April 5, 2017
Via Electronic Mail

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Subject: ENERGY STAR Specification for Televisions, Draft 1 Version 8.0

This letter is submitted on behalf of the Northwest Energy Efficiency Alliance (NEEA) in response to the request for input to the ENERGY STAR Draft 1 of its Version 8.0 specification for television. NEEA is a non-profit organization working to encourage the development and adoption of energy-efficient products and services. NEEA has long been a strong supporter of the ENERGY STAR program for a number of products, including televisions.

NEEA is in full support of the need for an updated specification for televisions. ENERGY STAR is a critically important federal program created with bi-partisan support that annually delivers billions of dollars of energy savings to consumers and business. Televisions is an important product category for ENERGY STAR and with consumer trends pushing TVs to be larger and more feature laden, there is a risk of losing many of the base efficiency gains made in the product category, potentially resulting in much more energy being used by consumers for TV viewing. As such, ENERGY STAR's leadership in setting appropriate high-efficiency voluntary specifications is once again needed to recognize those products that are able to meet consumer's experiential expectations as well as save them energy and money.

In this comment document we provide input on the Draft 1 Version 8.0 language regarding:

1. Automatic brightness control
2. Additional energy savings features including motion detection dimming (MDD)
3. Ultra High Definition (UHD) Allowance
4. High Dynamic Range (HDR) Upscaling
5. Software Updates

1. Automatic Brightness Control (ABC)

   NEEA applauds and supports the EPA's effort to move quickly to address persistence and performance issues related to efficiency features such as ABC. We agree with the EPA's intent to enhance the viewing experience and improve persistence of energy saving features by adding new screen luminance requirements to the ABC requirements. However, we strongly oppose the proposal to allow ABC to be disabled for one or two additional preset picture modes (other than HDR related or retail modes). Under the current proposed language there is potential the additional allowed preset

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modes with ABC disabled could be named or used in a manner by manufacturers that would encourage consumers to choose ABC disabled modes over modes with ABC enabled, thereby compromising the persistence and savings expected from ABC. Therefore, we recommend the language is updated to ensure ABC is enabled across all preset picture modes other than HDR related or retail modes.

We are also concerned the requirements of ABC related to consumer experience and energy savings across all ABC enabled picture modes are not sufficiently defined. Therefore, we recommend language is added to the specification to ensure that ABC delivers relatively similar savings and viewing experience across all ABC enabled preset picture modes. NEEA would support and participate in any effort among stakeholders to arrive at the right language.

2. Additional energy savings features including motion detection dimming (MDD)

   NEEA agrees with the language in section 3.2.3 regarding energy saving features and recommends EPA add language to clarity what 'typical viewing' experiences and 'variety of popular programming' means. To provide a meaningful definition, we recommend EPA consider defining appropriate scene length and frequency of scene changes to protect against the significant TV power drops from features such as MDD, as documented in the test results from National Resources Defense Council and others.

   NEEA believes MDD should persist in all preset picture modes. Therefore, we recommend EPA adopt a similar approach to MDD and other energy saving features as recommended for ABC. Similarly to ABC, if MDD is a desirable efficiency feature for the default home mode, then it also be on for other modes such as sports which are even more likely to have rapid motion.

3. UHD Allowance

   NEEA and other efficiency advocates have conducted extensive analysis into the on-mode power impact of UHD. Based on the analysis results and additional justification presented below we strongly believe now, in Version 8.0, is the time to adjust the UHD allowance.

   3.1. A comparative analysis of the power consumption gap between US models of HD and UHD TVs in the California Energy Commission (CEC) appliance database was conducted to build upon the analysis done by the Collaborative Labeling and Appliance Standard Program (CLASP) in Europe. CLASP's analysis shows on average only a 13% increase due to UHD. The CEC database results similarly show a narrowing gap of power consumption between the two technologies with an average of appromately13% higher power for UHD. See the chart below.

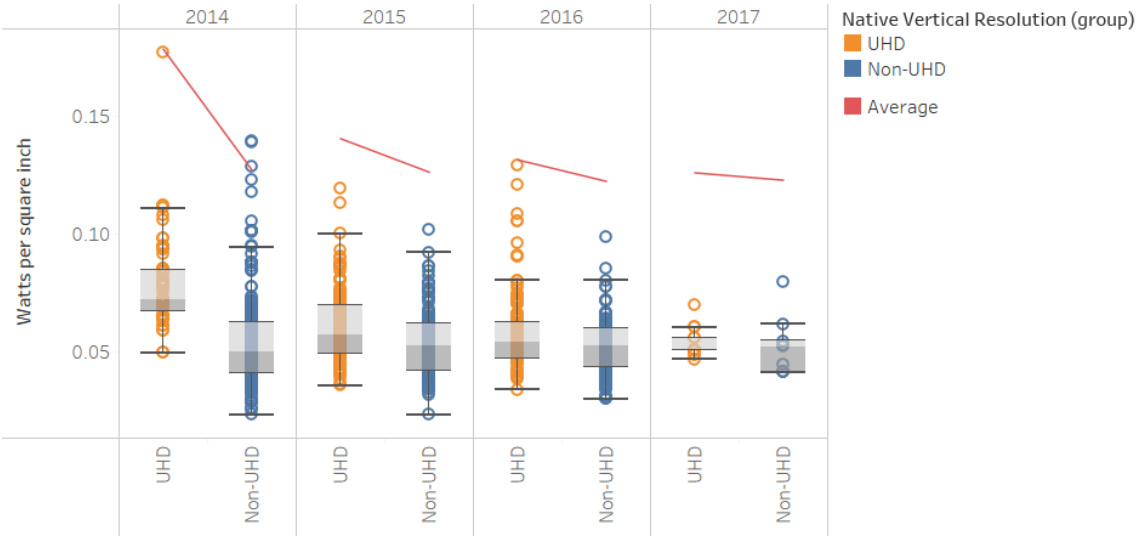

Figure 1. Watts per square inch of HD and UHD TVs

The CLASP and CEC analyses benefit from data that was understandably not available during the development of the Televisions Specification Version 7.0, but now provide a good reference point with which to re-examine existing UHD power allowance. The resulting 13% increased power consumption of UHD is not the recommended allowance level but acts as valid data point for reference in setting the appropriate allowance.

3.2. In addition, through its collaboration with other stakeholders NEEA has access to an analysis by efficiency advocates of the on-mode power impacts of UHD TVs to better understand the drivers of increased power and arrive at a concrete recommendation for the UHD allowance. The detailed analysis is provided as an appendix to this comment letter. The following is a high-level summary of the results:

3.2.1. There exists sufficient data and information among stakeholders in Europe and North America to arrive at an appropriate UHD allowance.

3.2.2. Taking a technology specific approach derived from product testing data (accounting for UHD, ABC, and brightness) suggests the first of three potential solutions, a flat UHD adder of 22 W is appropriate, as opposed to the current approach of allowing a percentage increase in energy consumption.

3.2.3. Taking a statistical approach leveraging the CEC database and using regression analysis results in a second and third potential solution: 2. A 5%+16W adder (essentially equivalent to the product testing based approach) and 3. Approximately a 30% adder.

3.2.4. When plotted with one another the three solutions provide very similar results across all UHD screen sizes.

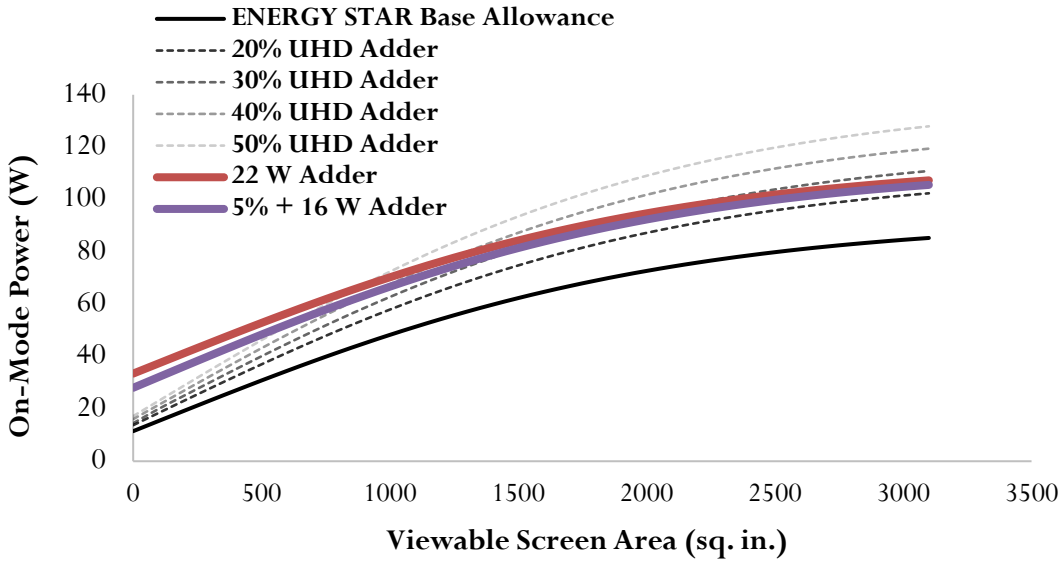

Figure 2. On-mode power vs viewable screen area for ENERGY STAR v7 and various UHD allowance levels.
Note: the analysis that generated the above summary is supported by details in the appendix and continues to be a work in progress.

3.3. As additional reference data points, NEEA analyzed sales data from our regional UHD TV initiative to arrive at the follow results:

3.3.1. We calculated average allowance of 2017 models meeting ENERGY STAR certification and the sales volume- weighted average allowance using 'equivalent' 2016 model sales as a proxy.

- Non sales volume-weighted average allowance: 22.3%
- Sales volume-weighted average allowance: 19.0%

3.3.2. We also look at what would happen to 2017 model sales if the allowance is lowered. The table below shows the expected impact on 2017 sales forecasts of ENERGY STAR certified UHD TVs in NEEA territory, using comparable 2016 model sales, if the allowance were lowered in 5% increments.

Table 1.

Estimated Sales Volume Covered by % Allowance:

Required Allowance	Cumulative 2017 Model Count	Cumulative Volume (2016 proxy)	Coverage
10%	11	18,734	**24%**
15%	16	30,933	**40%**
20%	20	31,105	**41%**
25%	27	63,065	**82%**
30%	28	64,615	**84%**
35%	33	68,428	**89%**
40%	35	70,382	**92%**
45%	38	75,182	**98%**

These results indicate a 30% allowance would cover an estimated 84% of the certified NEEA sales of 2017 models and would better align with rewarding the top efficiency models as opposed to allowing most UHD models to qualify.

3.4. During this Version 8.0 revision process the EPA has stated, as justification for not changing the UHD allowance, that the effects of the new requirements added around ABC and MDD may result in higher reported power values for TVs going forward and it's unclear how many TVs will no longer qualify or how large of a UHD adder remains warranted. We understand the EPA concern regarding ensuring a sufficient number of models qualify under the Version 8.0 specification and without the above analysis results we also understand the uncertainty of how large a UHD adder is warranted. However, with the analysis above, NEEA believes the question of how large a UHD adder is warranted is sufficiently answered.

Additionally, we respectfully suggest the concerns related to the impacts of the new ABC and MDD requirements are misguided. The method of 'reported' power values (versus measured or calculated) themselves create uncertainty around the true power values for stakeholders other than the manufacturers themselves and therefore make it difficult to put that reasoning in context. NEEA recommends the requirements for 'reported' values are strengthened. Regardless, according to how the UHD power requirements are written in the specification:

$$P_{HR} = 0.5 \times P_{ON\_MAX}$$

It appropriately and explicitly differentiates any power impacts from changes to ABC and MDD (as represented by P_{MAX}) from UHD impacts (as represented by 0.5 allowance). We believe this basic equation continues to be appropriate because ABC and MDD apply across both HD and UHD TVs. Therefore, any justification in relation to the new requirements around ABC and MDD should be equally applied to HD and UHD technology, completely independent of the UHD allowance. Leaving the generous UHD adder gives preference, if not outright certification benefit, to the UHD technology which occurs mostly in larger, more expensive and more energy

consumptive models. NEEA believes this may be an unintended consequence of the EPA's reasoning.

3.5. Another technology feature with unknown power impacts that has rolled out on the heels of UHD is HDR, both HDR upscaling and True HDR. It appears this has additionally clouded the understanding of UHD TV performance. However, our understanding of HDR is growing and it is now being discretely addressed beginning with the new requirements proposed for this Version 8.0 specification (as discussed below); we believe all stakeholders need to acknowledge the impacts of HDR and treat it separately from the UHD impacts being specifically discussed here.

3.6. Lastly, with the effective date of the next major revision of the TV specification likely two or more years out, not revising the UHD allowance downward will likely result in a significant lost opportunity.

Therefore, to summarize the above reasoning:

1. **There is sufficient on-mode power data now available for a large number of UHD TVs,**
2. **The analysis results provide a defensible estimate of the on-mode power impact of UHD technology at a flat 22W or 30% allowance,**
3. **NEEA's analysis of the certification impacts of lowering the allowance using NW sales data estimates 84% market penetration at the 30% allowance,**
4. **The new requirements around ABC and MDD need to be equitably applied to both HD and UHD TVs ,**
5. **HDR is better understood and discretely addressed,**
6. **Not lowering the UHD power allowance now is likely to be a significant lost opportunity,**

NEEA strongly recommends the EPA reconsider adjusting the UHD power allowance down in the version 8.0 specification and recommends that a flat 22W value or a 30% allowance would be an appropriate level. Taking these action now would send an appropriate message to manufacturers so they continue to work towards making UHD TVs as efficient as technically feasible.

4. HDR upscaling

NEEA agrees with the proposed approach to require models with HDR upscaling to be subject to an additional test with that feature selected on and to record the average power consumption data as described. NEEA recommends the model specific data and test results be made publicly available on the Qualified Products List. Additionally, we recommend that analysis is conducted to have an appropriate power allowance established for the next specification revision when HDR upscaling is occurring.

5. Software updates

With the number of TVs sold today that are capable of being updated after purchase, it is important to establish a requirement that TVs must continue to comply with the full set of requirements of the ENERGY STAR specification after updates are received. NEEA recommends EPA include language in this version of the specification to address connected “smart TVs” that are able to receive software updates from the manufacturers to require they meet the specification following all software updates.

Again we applaud and support the EPA’s effort to move quickly on this specification revision. However, we are concerned that not addressing major energy consuming TV features such as the UHD power allowance and the power demands of HDR in the Version 8.0 specification will result in a major lost opportunity that will not be addressed effectively for two or more years in the future. Therefore, NEEA again requests the EPA reconsider lowering the UHD allowance and should the revision schedule be delayed we ask that the EPA use the additional time to more comprehensively address setting a maximum allowance for increased power demands of HDR effects.

We thank EPA for the opportunity to comment on these important changes to its proposed specification, and we very much appreciate the Agency’s responsiveness to stakeholder input. NEEA looks forward to continuing our work with the ENERGY STAR program for televisions.

Respectfully,

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The below analysis was conducted through collaboration of a group of energy efficiency advocates and continues to be a work in progress.

Determination of UHD allowance (also known as a 'UHD adder').

Consider the technological requirements for a TV to be capable of UHD technology. Power requirements can be disaggregated into computing power (independent of screen area) and lighting power (linear dependence with screen area). Below is a table for a few features and how they affect the power of TVs:

Feature	Computing Power	Lighting Power
UHD	Increase due to higher pixel count (larger signal)	Smaller pixels may result in light loss, thereby requiring more power
ABC	Insignificant	Results in net lower brightness and thus power. Magnitude varies by brand/manufacturer
Brightness	Insignificant	Linear dependence

The energy characteristics of the TV can be determined by power vs. light output (in candelas) curves. Light output can be calculated by multiplying brightness (candelas/m^2) by screen area (m^2). The Y-intercept of this curve is a reasonable estimate of the computing power (power at zero brightness). The slope measures the "net luminous efficacy", which corresponds to the lighting power. When a TV is measured using the IEC test clip, this "efficacy" not only includes light loss, it also includes the effects of content-based dimming features.

ENERGY STAR defines the power allowance for UHD as:

$$P_{HR} = 0.5 \times P_{MAX}$$

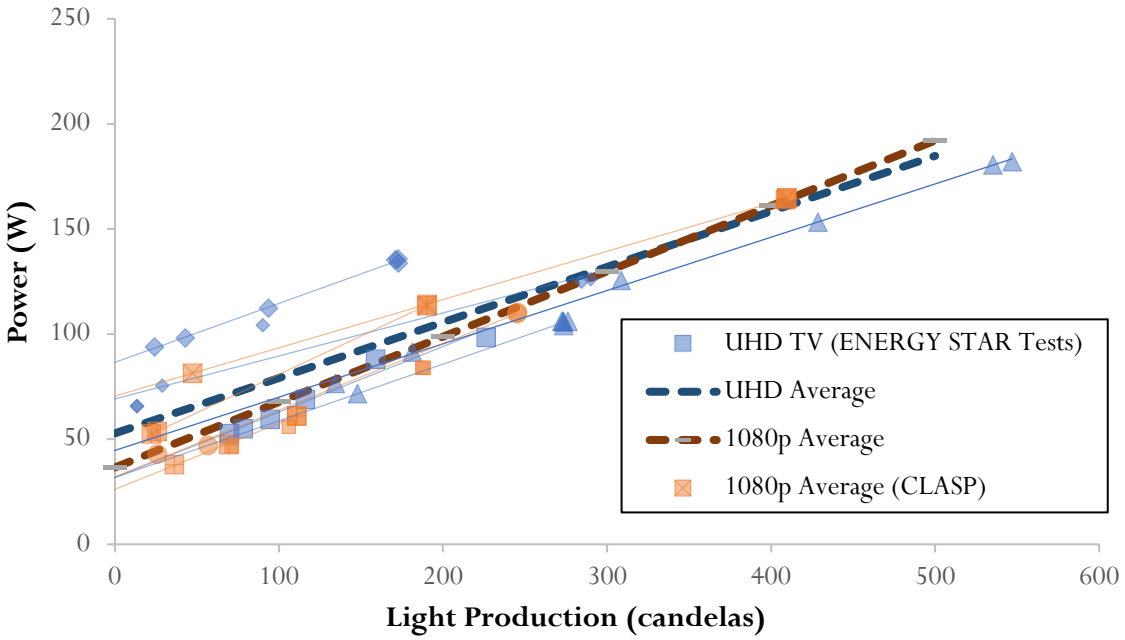
Based on the table and considerations above, the equation should be:

$$P_{HR} = A \times P_{MAX} + B$$

… where *A* is the difference in slope for UHD and non-UHD TVs, and *B* is the additional computing power required for UHD TVs. A 50% adder implies that UHD TVs are half as efficient as non-UHD TVs of producing light (require twice as much power for the same brightness, presumably due to losses from small pixel size), and no additional computing power is required. To assess what these values should be, consider the TV testing performed in the ENERGY STAR October 2016 Television Test Dataset and CLASP August 2011 report entitled "Analysis of Television Luminance and Power Consumption".

From ABC measurements performed by ENERGY STAR and CLASP, power vs. light output curves can be plotted for several UHD and 1080p TVs. The ENERGY STAR tests used 55-inch UHD models manufactured in 2015 or 2016. The CLASP tests used 1080p direct-list LED models considered to be new when the report was released in 2011. These separate reports each measured the on-mode power of TVs at various brightness settings which was determined by the TV in response to ambient light conditions since ABC was enabled. It is worth noting that the resulting data does not show true efficacy, but instead shows the on-mode power, tested using the IEC test clip, at various settings that produce a certain brightness when tested using the 3-vertical-bar broadcast signal. However, since all TVs were tested this way, the curves are comparable.

The figure below shows the curves plotted and averaged by UHD/1080p.



The slope for UHD TVs was found to be less than that of 1080p TVs. This is interpreted to mean that UHD TVs produced in 2015 or 2016 have more efficient backlights, or dimming techniques, than 1080p TVs produced in 2010 or 2011. However, the intercept for UHD TVs suggests an increased computing power (expected for higher resolution). The difference of the intercepts is about 16 W.

An assessment of the CEC Appliance Database shows that UHD TVs on average produce 23 candelas more light (about 20 nits more) than their 1080p counterparts, which equates to about 6 W of power. If UHD TVs are designed to be operated at higher brightness levels, as evidenced by their default settings, **this analysis suggests a flat UHD adder of 22 W**.

A Statistical Method

An alternate UHD adder can be assess by some statistical analysis of the CEC Appliance Database. Consider the following equation:

OnPower ~ A(ScreenArea) + B(ScreenArea)(Brightness) + C(ScreenArea)(ABC) + D(ScreenArea)(UHD) + E(Brightness) + F(ABC) + G(UHD) + H

Note that the table above suggests that E and F equal to zero, i.e., brightness and ABC have contributions to the power required for lighting, which is dependent on screen area, but not to area-independent variables like computing power. A flat adder, as suggested above implies that D is equal to zero, i.e., UHD does not change screen area's effect on the on-mode power.

First, consider a linear regression analysis on all TV models in the CEC database to determine constants A through H. The results are shown in the table below:

Constant	Variable	Estimate	Std. Error	t value	Pr(>|t|)
H	(Intercept)	1.09E+01	1.47E+00	7.379	1.80E-13
A	ScreenArea	5.04E-02	1.38E-03	36.47	2.00E-16

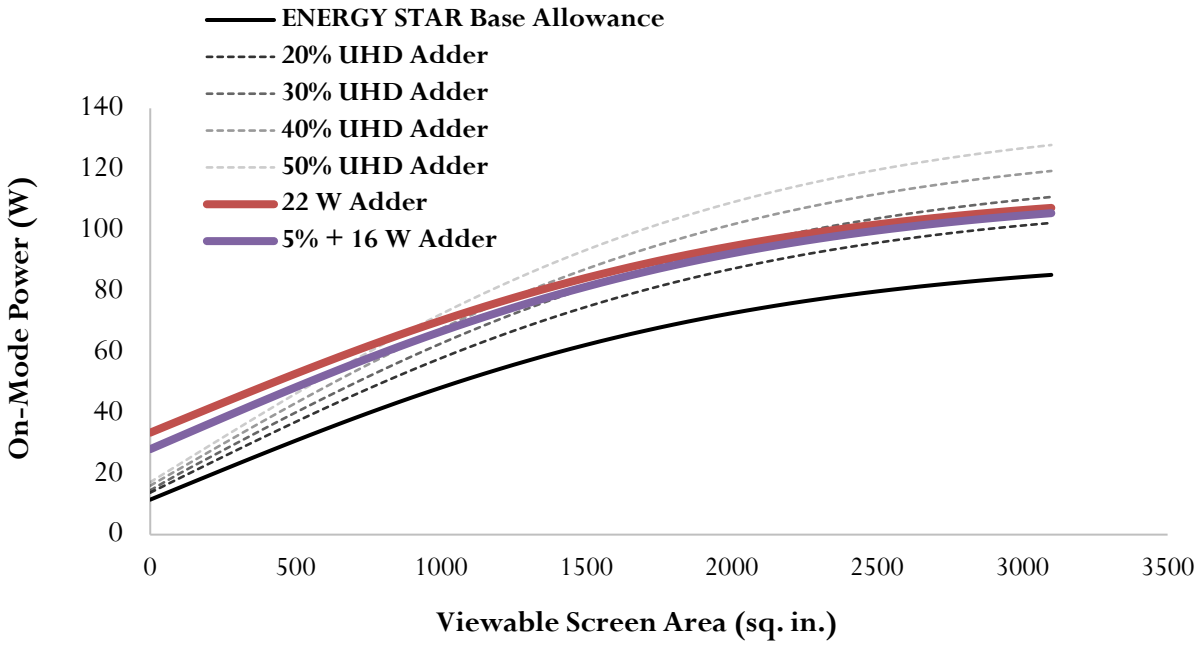
F	ABCTrue	1.06E+01	1.95E+00	5.407	6.65E-08
E	Brightness	-3.81E-02	8.02E-03	-4.753	2.05E-06
G	ResolutionUHD	-5.33E-01	2.13E+00	-0.25	0.803
C	ScreenArea:ABCTrue	-3.43E-02	1.57E-03	-21.898	2.00E-16
B	ScreenArea:Brightness	9.05E-05	6.64E-06	13.628	2.00E-16
D	ScreenArea:ResolutionUHD	1.34E-02	1.60E-03	8.346	2.00E-16
	Residual standard error: 18.93 on 6164 degrees of freedom				
	Multiple R-squared: 0.7661, Adjusted R-squared: 0.7658				
	F-statistic: 2884 on 7 and 6164 DF, p-value: < 2.2e-16				

As expected, the brightness constant is near zero; the ABC constant is significant, but with less certainty than the other variables. The results show large statistical insignificance in the UHD (very likely to be zero) constant but significant interaction with screen area (constant D). Comparing to constant A, these results suggest a UHD adder of 26.6%. That is, among TV models in the CEC Appliance Database, when the effects of ABC and brightness on on-mode power are controlled for, UHD TVs have about 26.6% larger on-mode power than non-UHD TVs across all screen sizes. **Adding 20 nits for constant B produces a total adder of 30.2%**

The regression can be altered by setting the constant D equal to zero. This forces the regression to ignore how UHD interacts with screen area, which would be the implications of a flat UHD allowance. The results are shown in the table below. This table suggests from constant G that a flat UHD adder would be 15.8 W, a value remarkably close to the 16 W determined through product testing. That is, among TV models in the CEC Appliance Database, when the effects of ABC and brightness on on-mode power are controlled for, UHD TVs have on average 15.8 W larger on-mode power than non-UHD TVs. Note that since brightness is controlled for, this also does not consider larger average default brightness for UHD TVs. Since constant E is near zero, using constant B and 20 nits produces an adder of 5% for brightness. **The net adder is 5% + 15.8 W.**

Constant	Variable	Estimate	Std. Error	t value	Pr(>|t|)
H	(Intercept)	1.33E+01	1.45E+00	9.192	2.00E-16
A	ScreenArea	4.86E-02	1.37E-03	35.417	2.00E-16
F	ABCTrue	6.12E+00	1.89E+00	3.235	0.00122
E	Brightness	-5.82E-02	7.69E-03	-7.566	4.42E-14
G	ResolutionUHD	1.58E+01	8.65E-01	18.226	2.00E-16
C	ScreenArea:ABCTrue	-3.04E-02	1.50E-03	-20.231	2.00E-16
B	ScreenArea:Brightness	1.08E-04	6.33E-06	17.127	2.00E-16
	Residual standard error: 19.03 on 6165 degrees of freedom				
	Multiple R-squared: 0.7634, Adjusted R-squared: 0.7632				
	F-statistic: 3316 on 6 and 6165 DF, p-value: < 2.2e-16				

The ENERGY STAR levels along with various UHD Adder values are shown in the plot below. A large difference in a flat adder compared to a percentage adder can be noticed at smaller screen sizes. However, UHD TVs are typically larger than 1400 square inches, which is why the two statistical results (26% and 5%+16W) are similar. The similarity between the 22 W adder, derived from product testing, and the 5% + 16 W adder, derived statistically is unusually noteworthy.



Comparison of Results

Method	Default Brightness Consideration	Resulting UHD Adder
Testing	No	16 W
Testing	Yes	22 W
Statistical – 7 constants	No	26.6 %
Statistical – 7 constants	Yes	30.2 %
Statistical – 6 constants	No	15.8 W
Statistical – 6 constants	Yes	5% + 15.8 W