

OLED vs. LCD: Testing Power Draw, Surface Temperature, and Light Output in Gaming Displays

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ABSTRACT

This research report compares a 2025 ASUS ROG Strix 27-inch OLED gaming monitor (ASUS) with a 2015 Apple MacBook Retina LCD (Apple) using five screen image examples: black, gray, white, a dark gaming screenshot, and a bright gaming screenshot. My report measures the monitors for power draw, surface temperatures, and light emissions for both monitors using each type of screen image. My goal was not to prove that one monitor's technology was better than the other, but was to understand how the display types differ under various use case scenarios. My OLED monitor showed a strong connection between image brightness and power consumption, especially when comparing black, gray, and white screens. The LCD monitor showed more consistent results in some tests, but the light meter I used had difficulty collecting measurements in low-light conditions. Overall, the experiments I ran demonstrated trade-offs between image quality, power consumption, and heat dissipation.

INTRODUCTION

When building my personal gaming PC, I spent months scouring the internet to find the best parts with the best performance specifications. There are so many things that go into producing a great gaming experience including the computer, its parts, and the applications themselves. But I wanted to take a deeper look at differences in gaming below the surfaces most people consider. Most people look at a display as just a screen, but inside the screen, engineering choices can determine an images' brightness, how much power it consumes, the heat it produces, and how good certain images will look on the screen across different scenarios.

OLED and LCD monitors deliver similar results in different ways. In an OLED monitor, its pixels can produce their own light or no light at all. In a LCD monitor, the display surface relies on a backlight that shines through many layers of liquid crystals. The difference between these two types of monitors can deliver dramatically different gaming experiences. Gamers playing a horror game that uses many dark scenes, or playing a bright game with colorful clouds and characters, will reveal different experiences to the user, depending on the displays they use.

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Monitor screens are complex, physical systems. They are made up of pixels, backlights, heatsinks, glass, plastic, wiring, sensors, and circuit boards. A monitor might have great specifications on paper, but their real-world performance can differ dramatically based on the quality of the parts used, and how they are assembled to work together.

In gaming, several trade-offs are easy to notice. Dark scenes require strong contrast. Racing games are better when the monitor's technology supports fast response times. Colorful games need to offer higher brightness and a greater variety of colors. At the same time, displays can't use unlimited power or generate endless heat. The choice of OLED vs. LCD is more than just a preference. It's influenced by how the monitor's system is built.

EQUIPMENT USED

Table 1 lists the equipment used in this experiment and the role each item played.

Equipment / Source	Role in Experiment
ASUS ROG Strix 27-inch 1440P OLED Gaming Monitor (XG27AQDMG), circa 2025	OLED display tested; QHD, glossy OLED, 240Hz, 0.03ms response time, custom heatsink, G-SYNC compatible, 99% DCI-P3.
Retina 15-inch LCD Display Assembly A1398, circa 2015	LCD display tested; Apple MacBook Retina LCD assembly used as the comparison display.
URCERI Digital Illuminance Meter (URCERI)	Used to record light output from the screen. Results were useful for bright scenes but were difficult to measure in the low-light LCD testing. Cost: \$29.98
MECHEER Plug-in Watt Power Meter (MECHEER)	Used to measure power consumption from the display/device setup. Cost \$11.99
TempPro TP30 Infrared Thermometer Gun	Used to measure the surface temperature on the monitor.
WhiteScreen.online (White Screen)	Used to generate solid black, white, and gray screens. The gray screen used the #7F7F7F color identifier.
Resident Evil Requiem image search result (Metro)	Used as the dark gaming screenshot.
Astro Bot image search result (Doucet)	Used as the bright, colorful gaming screenshot.

Table 1. Equipment used and its role in the experiment.

Results from the power meter include system-level measurements for the complete setup. They do not represent panel-only measurements. Because my OLED and LCD monitor setup differed in size, age, screen resolution, refresh rates, and other variables, the results of these experiments should be considered more of a real-world study than a scientific lab experiment.

METHODS

A number of tests were run across both monitors. Each monitor was set at 50% brightness with its auto-brightness setting turned off. We set the LCD monitor brightness on the MacBook using its Operating System systems settings control panel for its display. The brightness on the OLED monitor was set using its on-screen display and navigating to its image menu.

Each screen image we used was displayed for over 30 seconds before the reading was taken to allow the screens to settle into a consistent state and allow for more precise data collection. Multiple readings from the various test instruments were done over 15 - 30 seconds to ensure consistent measurements or ranges of readings could be recorded.

- The experiments used five different images with each monitor:
- Solid black screen
- Solid gray screen (#7F7F7F)
- Solid white screen
- Dark gaming screenshot, taken from Resident Evil Requiem
- Bright gaming screenshot, taken from Astro Bot

The experiment was organized into three parts:

- **Experiment 1:** Power draw by image type. The power meter measured how many watts each display setup used for each image type.
- **Experiment 2:** Surface temperature of the monitor. The infrared thermometer measured each monitor's surface temperature while each image was on the screen.
- **Experiment 3:** Light output for each image on the monitor. The illuminance meter measured the light output for each monitor. When testing the dark gaming and solid black screens, the meter showed zero light emissions even when light was visible to the naked eye, meaning that it was not accurate in the lowest lighting scenarios tested.

For the power draw and surface temperature tests, we ran three trials in total for each monitor. Between each test, we turned each of the monitors off for three to five minutes to help reset any color settings and stabilize the temperature of the screen materials. We did not run the experiments for the light output multiple times because the measures were not accurate in the lowest lighting scenarios.

RESULTS

Here are the results of the readings recorded during the experiments I ran. When experiments produced a range of datapoints I used a midpoint or average to represent the final value. As I mentioned before, the Illuminance Meter readings in low-light scenarios were not as accurate as I wanted them to be because the device had difficulty measuring the dimmest settings tested, especially on the LCD monitor. Table 2 represents the recorded readings showing the mean readings. Figures 1 through 4 show the same data using bar charts.

Screen content	OLED power (W)	LCD power (W)	OLED temp (F)	LCD temp (F)	OLED light	LCD light
Black screen	22.4	17.1	71.9	73.9	0.0	0.0
Gray screen	24.8	17.1	76.9	73.6	36.3	1.2
White screen	30.1	20.7	76.3	75.5	177.0	66.7
Dark game	23.3	18.9	78.3	71.2	0.0	0.0
Bright game	25.2	18.3	77.5	72.5	42.1	0.7

Table 2. Summary of readings from the experiments. Readings from the light meter are light output values from the device. The low-light LCD readings are not accurate due to limitations of the device to measure very low light output levels.

Table 2a represents the recorded readings over the range of the three trials for power draw measurements in watts for each type of content. The mean reading is shown across the three trials.

Screen content	OLED mean (W)	OLED range (W)	OLED trials	LCD mean (W)	LCD range (W)	LCD trials
Black screen	22.4	22.3–22.5	3 trials	17.1	16.9–17.2	3 trials
Gray screen	24.8	24.4–25.2	3 trials	17.1	16.8–17.4	3 trials
White screen	30.1	29.8–30.4	3 trials	20.7	20.3–21.0	3 trials
Dark game	23.3	23.1–23.5	3 trials	18.9	18.3–19.4	3 trials

Bright game	25.2	24.5–25.9	3 trials	18.3	17.9–18.7	3 trials
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Table 2a. Summary of readings from the three trials, including range and mean readings. Measured in watts (W).

Table 2b represents the recorded readings over the range of three trials for the surface temperature of the screens for each type of content. The mean reading is shown across the three trials.

Screen content	OLED mean (F)	OLED range (F)	OLED trials	LCD mean (F)	LCD range (F)	LCD trials
Black screen	71.9	71.8–72.0	3 trials	73.9	73.8–74.0	3 trials
Gray screen	76.9	76.8–77.0	3 trials	73.6	73.5–73.7	3 trials
White screen	76.3	76.0–76.5	3 trials	75.5	75.4–75.6	3 trials
Dark game	78.3	78.1–78.5	3 trials	71.2	71.0–71.4	3 trials
Bright game	77.5	77.4–77.6	3 trials	72.5	72.4–72.7	3 trials

Table 2b. Summary of readings from the three trials, including range and mean readings. Measured in fahrenheit (F).

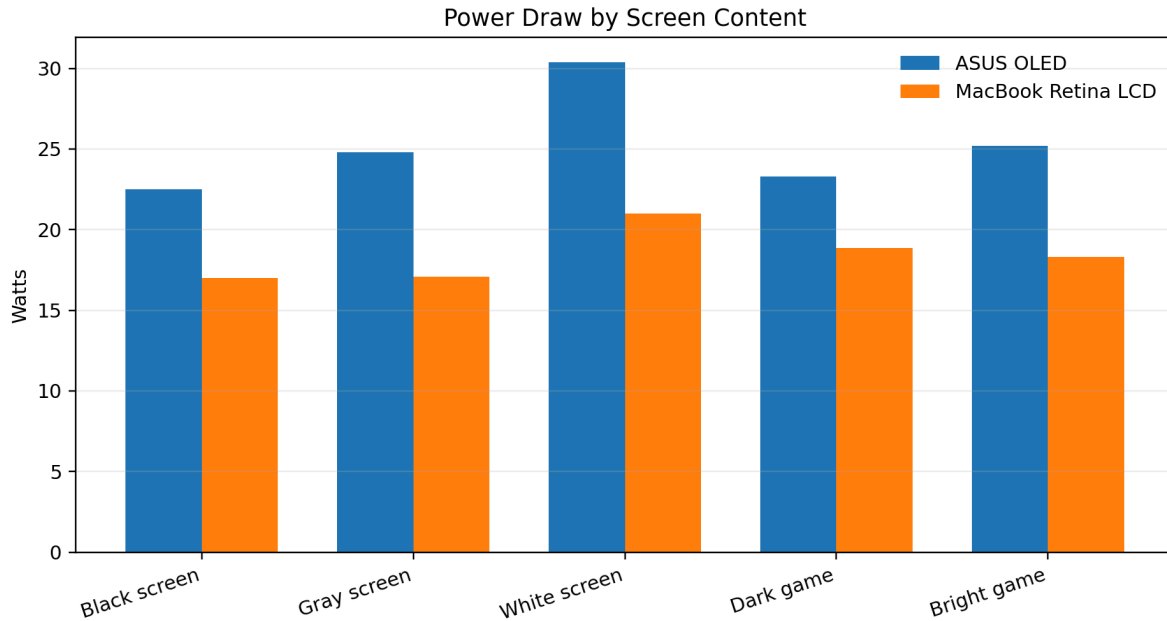


Figure 1. Measured power consumption by screen image type. In this setup, the OLED monitor used more power on white and bright images than the black and dark images. Note, the LCD monitor includes power consumption of the complete MacBook, not just its monitor.

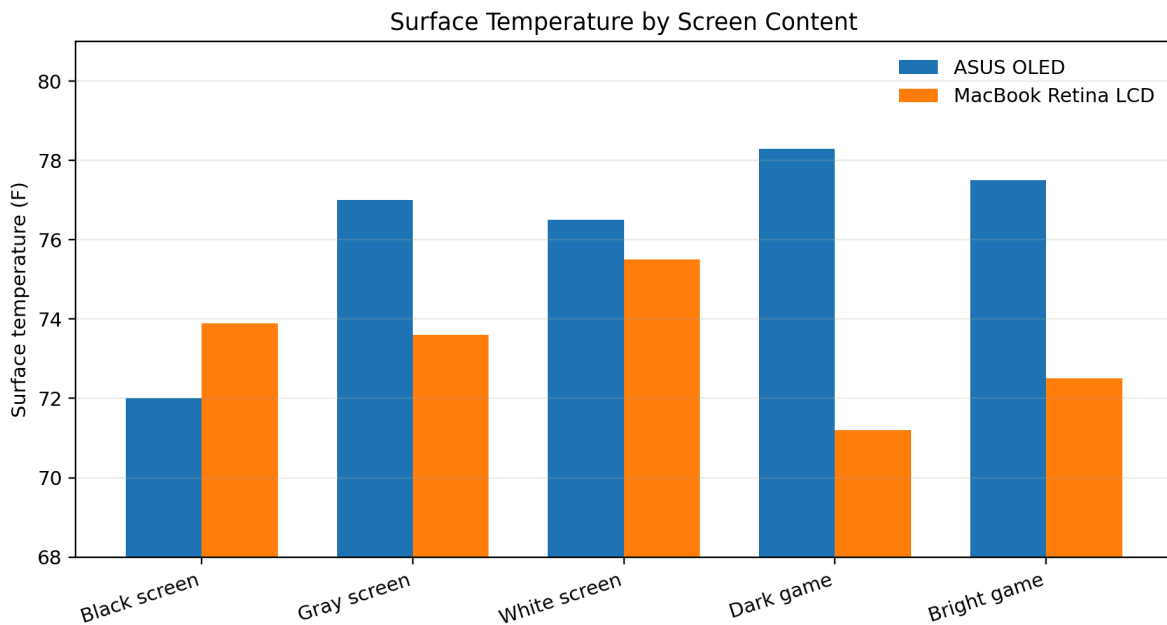
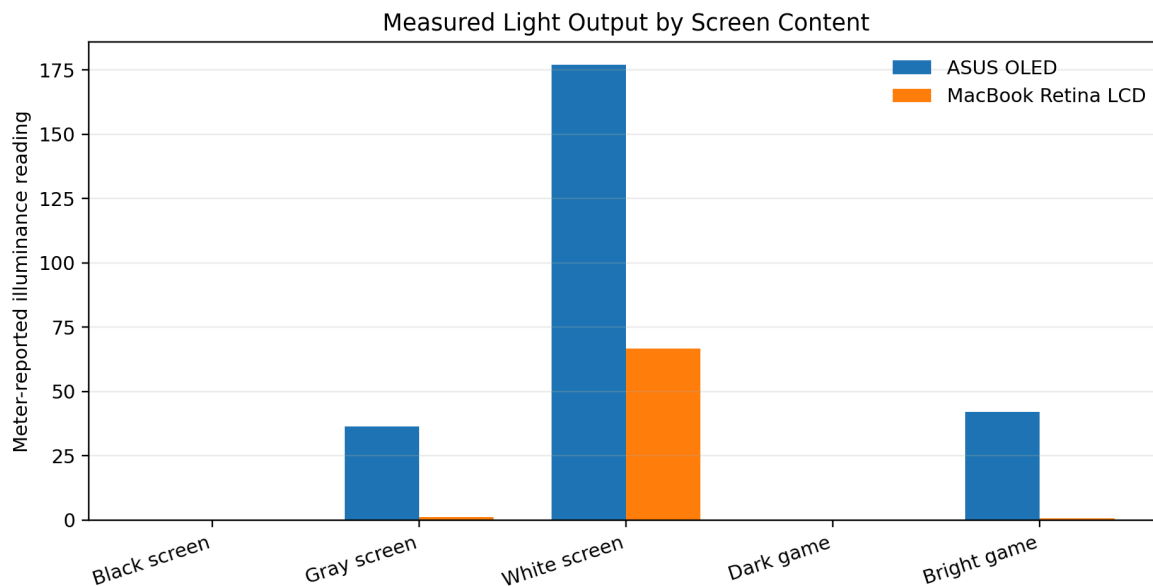
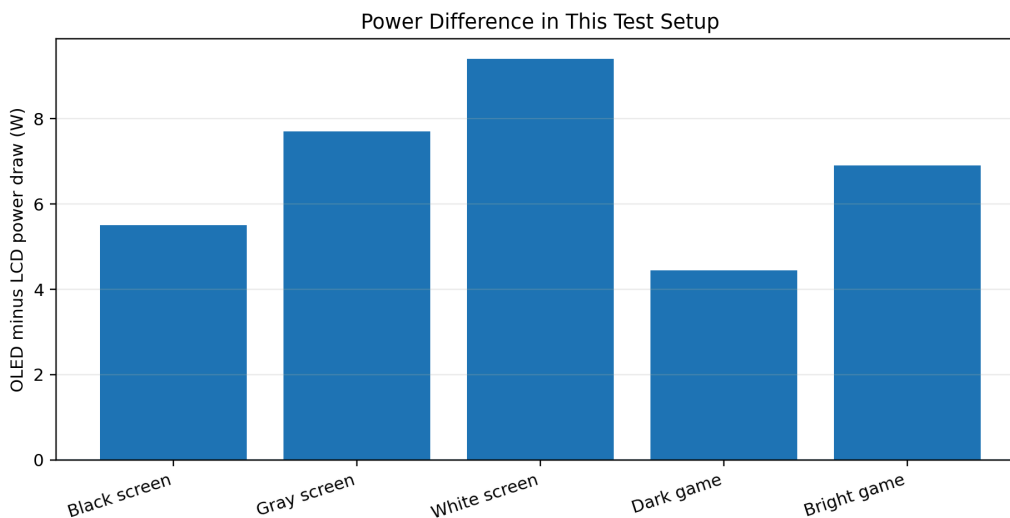


Figure 2. Temperature readings for each screen were fairly close during the color screen tests. For the gaming screen tests, the temperature readings were considerably higher on the OLED monitor.



Note: LCD readings in low-light scenes were limited by the meter and should be treated as unreliable.

Figure 3. The light meter we used had difficulty reading the lowest light settings on the LCD monitor. Readings are measured in Lux. When testing the white screen image, the OLED monitor's light output far exceeded the LCD monitor. Interestingly, the bright gaming screen, while colorful, produced a similar light output level to the gray screen.



Positive values mean the tested OLED monitor drew more power than the tested LCD setup. This is not a same-size panel comparison.

Figure 4. The OLED monitor drew considerably more power than the LCD monitor in all testing conditions. The OLED drew 20 - 30% more power than the LCD monitor, with the highest power draws measured during the whiter and brighter test scenarios.

ANALYSIS

Experiment 1: Power Consumption

The clearest results measured come from the power consumption experiments. On the OLED monitor, the black screen measured 22.5W, gray measured 24.8W, and white measured 30.4W. This demonstrated that the OLED monitor's power consumption increased by around 35% between showing the black and white image. Because OLED pixels produce their own light, brighter images require more energy to produce. The power consumption results are shown in Figure 1 and the OLED vs. LCD difference in power consumption is shown in Figure 4.

By comparison, the LCD monitor also showed more power consumption on the white screen vs. the black screen. The black screen showed 17.0W compared to the white screen at 21.0W. This represents about 24% more power consumption. Interestingly, the LCD setup did not show any difference in power consumption in the black vs. gray experiments. Both scenarios showed about 17W of power consumption. This makes sense, because even in dark settings, an LCD monitor is always backlit when the power is on, no matter how dim or dark the screen image is.

When testing the gaming screenshots, I saw less difference in the power consumption readings

For the OLED monitor, the dark game screenshot consumed 23.3W compared to the bright game image that consumed 25.2W, showing a difference of 1.9W. By comparison, the LCD monitor measured 18.9W on dark and 18.3 on bright, which does not represent a major difference in power consumption. Both monitors used static game images when testing power, but results may differ more during real game play depending on how much and how often the colors and brightness change over a longer period of time.

Experiment 2: Surface Temperature

The temperature reading during my experiments held a tighter range of results. The OLED and LCD monitors both stayed around room temperature throughout the experiments. The OLED monitor showed ratings between 72F and 78F, while the LCD monitor showed ratings between 71F and 75F. The temperature ratings for each monitor and experiment are shown in Figure 2.

Temperature and power consumption did not always align. For example, the OLED monitor had one of the highest temperature readings for the dark gaming screenshot even though its power consumption was not the highest. This might have happened because the infrared thermometer only measures the surface temperature and not the pixel or crystal surface temperature, or it could be because of slight differences in exactly where the thermometer was pointed. Regardless of the differences, I noted that both temperatures stayed within safe, normal room temperature ranges during these short tests. But it might be that temperature differences during longer-game play periods could result in more dramatic temperature changes, especially if confined to a smaller gaming room or area.

Experiment 3: Light Output

The URCERI Digital Illuminance Meter was not reliable in all of the testing conditions attempted. But I was able to collect some helpful information. The OLED monitor white screen readings were the highest recorded, showing a reading of 177.0. By comparison, the LCD monitor's white screen reading was only 66.7. Even at the same 50% brightness setting I applied to each monitor, the OLED measured much brighter according to the light meter. This does not prove that all OLED monitors will be brighter than LCD monitors, because more recent advances in newer LCD monitors could show less dramatic reading differences. The two monitors I had to test were 10 years different in age, meaning the older LCD monitor might show lower light readings than a more modern 2025 LCD monitor. The light output measurements are shown in Figure 3.

During the light measurement experiments, I tried to use the light meter to capture low-level light readings on the monitors. When testing black screen, dark screen, and even bright game images across both monitors, the light meter had difficulty measuring any light output. With the naked-eye, I could tell that light was emitting from the monitors during these test scenarios, but the light meter I purchased was likely too low a quality to measure the faintest light settings. The measurements in these scenarios should not be treated as strong evidence because of the faulty or low-quality device measurements.

DISCUSSION

The experiments helped me understand that display technology is not just about which screen looks better. It is also about how the screen creates the image. OLED is very strong in dark scenes because black areas can be truly dark. That makes a difference in games like Resident Evil, where the mood of a scene depends on shadows and low light. But bright scenes and white screens can require more power, especially on a large, high-performance OLED monitor.

The LCD setup behaved differently across the experiments. On darker screens, it still had a baseline level of power consumption, which is what I expected from a backlit display. But because the LCD test used a 2015 MacBook Retina display assembly and the OLED test used a modern 27-inch 240Hz gaming monitor, the comparison was not perfectly controlled. The OLED screen was larger, newer, and built for gaming. The LCD was smaller and older. That means this project is better at showing real-world trade-offs than making claims that all computer users or gamers should rely on.

If I had a newer MacBook Pro to test against, the results would have been very different because the latest versions improved monitor performance across many specs. MacBook Pro displays in 2026 deliver 3x nit brightness (5x at peak), 10x color variations, and 2500 dimming zones (Apple, Apple). This is supported by reports from Apple and Alibaba who report, "Instead of dozens of large LED zones, Apple uses thousands of tiny LEDs (*up to 10,000 in the 16-inch model*) grouped into precise local dimming zones (up

to 2,500 zones). This enables deep blacks and high peak brightness (up to 1600 nits sustained, 2500 nits HDR)”. (Rodriguez)

My setup for the experiments was different from a real-world testing lab. For example, when testing power consumption, I was testing the power draw of the OLED monitor but comparing it against the power consumption of the entire MacBook. In a lab, test engineers would run tests purely comparing one monitor versus another, without measuring other things like CPUs that could influence power consumption measurements. In a 2011 research study by Somavat and Namboodiri, they found the LCD display from laptops showed power consumption between 20 - 25%. (Somavat, P., & Namboodiri)

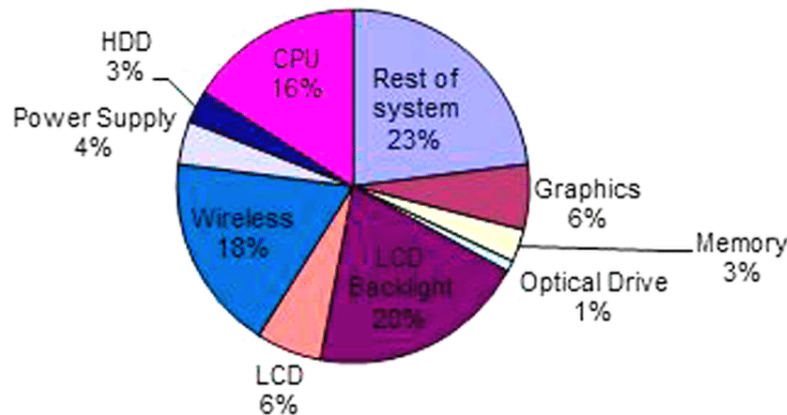


Figure 5. The LCD monitor drew 20% of the overall power of the laptop in this study of Energy consumption of personal computing including portable communication devices. Source: Somavat, P., & Namboodiri, V. (2011, July). (Somavat, P., & Namboodiri)

One other thing that would be different in a real-world lab would be the light meter. The meter we purchased on Amazon was not as accurate as I wanted it to be, especially in low-light environments. For the LCD screen, I could see the faint glow coming from the monitor on the darkest screen setting, but the Digital Illuminance Meter did not measure any light output. Real-world labs would have more sensitive light meters, and pitch black rooms, to capture the true output from the screens.

The other thing that true gamers will recognize as a flaw in the tests I ran is that they relied on static gaming images. Using these static images meant that I could get consistent apples-to-apples readings from the measurement devices. But real gamers understand that screens change with scenes every millisecond. More scientific results would have used many more gaming scenarios over a longer period of time to collect accurate measurements that could withstand the scrutiny of gamers like me.

The biggest thing I learned is that good engineering is usually not about one technology being perfect. It is about trade-offs. OLED can make dark games look better and may save energy in dark scenes, but it can use more power on bright images. LCD can be more consistent in some cases, but it depends on a backlight, which changes how black scenes look. Materials engineering matters because these differences come from the physical design of the display.

CONCLUSION

OLED and LCD monitors can both deliver exceptional experiences for users and gamers alike, but when comparing them by more scientific standards, differences appear. Depending on what is on the screen, power consumption changes, light output differs, and temperatures can fluctuate. In my experiments, the OLED monitor consumed less power when dark and black images were on the screen compared to white and bright images. The LCD monitor shows much smaller differences in power consumption overall with very little differences across black, gray, dark, and bright images.

Temperature readings across both monitors were fairly consistent, and stayed in safe comfortable ranges that were consistent with standard room temperature. Unfortunately, the quality of light readings produced limited reliable data to draw any strong conclusions from, due to the inability of the meter I used to register light in the dimmest test settings.

My main conclusion is that the differences between the OLED and LCD monitors is about their materials and engineering. The way OLED and LCD monitors produce light affects their power consumption, brightness, and heat dissipation. All of these together, produce a different experience for users, especially in how the game-play experience feels to them. Monitors aren't just showing the game, their materials, quality, and construction are part of the gaming experience. Engineering is not just what happens in the factories or with the engineers building the monitors, it makes a difference to the people playing the games, even in the most subtle, measurable ways.

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