



ENERGY STAR®
Televisions
Draft 1 Specification Webinar
September 30, 2020

ENERGY STAR Products Labeling Program



Webinar Details

- Webinar slides and related materials will be available on the Television Product Development Web page:
 - www.energystar.gov/RevisedSpecs
 - *Follow link to "Version 9.0 is in Development" under "Televisions"*
- **To Use Computer Audio:**
 - Participants can use their computer mic & speakers (VoIP)
- **To Use Telephone:**
 - If you prefer to use your phone, you must select "Use Telephone" after joining the webinar and call in using the number and access code below:

Call in: +1 (562) 247-8421 (U.S.)

Access Code: 154-876-422

Webinar ID: 613-246-795



Webinar Agenda

- Introductions
- Goals for Revision
- Draft 1 Specification
 - Dynamic Luminance and the Camera-Based Testing Approach
 - On Mode Power Requirements
 - Methodology for Criteria
 - Standby Mode Requirements
 - Additional Standby Testing
 - Standby Testing with Smart Speakers
- Open Discussion
- Timeline and Conclusion



Introductions

Time	Topic
1:00-1:05	Introductions
1:05-1:15	Goals for Revision
1:15-3:15	Draft 1 Specification
	Dynamic Luminance and the Camera-Based Testing Approach
	On Mode Power Requirements
	Additional Standby Testing and Criteria
3:15-3:30	Timeline and Conclusion



Introductions

James Kwon

U.S. Environmental Protection Agency

Emmy Feldman

ICF

Cody Niblett

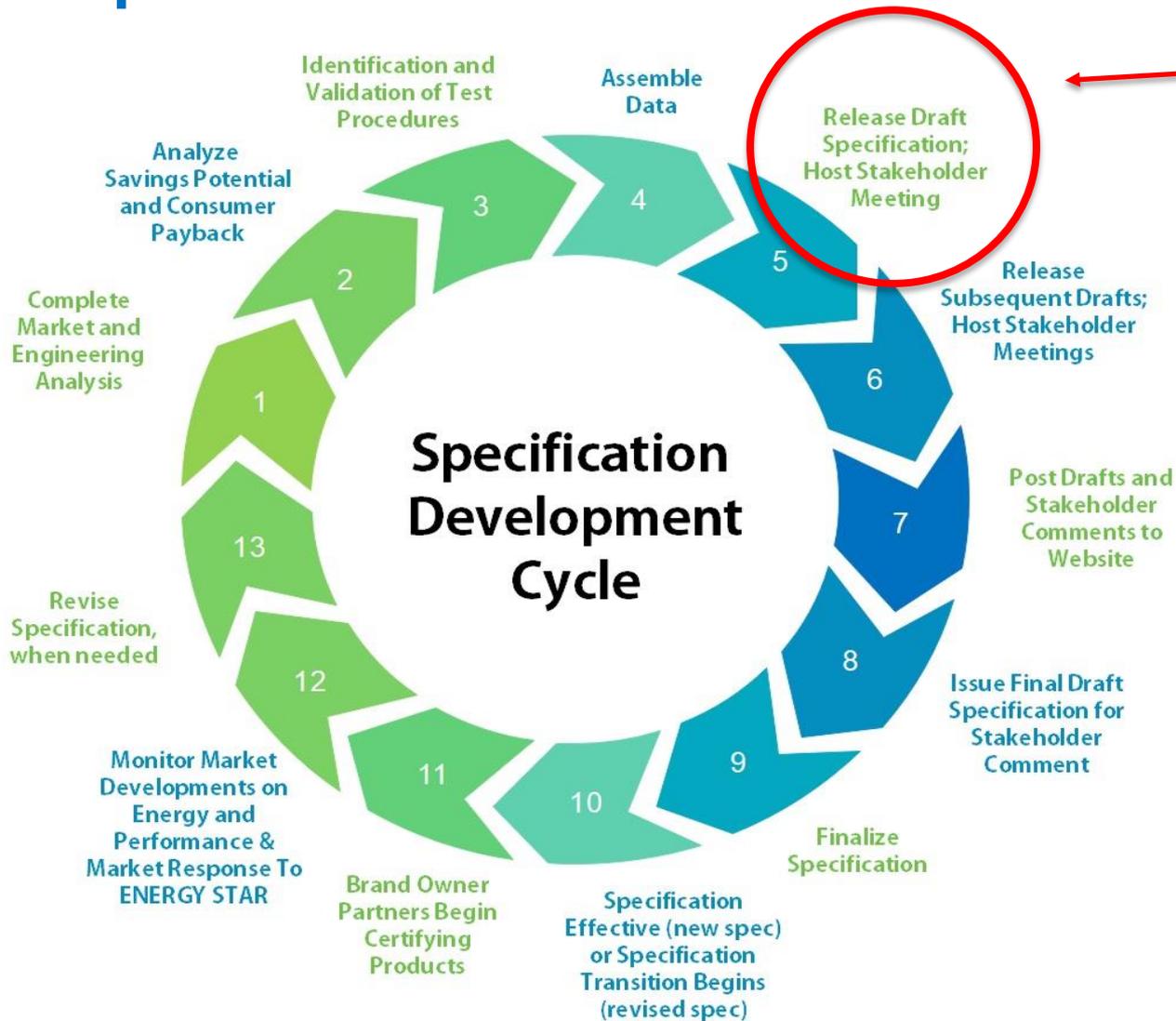
ICF

Gregg Hardy

Pacific Crest Labs



Next Steps



We are here





Efforts Leading to Draft 1 Release

Effort	Description
<i>Industry Research</i>	<i>Studied the current state of television technology and consumer attitudes toward such to understand how an updated specification can promote the implementation of energy efficient designs.</i>
<i>Dataset Analysis</i>	<i>Analyzed datasets of contemporary TV models to reveal the relationships between employed technologies and power consumption.</i>
<i>Test Method Development</i>	<i>Began development of a test method that enables data to be collected that better represents how a TV is commonly used by consumers.</i>
<i>Criteria Development</i>	<i>Developed initial criteria to evaluate TVs based on their capacity to efficiently produce light as opposed to limits based purely on power consumed per area of screen.</i>



Goals for Revision

Time	Topic
1:00-1:05	Introductions
1:05-1:15	Goals for Revision
1:15-3:15	Draft 1 Specification
	Dynamic Luminance and the Camera-Based Testing Approach
	On Mode Power Requirements
	Additional Standby Testing and Criteria
3:15-3:30	Timeline and Conclusion



Goals for Version 9.0

1. Ensure energy savings and deliver a positive viewing experience for consumers.
2. Utilize power metrics that are representative of how televisions are used by consumers.
3. Establish performance-based criteria to encourage more efficient product design through adoption of efficient design/components.
4. Reflect the impacts of fundamental characteristics, such as screen resolution and contrast ratio, and auxiliary capabilities, such as control via a smart speaker, on power consumption.



Proposed Priority Areas for Version 9.0

- More specifically, EPA has included the following in the Draft 1 Specification to achieve these goals:
 1. Metrics that encourage the efficient production of light as opposed to rewarding dim settings;
 2. A newly developed test procedure to measure average screen luminance with a camera during dynamic video play;
 3. On Mode testing with Automatic Brightness Control and Motion Detection Dimming disabled;
 4. The requirement to test in multiple preset picture settings; and
 5. Additional testing procedures to gain information about the effects of maintaining auxiliary connections on Standby Mode power consumption.



The Camera-Based Testing Approach

Time	Topic
1:00-1:05	Introductions
1:05-1:15	Goals for Revision
1:15-3:15	Draft 1 Specification
	Dynamic Luminance and the Camera-Based Testing Approach
	On Mode Power Requirements
	Additional Standby Testing and Criteria
3:15-3:30	Timeline and Conclusion



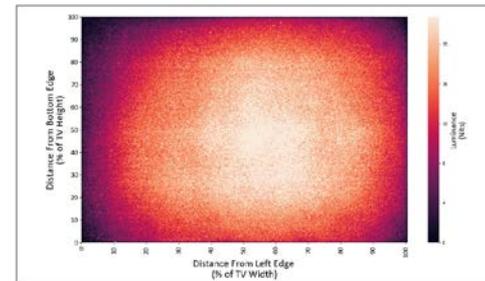
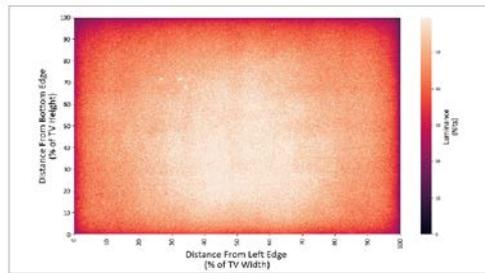
A New Metric to Put Performance in Perspective

- Previous ENERGY STAR TV specifications inadvertently incentivized TVs to dim for compliance with On Mode power requirements based on screen size.
- Version 9.0 incorporates the light produced by the TV during video play into the On Mode power requirements, in addition to screen size.
 - This eliminates the need for minimum luminance requirements.
- EPA proposes the term **Dynamic Luminance** and the definition below for use in the On Mode power requirements:

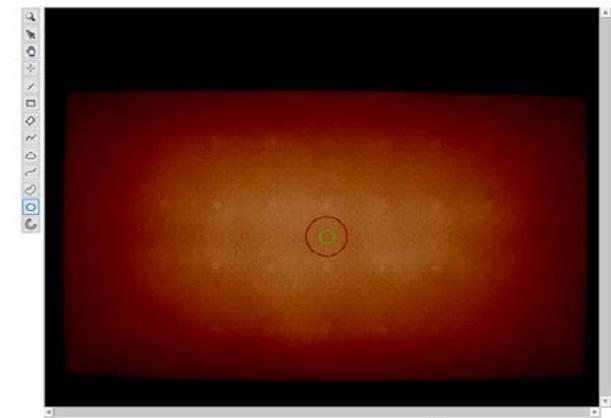
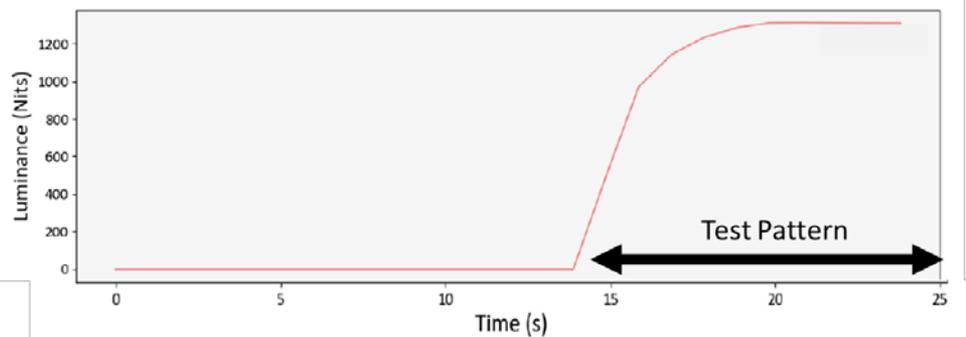
Dynamic Luminance: The luminance averaged across the entire screen area as measured during dynamic video play.

Dynamic Luminance

- Dynamic Luminance value tends to be 10-20% of 3-bar luminance value depending on how evenly light appears to be distributed from the viewer (camera) perspective.



- Two TVs can have the same 3-bar luminance measurement and one can have twice the screen average luminance value (e.g. the TV on the left), not counting inaccuracies that can result from LED matrix local bright spots (below right) and temporal issues associated with test patterns (below left).



New Dynamic Luminance Measurement Reduces Error

- Previous method can have spatial and temporal errors that sum to $\gg \pm 100\%$.
 - Furthermore, when measuring the luminance of an LED TV with a luminance meter that meets IEC accuracy requirements (2% against incandescent Illuminant A), we saw errors as high as 9% compared to a spectroradiometer.
- The proposed camera approach has spatial error $< 1\%$ and no temporal error, and we are calibrating the camera against every TV using a spectroradiometer (or luminance meter with close filter match to luminosity function $[f_1']$), which ensures $< 2\%$ filter mismatch error.
- Overall, the camera photometer approach measures the screen-average, dynamic luminance experienced by a typical viewer with about 5 or 6% error, factoring in the 2% advertised accuracy of the spectroradiometer.





Measuring Dynamic Luminance with a Camera Photometer

- EPA will post the NEEA methodology for measuring TV screen-average dynamic luminance with a camera photometer document on the ENERGY STAR V9.0 TVs webpage
- This documents the rationale behind the camera photometer technical approach and puts the accuracy of this approach in context with the current test method

NEEA Method for Measuring TV Screen-Average Dynamic Luminance with a Camera Photometer

August 26, 2020

Pacific Crest Labs on behalf of Northwest Energy Efficiency Alliance (NEEA) with support from Dynamic Motion Control (DMC) and VideoQ.

Contents

Introduction	2
Background	2
CIE 1931 luminosity function.....	2
<i>f</i> 1' against Illuminant A	4
Spectral mismatch against TV light	4
Camera System.....	6
Camera and Lens	6
Basler acA720-290gm Camera	7
Basler C125-0618-5M F1.8 f6mm Lens.....	7
Using Cameras to Measure Luminance	8
Camera Exposure Settings.....	8
Camera Filters	9
B+W 43/47mm XS-Pro MRC-Nano 806 ND 1.8 Filter (6-Stop).....	9
Omega 558BP100 38mm photopic filter	10
Camera Calibration.....	11
Initial/Annual Calibration	11
Aperture Setting.....	11
Vignette Effect Correction (Flat Field Correction)	11
Black Level and Dark Field Correction	14
Per-TV Image Processing and Correction Factors.....	15
Screen Detection	15
Distortion and Perspective Calibration.....	16
TV Light Calibration	17
Error Analysis.....	18
Overview	18





Camera Approach – Validation in Progress

- Working to mitigate the impact of TV stability by taking spectroradiometer calibration readings concurrently with Basler.
- Opening camera aperture to allow 2:1 ratio of Basler signal level to cd/m^2 . This improves camera accuracy at low light levels.
- Tentatively planning to move cameras back to about 2x screen diagonal based on early manufacturer feedback. This will require new lenses.
- Plan to finish camera validation, shift to new lens and test 50 TVs by end of November



On Mode Requirements

Time	Topic
1:00-1:05	Introductions
1:05-1:15	Goals for Revision
1:15-3:15	Draft 1 Specification
	Dynamic Luminance and the Camera-Based Testing Approach
	On Mode Power Requirements
	Additional Standby Testing and Criteria
3:15-3:30	Timeline and Conclusion

Factors Influencing Energy Efficiency

TVs available today have a wide range of features and configurations that affect how efficiently they operate. Version 9.0 aims to account for value-added features whose base technology innately requires more energy, and influence TV design to encourage the use of more efficient components.

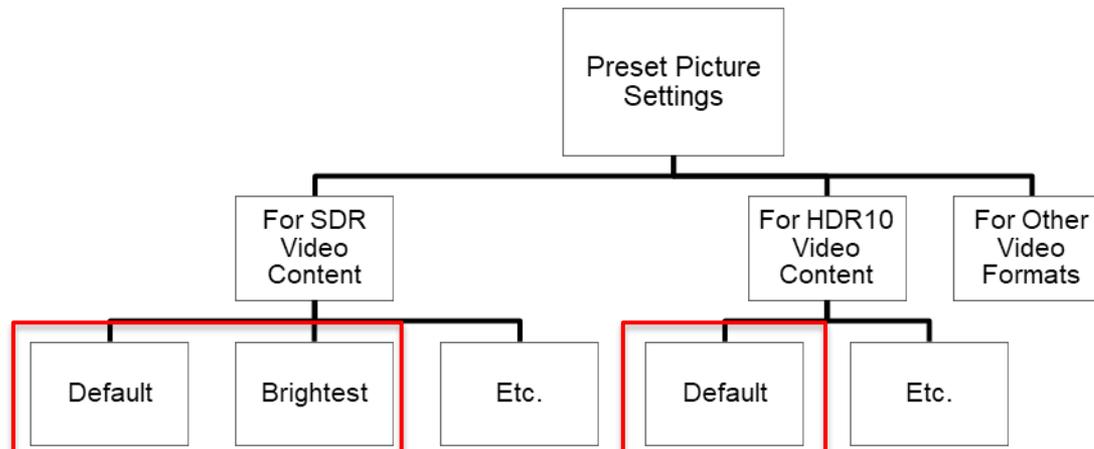


Testing Multiple Preset Picture Settings (PPSs)

- Each PPS is programmed to provide the viewer a configuration of settings ideal for a specified type of viewing, which most often involves a change in brightness.

Research indicates that a majority of devices are left in either their default setting or have been put into their brightest setting.

- Version 9.0 requires the testing of both of these PPSs, and the default PPS for playing HDR content, to capture metrics on how a TV performs under the most commonly employed configurations.





Television Configuration During Testing

EPA proposes that TVs be configured as follows while performing tests as outlined in Version 9.0:

- Unless otherwise specified, as indicated in the Federal Test Procedure (Uniform Test Method for Measuring the Energy Consumption of Television Sets incorporated in Appendix H to Subpart B of 10 CFR Part 430);
- Programmed with the most up-to-date software available; and
- With Automatic Brightness Control (ABC) and Motion Detection Dimming (MDD) disabled.

EPA is following the progress of IEC MT62087 (which is updating the ABC test method) and will reevaluate whether to incorporate criteria regarding ABC into future revisions once data is available.

On Mode Power Requirements

Version 8.0

The On Mode Power requirement is based on the relationship between screen area and power consumption, with an allowance for models with a suitably high resolution.



Version 9.0

On Mode Power requirements factor the light created by the TV (measured Dynamic Luminance) into the equation. This creates a performance-based efficiency limit based on the idea that a TV's fundamental purpose is to provide a high-quality light viewing experience, eliminating the need for minimum luminance requirements.



Screen Resolution/Technology Considerations

- In Version 9.0, EPA proposes offering criteria for HD, 4K, and 8K models
 - 93 UHD LED and 11 High Contrast Ratio (HCR) models tested by NEEA were used to establish the V9.0 specification criteria and HCR allowance
 - A HD adjustment was established by comparing HD vs. UHD models in the CEC database
 - An 8K adjustment was similarly established by comparing 8K vs. UHD models in the CEC database
- In Version 9.0, EPA proposes offering criteria specific to HCR models based on NEEA test results since HCR TVs offer a high contrast ratio and unique viewing experience*

*<https://www.rtings.com/tv/tests/picture-quality/contrast-ratio>



On Mode Power Requirements for Multiple PPSs

- Version 9.0 requires that all TVs meet distinct On Mode Power Requirements for the 3 tested PPSs.
- The On Mode Power Requirement Equation for each PPS follows the same structure:

$$P_{OA} \leq P_{OA_MAX} \times AF$$

Where:

- P_{OA} is the On Mode Power measured for the Preset Picture Setting, in watts;
- P_{OA_MAX} is the maximum On Mode Power for the Preset Picture Setting, in watts; and
- AF is the Adjustment Factor, dependent on the TV/HTD's screen resolution format and contrast ratio



Maximum On Mode Power

$$P_{OA} \leq P_{OA_MAX} \times AF$$

Where:

- P_{OA} is the On Mode Power measured for the Preset Picture Setting, in watts;
- P_{OA_MAX} is the maximum On Mode Power for the Preset Picture Setting, in watts; and
- AF is the Adjustment Factor, dependent on the TV/HTD's screen resolution format and contrast ratio

- The maximum On Mode Power is found through the following two equations for each tested PPS, equaling the value of the lesser result:

Preset Picture Setting	Functions: (P_{OA_MAX} is the lesser of the two limits)	
	Limit 1: Performance-based efficiency limit	Limit 2: Power cap
Default SDR	$1.08 \times ((0.001 \times A + 0.38) \times DL_{\text{Default}} + (0.009 \times A + 18.1))$	$1.1 \times ((0.072 \times A) + 17.14)$
Brightest SDR	$1.08 \times ((0.001 \times A + 0.28) \times DL_{\text{Brightest}} + (0.007 \times A + 17.1))$	$1.1 \times ((0.089 \times A) + 13.65)$
Default HDR10	$1.08 \times ((0.002 \times A + 0.38) \times DL_{\text{HDR10}} + (0.014 \times A + 17.7))$	$1.1 \times ((0.089 \times A) + 10.12)$

- Limit 1 is the foundation of the Version 9.0 approach to incentivize the efficient production of light and Limit 2 acts as a cap to disincentivize overly bright TVs.

Resolution Formats and Power Requirements

- EPA evaluated a dataset of over 90 LED TVs with 4K resolution. Analysis of this and a CEC dataset of HD, 4K, and 8K models provided insight on the relationship between screen resolution and energy consumption.
 - EPA plans to conduct further testing this year to evaluate/validate these proposed adjustment factors.
- Version 9.0 incorporates allowances for On Mode Power based on the perceived increase in power consumption due to resolution:

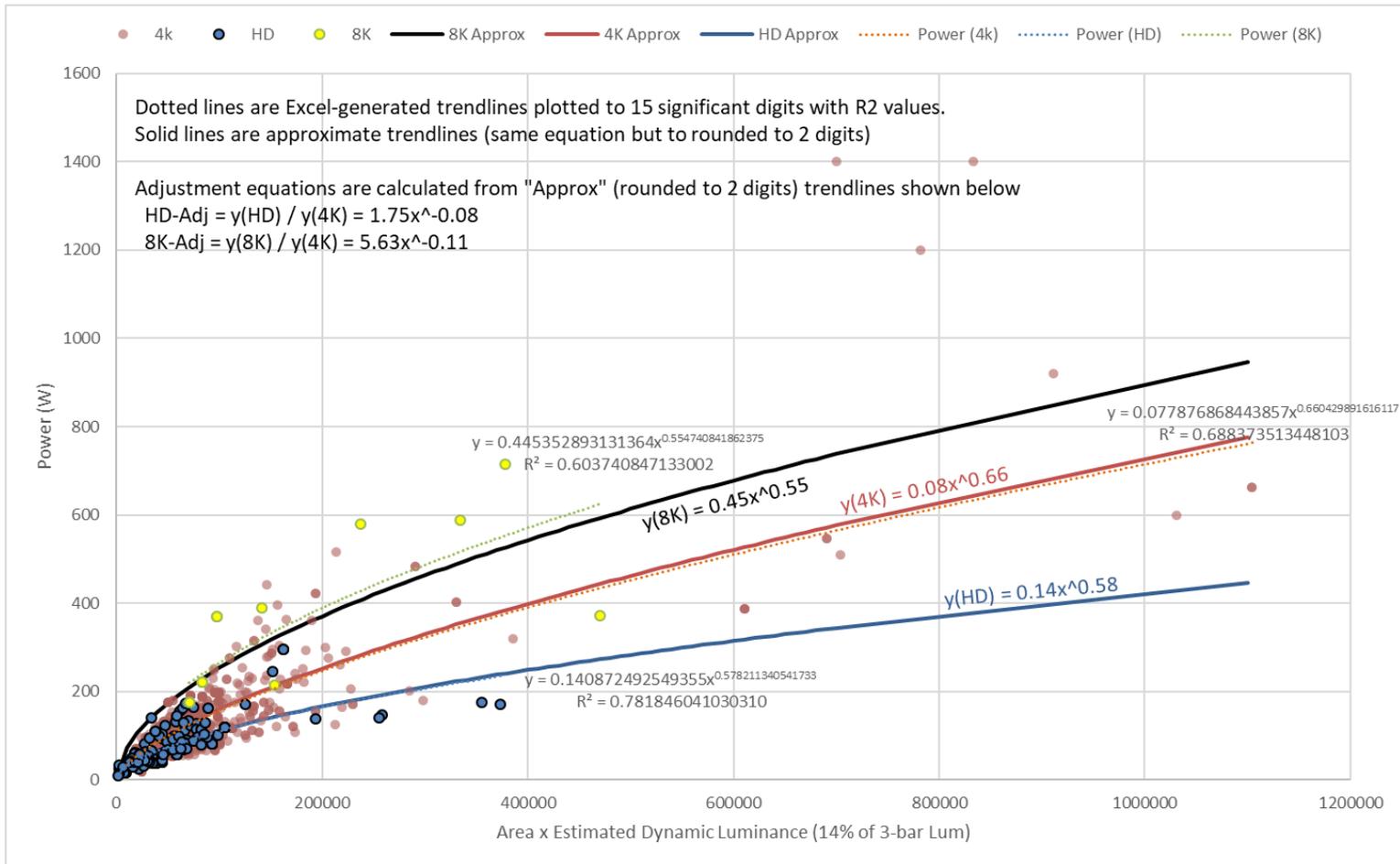
Resolution Formats	P_{OA_MAX} Adjustment Factor (AF)	Value
HD (1920p x 1080p)	HD_Adjustment	$1.75 \times (DL \times A)^{-0.08}$
4K (3840p x 2160p)	4K_Adjustment	1
8K (7680p x 4320p)	8K_Adjustment	$5.63 \times (DL \times A)^{-0.11}$

Where:

- 1) A is the viewable Screen Area of the product in square inches; and
- 2) DL is the Dynamic Luminance measured for the Preset Picture Setting tested.



Resolution Formats – Criteria Adjustments for HD and 8K



Contrast Ratio and Power Requirements

- EPA proposes the following definition of Contrast Ratio:

Contrast Ratio: The contrast ratio is the ratio between the luminance of the brightest white and the darkest black that a TV can produce.

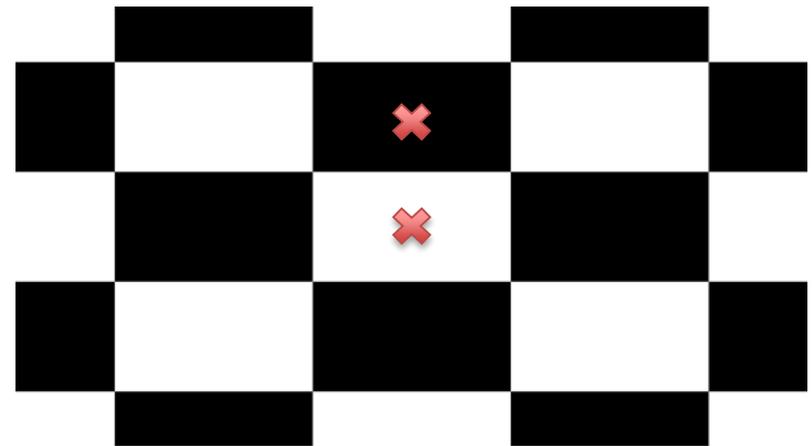
- Through further data analysis, EPA found that models with an extremely high contrast ratio require more power to operate.
 - Because such a contrast ratio is highly desired by consumers, EPA proposes that 4K models with a contrast ratio **greater than or equal to 1,000,000:1** be given an Adjustment Factor as well:

P_{OA_MAX} Adjustment Factor (AF)	Value
4K_HCR_Adjustment	1.25

There are not enough 8K models with HCR capabilities available to consumers from which to assess the need for a separate 8K_HCR Adjustment Factor. EPA seeks information on the requirement for such and insight on any future technological developments that may cause an HCR Adjustment Factor to become unnecessary.

Contrast Ratio Testing

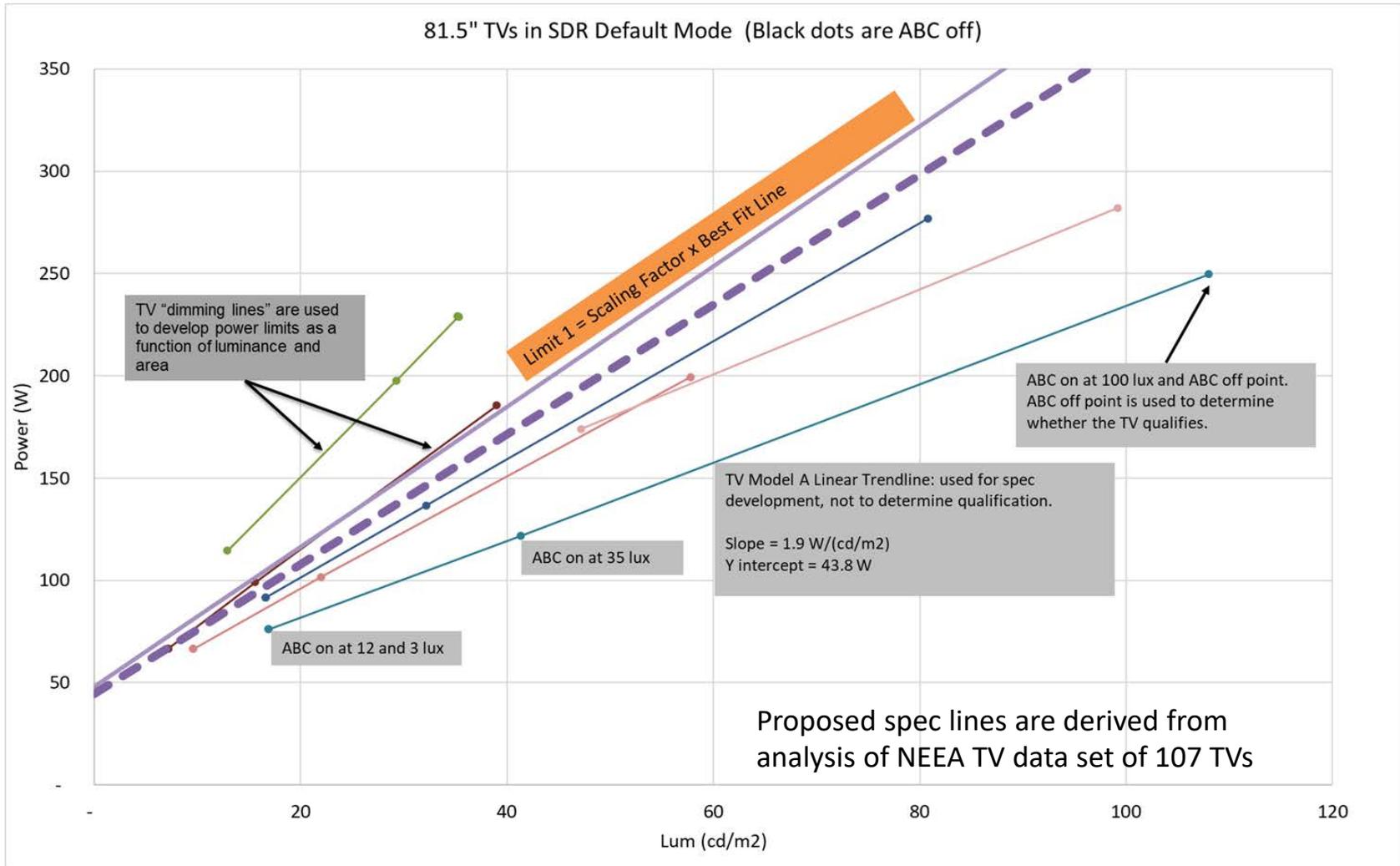
- Version 9.0 proposes to use the testing pattern to the right, obtained from rtings.com with their permission, for contrast ratio testing.
- Contrast ratio testing will be completed with MDD and ABC turned off.
- The calculated contrast ratio is directly related to perceived viewing quality, especially when viewed in dark settings.



$$\textit{Contrast Ratio} = \frac{\textit{Luminance}_{\textit{White}}}{\textit{Luminance}_{\textit{Black}}}$$

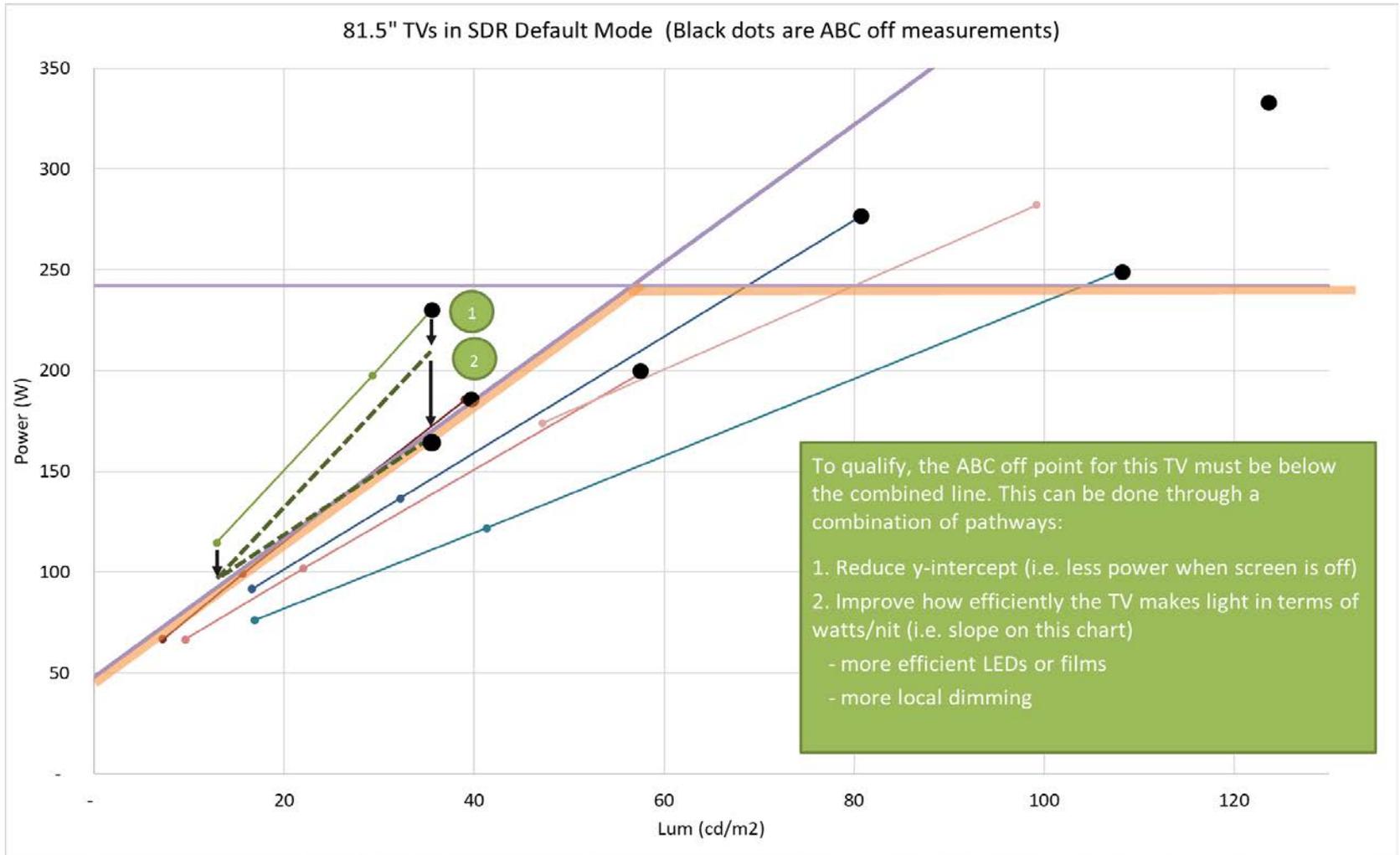


A Performance-Based Efficiency Limit



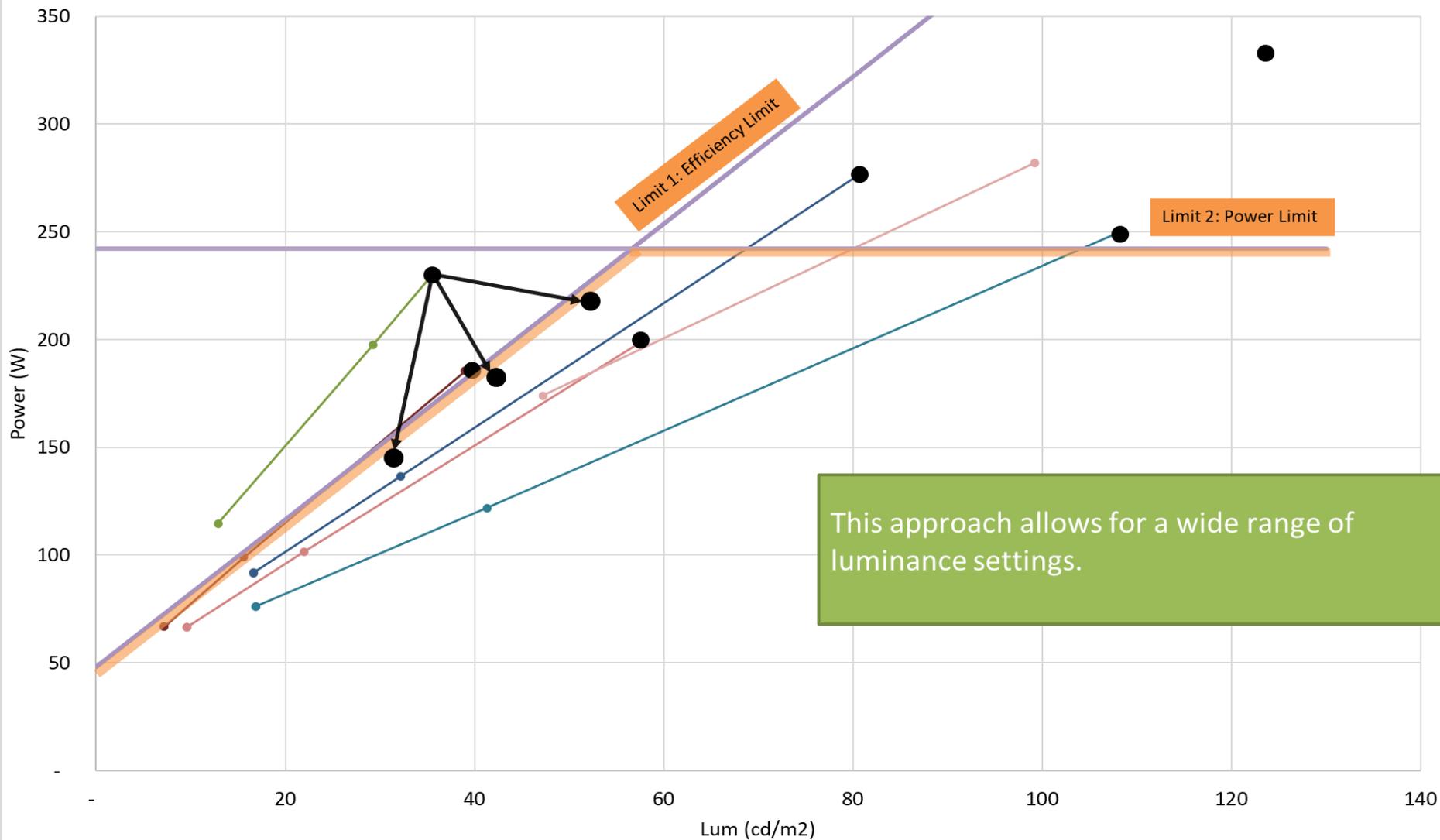


Performance-Based Efficiency Limit allows for Flexibility





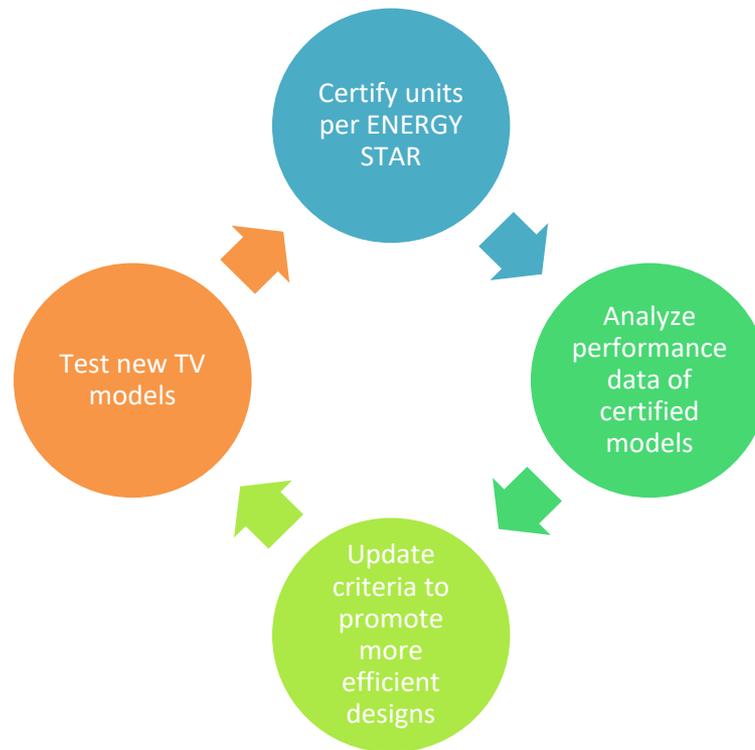
81.5" TVs in SDR Default Mode (Black dots are ABC off measurements)





Performance-Based Efficiency Limit

Setting limits in this way will allow for a more streamline approach to future specification revision – just create new lines with data from certified models.





Standby Testing and Criteria

Time	Topic
1:00-1:05	Introductions
1:05-1:15	Goals for Revision
1:15-3:15	Draft 1 Specification
	Dynamic Luminance and the Camera-Based Testing Approach
	On Mode Power Requirements
	Additional Standby Testing and Criteria
3:15-3:30	Timeline and Conclusion



Standby Mode Requirements

- EPA seeks to continue driving down power consumption of TVs while in Standby Mode, both while TVs maintain a network connection (Active, Low Mode) and not (Passive Mode).



Hierarchy
of Standby
Testing
Procedures

- Version 9.0 includes a 0.5 W limit while in Standby, Passive Mode, as measured per the Federal Test Procedure.
- Additionally, Version 9.0 includes a 2.0 W limit while in Standby, Active-Low Mode, as measured per the Federal Test Procedure *and* the additional testing outlined in the specification.

Currently, the Version 9.0 requires the repetition of all Standby Mode testing be with each of the 3 PPSs applied. However, EPA seeks information about the relationship between PPSs and Standby Mode to understand whether this is necessary.



Additional Standby Mode Testing

Additional tests are prescribed for Standby, Active-Low Mode to:

1. Ensure that all effects on power consumption caused by the most recent software update are captured;
2. Incorporate observed effects of maintaining a network connection (if the device is capable), especially when Multicast DNS requests are present; and
 - The effort to develop a network traffic test environment that is representative and repeatable using a packet generator is ongoing and specifics regarding this test procedure will be available in future drafts.
3. Measure the effect of maintaining connection to a Smart Speaker for control (if the device is capable).



Additional Standby Mode Testing

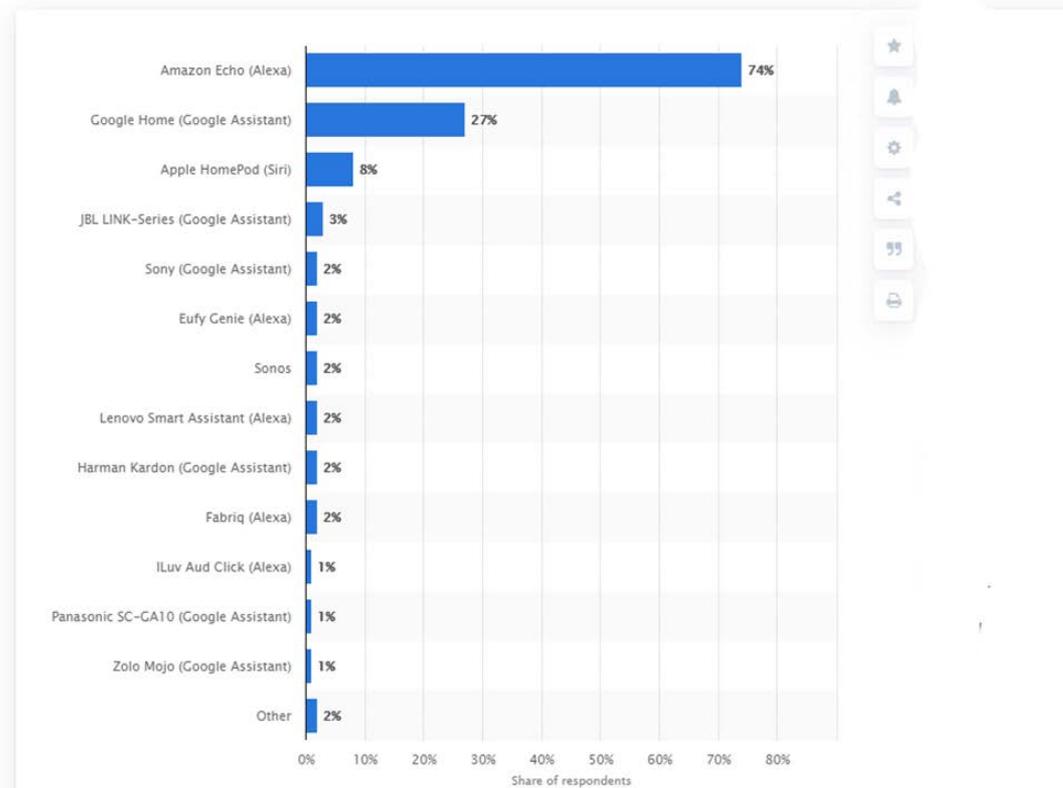
- Additional standby-active, low power and wake-time measurements shall be conducted in the SDR Default Preset Picture Setting configuration with updated software and active LAN and WAN connections, and then repeated in the SDR Brightest and Default HDR10 Preset Picture Settings.
- EPA has observed that some TVs use significantly more power (e.g. > 10 watts) in standby-active, low when Multicast DNS requests are present on the network.
 - These are packets broadcast by an application (e.g. Spotify, YouTube) on one device (e.g. iPhone) requesting identification (i.e. local IP addresses, device profiles) from other devices on the subnet.
- For TVs with a Quick Start (QS) feature that is disabled by default: if the wake time is equal to or greater than 10 seconds, the test is performed with QS enabled to enable compliance determination.
- EPA proposes testing with and without a smart speaker connected and configured to wake the TV.



Standby Mode Testing with a Smart Speaker

- As smart speakers permeate more households, they are more often being configured to control TVs. This trend is expected to continue.
- Previous testing has shown variation in energy consumption with different brands of speaker. As such, **Version 9.0 requires that capable TVs are tested with products from the top two market leaders: Amazon and Google.**

Which smart speaker with an integrated virtual assistant do you own?



Sourced from Statista



Test Method Demonstration

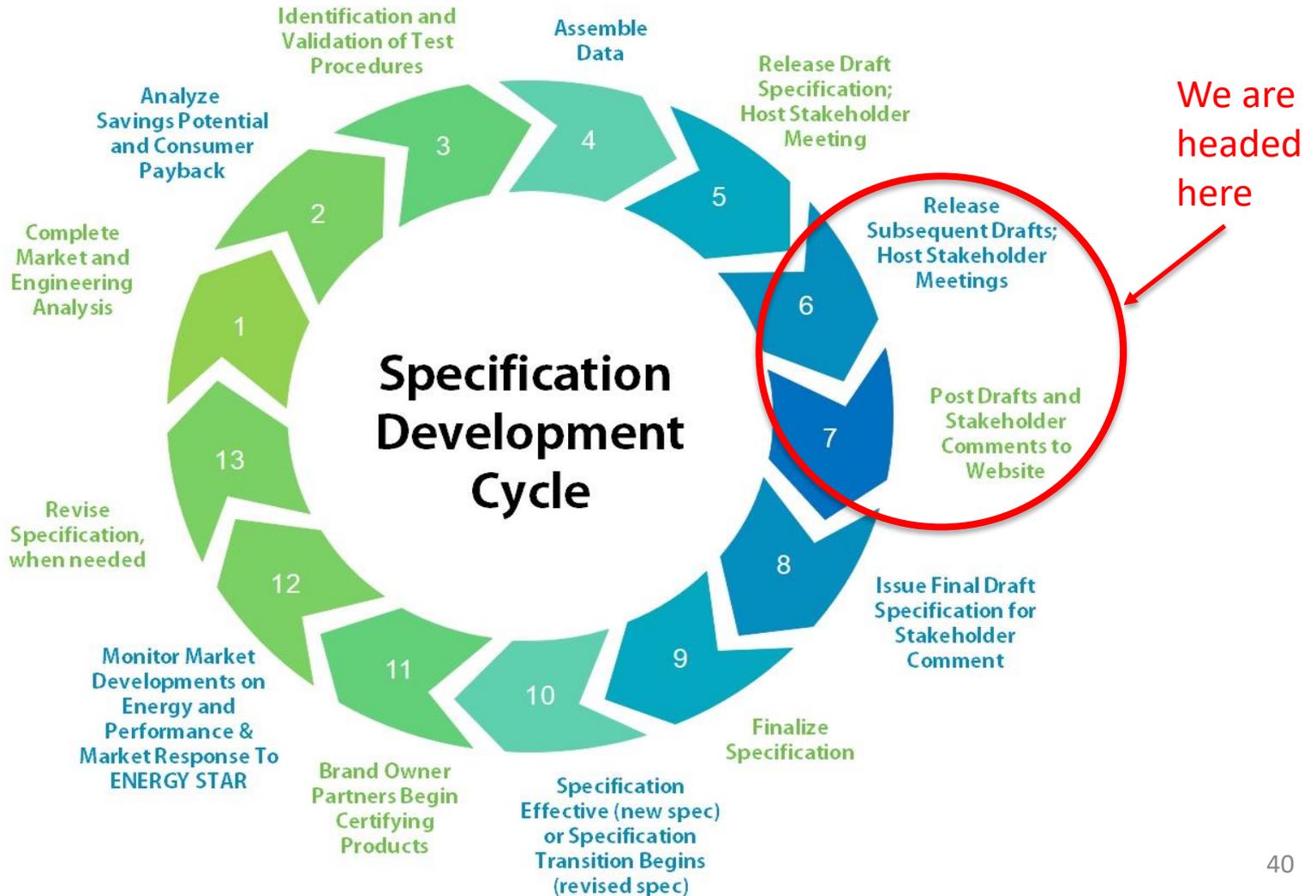
- EPA posted a demonstration video of the proposed test method on the ENERGY STAR V9.0 TVs webpage.
- This demo will include an overview of the:
 - Software setup
 - Camera configuration
 - Testing
 - Automatic test report generation



Timeline and Conclusion

Time	Topic
1:00-1:05	Introductions
1:05-1:15	Goals for Revision
1:15-3:15	Draft 1 Specification
	Dynamic Luminance and the Camera-Based Testing Approach
	On Mode Power Requirements
	Additional Standby Testing and Criteria
3:15-3:30	Timeline and Conclusion

Next Steps





Version 9.0 Timeline

Event	Date
<i>Draft 1 Specification Released</i>	<i>September 17, 2020</i>
<i>Draft 1 Specification Webinar</i>	<i>September 30, 2020</i>
Draft 1 Stakeholder Comments Due	October 29, 2020
Subsequent Drafts of Specification Published	November 2020 – Early 2021
V9.0 Effective Date	Q4 2021



Comments

- Stakeholder comments and any additional data supporting the development of Version 9.0 are due on **Thursday, October 29, 2020**. Please send all comments and data to:

Televisions@energystar.gov

- Unless marked as confidential, all comments will be posted to the TVs product development page at www.energystar.gov/products/spec/televisions_specification_version_9_0_pd
- Accessible through www.energystar.gov/RevisedSpecs and clicking on “Version 9.0 is in development” under “Televisions”



Thank you!

To be added to EPA's stakeholder listserve to receive specification updates, please email:

Televisions@energystar.gov.

James Kwon

Product Manager, ENERGY STAR

(202) 564-8538

Kwon.James@epa.gov

Emmy Feldman

Managing Consultant – Energy and Sustainability, ICF

(202) 862-1145

Emmy.Feldman@icf.com

www.energystar.gov/productdevelopment

