacturers/Industry	Policy Makers/Government
<ul style="list-style-type: none"> Buy ESTAR qualified models; Rely on FTC ENERGY GUIDE label 	<ul style="list-style-type: none"> Optimize 4K TVs for energy efficiency Ship TVs with ABC enabled 	<ul style="list-style-type: none"> Update test method – include 4K and HDR content; revise standby testing for internet connected TVs
<ul style="list-style-type: none"> Make sure Automatic Brightness Control (ABC) is on 	<ul style="list-style-type: none"> Get ahead of HDR – develop consensus test clip, perform testing and bring down energy use 	<ul style="list-style-type: none"> EPA - Reduce size of 4K/UHD adder in next revision of ENERGY STAR specification Utilities offer rebates for most efficient models
<ul style="list-style-type: none"> Avoid Quick Start if you can 	<ul style="list-style-type: none"> Limit growth in standby power as new Apps/features are added 	<ul style="list-style-type: none"> Consider mandatory standards at the state or federal level to remove the least efficient models on the market

Acknowledgements

- Ecos Research (David Cadier, Chris Calwell and Gregg Hardy) for their excellent testing and analysis work;
- Northwest Energy Efficiency Alliance and Energy Solutions – for collaborating on market share analysis
- US Environmental Protection Agency – for providing grant funding for this research
- **Note: The findings of this work are solely those of the authors and do not state or reflect those of the EPA**

Test Method Improvements needed

- Create and use updated test clip that includes HDR and 4K content for measuring On mode power
- Clarify how to test and report average standby power for TVs that fluctuate between standby-active low and standby passive. Perhaps expand test to 24 hour period, not just when TV appears to stabilize
- Assess need to test with WAN connection