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The New Light Is Bad There's something off about LED bulbs — which will soon be, thanks to a federal ban, the only kind you can buy.

By Tom Scocca, the editor of Indignity

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The lightbulb was flickering over my head. Not the idealized cartoon lightbulb, the universal symbol for a flash of inspiration, but a Philips-brand 800-lumen A19 LED bulb. I'd put one in the bedroom-ceiling fixture only a few months before. In theory, it should have been the last I would put up there for years, maybe even a decade. Instead, the bulb was a dim, dull orange, its levels of brightness visibly fluttering through the frosted dome.

LED bulbs do this to me all the time. The two in my youngest son's bedroom went near dark not long after I installed them. When I left them alone for a week, they inexplicably came back on at full blast. At story time, the LED in the clamp light on his bunk revolts if you cycle the power too fast. It sits there feebly glimmering, its perimeter a semicircle of white jelly-bean light blobs, until you turn it off and wait a while.

For most of my life, I expected energy-saving lighting to be bad. Traditional fluorescents, buzzing in grim-colored tubes, were synonymous with institutional austerity and migraines. A new generation of streetlamps somehow made city nights seem darker; CFLs shattered into mercury-flecked shards. New lighting tech was something people resented and worked around. My generation, presented with thrifty overhead fluorescents in '90s dorms, countered by plugging in the newly popular halogen torchieres, whose 300 blazing watts would incinerate wayward moths or occasionally a stray curtain along with the university's planned energy savings.

LEDs were going to be different. Their widespread appearance on store shelves was supposed to mark not another depressing trade-off but rather a Nobel-worthy breakthrough: They provided brilliant illumination at a fraction of the old energy costs and were nearly immortal by the old tungsten standard. The federal government has fully committed. Some rearguard action by the Trump administration delayed the process, but a new lighting-efficiency standard has finally taken effect. The Department of Energy is scheduled to start penalizing incandescent distributors and retailers this month, levying fines of as much as $542 per illicit bulb, with full enforcement of the ban beginning in August.

The plan is for LEDs to be the only available form of artificial lighting. Already, the old bulbs are dwindling to nothing on retailers' shelves. You have to know where to look — mom-and-pop hardware stores, mostly — to get your hands on a beige-sleeved pack of Hungarian-made GE Básica bulbs or a yellow pack of GE Blanco Suaves, both with a bold stamp on the side reading, NOT FOR SALE FOR USE IN THE UNITED STATES.

BEST IN CLASS

The Best Bad Bulb

Years ago, I got a head start, joining the LED revolution with fervor. Screwing one into a socket vacated by an incandescent felt like the easiest good-citizen points I'd ever earned, as if I could keep on doing things exactly as before but with better and greener results. And the light coming out of the things was — well, it was light, right? I don't remember how long

Illustration: Marcus McDonald

Strategist writer Erin Schwartz spoke to architects, designers, and LED enthusiasts to find the best lightbulb in a sea of bad options. ***Read about the very best LED lightbulbs here*** ➛

it took to notice, or think I had noticed, a series of letdowns: a faded look to the page of a storybook, a flicker in the corner of the eye, those sudden unexplained failures or half-failures. A slate-blue sock that was indistinguishable from a charcoal-gray one till I brought them over by the window. A certain unreality was creeping in.

We were renovating our apartment, and one day our contractor summoned me to the bathroom in dismay. He adjusted the dimmer switch he'd just installed, and a new LED fixture began strobing like we were in a seven-by-eight-foot basement dance club. We gave up and had him install a normal switch. The quirks were becoming malfunctions were becoming betrayals. Things I might once have ignored caught my eye. Out in the world, I noticed more and more public spaces had a frigid cast and a liminal flicker. The interiors of bubble-tea shops and ice-cream parlors took on a queasy aspect. Getting up in the early-morning darkness in a San Francisco Airbnb, I could see the bedside lamplight trembling.

I started to confide in people that I was seeing things, that the *light* was *wrong,* and usually they knew exactly what I was talking about. Over lunch, a friend unspooled an epic account of his quest for dimmable bulbs that would actually dim. A stranger in a shared taxi forwarded me a blog post he'd written about his conviction that the color of objects lit by LEDs was washed out and about his incredulity at how fast they failed.

A technology that was once the epitome of simplicity ("How many people does it take to change a lightbulb?") has become an ever-branching set of complications. Where before I would pick up a pack of 60-watt soft-white incandescents at the hardware store, I now search the internet for the highest-rated equivalent LEDs, then systematically cross-check those equivalences point by point. Everything you used to know about indoor illumination is outmoded. For 60 watts' worth of incandescent light, you're looking for about 800 lumens of LED output. To make that light come out the approximate color that the old bulb generated, you need to check the listed bulb temperature and make sure it's 2,700 degrees Kelvin.

Got it? Hang on. If you want the *objects* that the light shines on to look the same, you're getting into a different color question, specifically the color-rendering index. Your incandescent bulb — a glowing analog object, its light coming from a heated wire — had a CRI of 100 for a full unbroken spectrum. Your typical LED bulb, shining with cold digital electroluminescence, will not. Some colors will be missing or just different. If you're lucky, the LED will have a CRI of 90 or higher. The box may not list any CRI at all.

Oh, but: Experts agree that the color-rendering index doesn't really index how colors are rendered. Some bulbs with a 90 CRI make things look wan; some with an 80 are passable. There are better, more useful metrics, but you can't have them. Nobody puts them on the packaging. One lighting professional — an LED advocate, no less — told me he sometimes calls up the manufacturer and asks to talk to an engineer to get the real specs.

To study this stuff, to attempt to stare at light and understand it, makes you suspicious of any claims to objective truth. Snap a picture of an oddly tinted space and Apple's software will convert the image according to what it has machine-learned that white ought to be. The eye-brain system does its own constant white balancing, too. I downloaded an extremely erratic color-temperature app to try to get some grounding, an amateur feel for what professionals are trained to spot. I interrogated lighting designers, engineers, decorators, and researchers.

Most of them were enthusiasts about the technology. They praised LEDs, at their best, for their unmatched efficiency, precision, and practical power. They also said things like "There's a lot of nonperformance" and "Super–beta phase" and "Don't give up on beauty" and "You're going to spend $200 on four bulbs at Home Depot" and "You start seeing grayness."

Grayness — I was definitely seeing grayness. There ought to be a term for what happens when the light gets weaker and everyone acts as if it's as strong as always. By the science, by the ethics, even by law, the reign of the LED is a certainty. It is taking the place of the most standard and omnipresent technology we know. And yet, when you flip the light switch, you don't know what's going to happen.

One Bulb, Three Temperatures: Illuminating a doll-size *I Love Lucy* kitchen. From left, 3,000 Kelvin, 4,500 Kelvin, and 6,000 Kelvin. Photo: Beth Sacca

Ecologically, the case for LEDs is unassailable. Economically and practically, too, they're a godsend. Integrated LED fixtures are little miracles: In our kitchen and living room, which were gloomy and fixtureless, respectively, the contractor put in can lights without the can,

thin as saucers, brilliant, and free from the oppressive heat of recessed incandescents.

The heat! Most of the watts of electricity that flow into an incandescent bulb don't come out as visible light at all but as infrared. It's a handy feature if you're using a bulb to incubate chicken eggs or power an Easy-Bake Oven but otherwise pure waste.

Every LED that replaces an incandescent reduces that baseline waste by as much as 90 percent. Multiplied by dozens of sockets in a household, 125 million households in the country — the difference is millions of metric tons of carbon. As habit, inertia, and malfeasance keep the planet's carbon-consumption graphs veering upward toward collapse, the change from incandescent to digital lighting is one thing pulling measurably downward on the curve. And joining in will save the average American home an estimated $225 a year. LEDs, in this light, start to seem almost Promethean. Walk by a film shoot on Henry Street and you're no longer stepping over cables running from a generator truck. The lighting crews don't need to haul their own power supply with them anymore. In place of sweltering fire-hazard tungsten lights, they can now hold fixtures in their hands, right on top of the actors.

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This change happened incredibly quickly. Less than a decade after the Nobel physics committee honored Isamu Akasaki, Hiroshi Amano, and Shuji Nakamura for using gallium nitride to create powerful and efficient blue LEDs, their breakthrough work is everywhere: in headlights, streetlights, and flashlights; in construction-site tripods and Broadway rigging; in regal architectural coffers and the exploratory ends of colonoscopes.

And in my home. When they shine, that is. When they don't — when this basic piece of household equipment gets finicky or when the colors of things start slipping away — I feel my thoughts flickering somewhere darker, too. It's embarrassing to resent a product that's doing this much good, knowing all the while how grievance politics has dragged energy efficiency into the culture wars to the point where people who don't even cook are fetishizing gas stoves. It's literally a Donald Trump rally line: "I say, 'Why do I always look so orange?'" The broken clock, twice a day. "You know why. Because of the new light. They're terrible. You look terrible."

There is a world, almost within reach, in which LED lighting could be aesthetically fabulous. But right now, it's one more thing that overpromises and under-delivers. What we're starting to glimpse is a new phase in which good light, once easy to achieve and available to everyone, becomes a luxury product or the province of technological obsessives. The rest of the world will look a little more faded.

Metropolitan Museum of Art. Second floor, European Paintings, Gallery 614. I was standing in front of Jacques-Louis David's 1816 portrait of General Étienne-Maurice Gérard, and I was gazing not at the depicted light falling on Gérard's pale brow, or at the muddled play of clouds and gold in the sky behind him, but past the frame to the ceiling. Up there,

mounted behind the glass of a frosted laylight, were rows of LED spotlights forming bright blurry circles. They should have been uniform. Some were white; others were turning a sickly magenta or green. The person who had directed my attention to them was Amy Nelson, the museum's head of lighting design. "The quality of the light," she said, "is just not what we want it to be."

Nelson is in charge of the Met's ambitious project to overhaul the museum's lighting for the LED age — a long, piecemeal process that can involve anything from workers simply swapping out bulbs to architects and designers entirely rebuilding displays. Among the goals, Nelson said, is to eventually fill the museum with a standard white light — 3,000 degrees Kelvin, slightly crisper and cooler than the 2,700 of a soft-white incandescent bulb.

That was the theory. Now we were looking up at the reality of one of the Met's early LED installations from the mid-2010s. "The galleries looked beautiful when they opened," Nelson said. But the lamps had gone screwy. They were meant to have a life span of at least seven years, but even before that, their color had started to visibly decay. We walked on, through more of European Paintings, under still more fixtures that were shining past their point of practical failure. "It just looks like Christmas lights up there," Nelson said.

What Nelson had discovered is that LEDs are not good or bad but more like weird. The finickiness reflects the fundamental nature of the product. The LED bulb is the shape of an old lightbulb, and it fits into a lightbulb socket, and it gives off light, but it's not so much a lightbulb as a lightbulb emulator. What it is is a computer.

Where an old-fashioned tungsten filament can generally be trusted to be either intact or broken, the drivers and diodes inside the new bulbs are subject to the kinds of glitches and compatibility errors you get from other electronics, especially once dimmers get involved. They can crash or hang, or audibly buzz from electromagnetic interference, or go haywire from being fed the wrong kind of power signal.

LEDs, in other words, can be broken even when they appear to be working. "It's still *on*. You still have light coming out," Nelson said. "They don't just fail or burn out like a halogen source does. Oftentimes, there's light loss or there's color shift." When an LED bulb package says it's supposed to last a certain number of years, that doesn't tell you when the light will go dark. It's a guess about an arc of degradation. The end date is when the bulb is estimated to be 70 percent as bright as it started out.

The impetus is on you to decide when things have started to look uncanny. "I wish that would be addressed by the industry — like, maybe if it reached a certain light-loss factor, it would just shut down, you know?" Nelson said. "Or if it shifted in color past a certain point, it went into failure mode."

Earlier, in a gallery of ancient Chinese objects lit by halogens, Nelson showed me a Shang-dynasty bronze in a display case. When the setup was created, her designers were able to get focused four-degree spotlights to isolate items from their backgrounds. But lighting manufacturers are abandoning halogen as an obsolete technology, creating a shortage of reliable parts as they retool for an all-LED future. "Now, the tightest beam

we can find is a 12-degree," Nelson said. The bronze sat in a loose puddle of light, making the sides and back of the display as bright as the object itself, and stray purple rays spilled out of the halogens on the ceiling. "It's very hard to come by quality," she said.

In some places, newer and more finely tuned LEDs work magic. Nelson pointed out a Winslow Homer with watercolor oceans in stunning blues, brought to vibrant life even at the low foot-candle output required to protect the art. But not everybody, of course, has the Met's resources.

And once you know what to look for, you can't unsee it. A few weeks after I visited the museum, I watched a small ensemble of musicians run through new pieces by teen composers in a midtown studio. The facility was built 11 years ago, and the room still looked brand new, but when my eye went up to the ceiling, I could see the same color decay as at the Met. The shadows on the floor, pointing this way and that, were in pinks and greens. The light was coming apart.

For something you may assume is universal and constant, light turns out to be a culturally mediated and often paradoxical phenomenon. Our ideas about it start 93 million miles away — eight minutes and 20 seconds as the photon flies — with our friend the sun. The sun is close to what physicists call an ideal Planckian blackbody radiator, delivering a smooth and broad electromagnetic spectrum from radio waves up through infrared, visible light, ultraviolet, and X-rays. A hot tungsten wire does the same, only with a much narrower range of output tilted toward the red and infrared.

But here, unfortunately for the layperson, the terminology reaches a point that is profoundly counterintuitive. In physical light-emission terms, blue is a hotter temperature than red. The sun looks yellow up in the sky, but with a surface temperature of 5,772 degrees Kelvin, or about 10,000-degrees Fahrenheit, it has much more blue in it than an incandescent filament at 2,700 degrees Kelvin does. (A red-hot steel bar, in turn, would be somewhere down around 1,000 degrees Kelvin.) The higher the color temperature, the colder, in everyday speech, we say the light looks.

"Warm" colors are the colors of the things humans experience as being warm. Obviously enough, through millennia of human existence, the point of reference for artificial illumination was firelight or lamplight. But they don't burn at the same temperature as a star. If you bring a light source that is actually the color of the sun indoors, it stops looking golden and appears strikingly, severely blue. What to do about this fact is a debate that's been unresolved for well over a century: Should the ideal artificial light approximate the sun, or should it approximate a flame?

From an engineer's point of view, the answer seems clear. Blue light is rational: These are the literal technical specifications of our ultimate light source. A bulb "with its proper proportions of violet light as determined by our natural illuminant the sun is to be desired and not avoided," declared a piece in the July 10, 1897, issue of the journal *Western Electrician*. But with certain exceptions — the incursion of fluorescent tubes, the creation of blue-tinged "daylight" incandescents — it was the warm-light faction that ruled most of the electric age. The tones of a standard incandescent bulb

may have been too warm, scientifically speaking, spilling emissions right off the bottom of the visible spectrum into useless waves of heat, but they were what the lightbulb-using public expected.

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Still, today, this preference for orangish light over bluish is not universal. Hervé Descottes, the founder of the high-end lighting-design firm L'Observatoire International, told me that he once worked on two projects at the same time: a museum in Helsinki and a shopping center in Hong Kong. He flew to Helsinki for a meeting, "and in the meeting room, in the center of the table, they light a candle," he said. "It's very Scandinavian, you know. *Get the warmth*." He then flew to Hong Kong, where the temperature and humidity, he recalled, were both in the 90s. That meeting was held in a space with no windows and ceiling lamps cranking out 5,000 degrees Kelvin. "Because when we've put in cool light, we feel that it's cooler outside," he said. Another time, in Singapore, Descottes found himself arguing with clients who wanted the coldest, brightest lighting for the executive floors of a tower to signify abundance.

Medical science, surprisingly, comes down on the side of the cozy candle-burning romantics. The body's internal clock is tuned to sunlight, and when artificial light imitates the sun, as the warnings about using your phone at bedtime tell you, things start going wrong. At the start of this century, biologists pinned down the workings of intrinsically photosensitive retinal ganglion cells — a whole separate sensing apparatus in the human eye beyond the brightness-sensing rods and the color-sensing cones you learn about in school. As with the taste buds that detect umami, the retinal ganglion cells were there, but generations of scientists had left them out of their perceptual models.

These cells are keyed to light between blue and green, with a peak sensitivity to wavelengths of about 480 nanometers, around cyan. "They're not actually connecting to our visual cortex," said Michael Royer, a color expert at the Department of Energy's Pacific Northwest National Laboratory. "They're going to other parts of our brain — the prefrontal cortex, the hypothalamus, these parts of the brain that are really critical to all our other functioning. And they're just sending signals: *Hey, it's daytime right now, so it's time to be alert*."

If blue light is overstimulating and clammy, it'd be better for our brains to have less of it in indoors, especially late at night. But blue light is also cheaper. Adding warm tones to a blue LED requires extra material and effort. To get something in the whitish color range of traditional indoor lighting, manufacturers coat the underlying blue elements with phosphor, which shifts some of the photons to longer wavelengths — that is, greens and yellows and reds. (This coating partly explains why LED color varies over time. As the diode heats and cools again and again, "maybe the phosphor will curl a little bit," says Royer. "And those tiny changes will allow a different amount of blue photons to escape versus yellow.")

Last year, the New York *Times* warned in a front-page story that "lower-end retailers like dollar stores or convenience shops still extensively stock

their shelves with traditional or halogen incandescent bulbs, even as stores serving more affluent communities have shifted to selling far more efficient LEDs." This was, the *Times* fretted, preventing poorer people from receiving the benefits of energy efficiency. The studies the newspaper cited, finding incandescent bulbs on discount-store shelves, were both a few years old. I checked my nearest dollar store and discovered that there were plenty of LED bulbs to be had there. Their color temperature was 6,400 Kelvin — the harshest, cheapest possible light, a light so blue that when I Googled it, what came up were grow bulbs. The efficient future of lighting now includes poor people; it just does it by making lighting one more form of privation.

Checking for spares in my mom's basement recently, I discovered that she had picked up a pack of 5,000 Kelvin bulbs to replace her living-room floodlights. Of all the people to have made this mistake! Mom used to teach schoolchildren about color perception, showing them how that part of their vision faded in the periphery or how a wheel of colored panels mounted on a salad spinner would turn gray. But she had no idea what 5,000 Kelvin meant, and the package had no color-rendering index at all. Had she ever put the things into her ceiling, she'd have ended up with a living room that looked like the inside of a refrigerator.

It's true that CRI numbers are kind of useless. All else being equal, if light on an object gets dimmer — if you start with an object outdoors, in full sunlight, then bring it indoors to that same daylight, but less of it, now coming through a window — the object will appear more gray. The way color rendering is defined, the diminished light is performing at the same level as it did outside. The color-rendering index scores it the same. But the object looks worse.

In lower light, people prefer to see the vividness of colors boosted, especially in the reds. Incandescent lights naturally boost reds as they get dimmer and the temperature of their filament gets lower. LEDs, again, operate in a fundamentally different way. Many cannot dim at all; those that are advertised as dimmable do not reduce their temperature or even reduce the intensity of the light they put out. Instead, a common method is to adjust how frequently they switch off and on, which is dozens of times per second. Extra-sensitive people can sometimes detect this flicker or find themselves with unexplained headaches and dizziness. For everyone, the light gets even duller looking than before.

Royer is a fellow at the Illuminating Engineering Society (motto: "Improving Life Through Quality of Light"), which has created an elaborate alternative to CRI called TM-30. In this scheme, bulbs are classified under three separate but interrelated categories: P, V, and F, for preference, vividness, and fidelity, each of which is further broken down into subcategories indicating performance level. Manufacturers and retailers have not agreed to this new scoring system. "They don't want to provide a lot of information that might confuse consumers," Royer said. "But consumers aren't going to understand information until it's provided to them."

If you don't mind spending extra money — say, three or four times as much per bulb, plus a $60 controller — and fooling around inside an app, you can

get color-tunable lightbulbs today. They have different colored LEDs inside, instead of simply phosphor-treated blue ones. The Department of Energy notes that programming the bulb controls “may not be intuitive,” that tunable whites won’t necessarily match any other whites, and that colors may come out “cartoonlike.” And they won’t save as much electricity. The LED industry is still trying to develop an efficient green LED to go with the red, blue, and amber ones. Royer remains hopeful and is encouraged by the continued search for improvement. Tunable LEDs may overtake phosphor-converted bulbs in efficiency by the 2030s.

Until then, there’s amber nail polish. Ordinary, transparent amber from the drugstore. “I highly recommend every person who reads this story buy this nail polish and start painting it on their LED bulbs,” said Robin Standefer. “It is a game changer.” Standefer is one of the founders of Roman and Williams Buildings and Interiors, a design company that works with Descottes and L’Observatoire. We were talking on Zoom, and behind her was a paper Noguchi lamp. “It’s the most beautiful light in the world,” she said, “but you put an LED in and it’s not that beautiful.” To compensate, she’d wrapped the bulb in a filter.

I wanted to see the best possible application of LED lighting, so Standefer said I had to go downtown. At dusk, I took a blazingly lit N train (my light-meter app reported 4,292 Kelvin) to the Roman and Williams Guild and La Mercerie, their combined retail store and restaurant on Howard Street. The light inside was opulent and gorgeous. Tall candles flickered on the dining tables, but everything else was LED. As I studied the fixtures in the store — in burnished bronzes with glass that was dark and pearly, or a delicate nude pink, and with prices starting in the low four figures — I realized that the surrounding lighting had subtly dimmed and warmed, shifting its Kelvin temperature for nighttime. In the restaurant, copper pans gleamed and a row of double-magnum bottles of rosé glowed extra pink. The bread’s crust was shaded in lush browns. Stacked white towels were creamy, and spotlights from tracks overhead threw the shadows of the candles this way and that on the tables.

It was sublime. And if I really wanted to experience LEDs at their most exquisite, Standefer said, I should see what Descottes and Roman and Williams had done at Le Coucou, another client. I walked two blocks east and stepped inside. The restaurant was wonderfully dim, the dimness alive with color and warmth. Huge chandeliers hung with rings of dozens of flame-tipped bulbs in rose-pink inverted glass cups. That glass, Standefer had told me, was Roman and Williams’s special formula for LED bulbs, the work of a septuagenarian glassblower in Brooklyn. “If she stops blowing this glass, I don’t know what I’ll do, because she’s been the only person to achieve a very beautiful color in the glass,” she said.

Inside the bulbs were the little V’s of filaments. You can do remarkable things with LED filaments these days, reviving old-timey clear bulb shapes with all sorts of whorls or zigzags. I swore they looked just like the real thing.

I was trying to figure out how to describe the particular color the light made on the white ductwork above — the color of the flesh of a white peach, I decided — when I ran into John Barclay, the facilities manager for Le Coucou and its sister restaurants. Barclay studied theater lighting in college

before going into hospitality, and when LEDs arrived, he gave himself a crash education in the technical ins and outs. Now he was near evangelical about the LEDs. He ran through the interplay of the lighting sources: The chandeliers were at about 1,700 Kelvin, he said, while spotlights above the tables were at 2,400 and task lighting in the kitchen was slightly colder, at 2,700, to give the staff a precise look at the plated food on the way out.

I'd been told I had to see the restroom. I went to see the restroom. The all-pervading glow was so honeyed I couldn't tell if the grab bar by the toilet was mere steel or luxurious brass.

Maybe I was wrong about LEDs. Maybe I just had to be patient — to wait and let this luminous future trickle down to the rest of us. Later, upon follow-up questioning, I learned that the warmly glowing filaments in the Le Coucou chandeliers are not, in fact, LEDs. They are hot wire filaments. Inside the LED-optimized glass of the chandelier fittings, the LED-forward restaurant is still using incandescents for that ineffable and as yet irreplaceable glow.

I asked Barclay how he would navigate the future. "In the near term," he said, "I have a large stock of those bulbs."