Product Environmental Report

MacBook Pro 16-inch

Date introduced
October 30, 2024

Progress toward our 2030 goal

40% recycled content[1]

More than 45% of manufacturing electricity sourced from renewable energy[2]

Packaging

100% fiber-based, due to our work to remove plastic in packaging.[3]

100% recycled or responsibly sourced wood fibers.[4]

Supplier Code of Conduct

Through the Apple Supplier Code of Conduct, we set strict standards for safeguarding people and the environment in our supply chain.

Smarter chemistry[5]

- Arsenic-free glass
- Mercury-free
- Brominated flame retardant–free
- PVC-free

Longevity

We assessed MacBook Pro 16-inch in our Reliability Testing Lab using rigorous testing methods that simulate customers' experiences.

Recovery

Return your device through Apple Trade In—at a retail store or online—and we'll give it a new life or recycle it for free.

MacBook Pro 16-inch uses 100 percent recycled gold plating, tin solder, and copper in multiple printed circuit boards

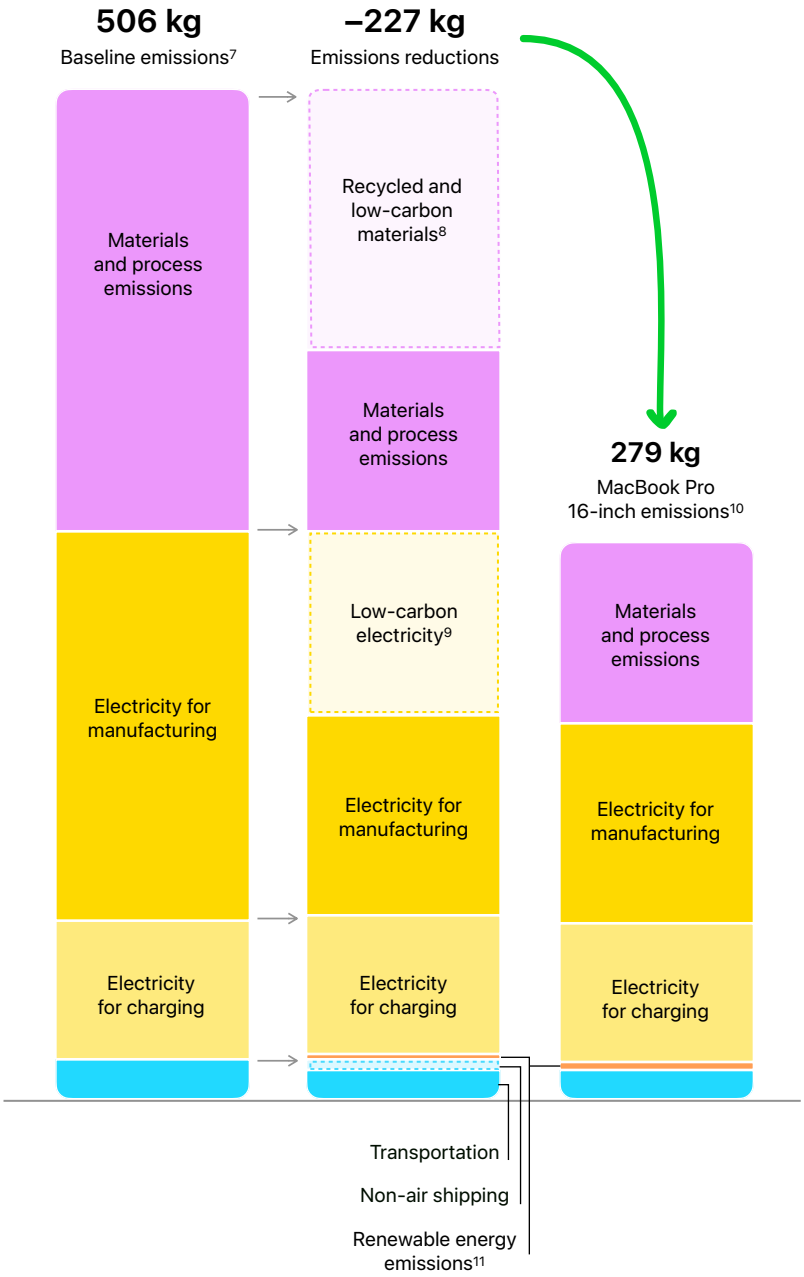
This report includes data current as of product launch. Product evaluations are based on U.S. configuration of MacBook Pro 16-inch. Product carbon footprint calculations include in-box accessories as well as packaging.

ENERGY STAR

epeat GOLD [6]

Progress toward carbon neutral

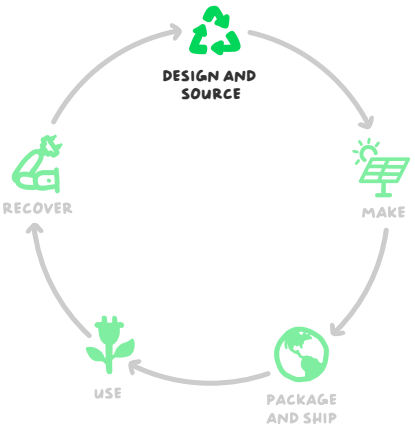
We've reduced emissions for MacBook Pro 16-inch with 512GB by 45 percent against our business-as-usual scenario as modeled by Apple.[7] This device contains 40 percent recycled content, including 100 percent recycled aluminum in the enclosure, reducing total product emissions by about 25 percent. We're also working with our suppliers to transition to 100 percent low-carbon electricity for Apple production. The low-carbon electricity solutions that suppliers have already implemented to date have reduced product emissions by more than 15 percent. In our carbon footprint calculations, we also account for the emissions necessary to generate low-carbon electricity, specifically to manufacture and maintain renewable energy infrastructure, like wind and solar farms.



Taking responsibility for our products at every stage

We take responsibility for our products throughout their life cycles—including the materials they are made of, the people who assemble them, and how they are recycled at end of life. And we focus on the areas where we can make the biggest difference for our planet: reducing our impact on climate change, conserving important resources, and using safer materials.

We sell millions of products. So making even small adjustments can have a meaningful impact.



Design and Source

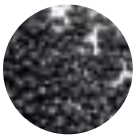
MacBook Pro 16-inch contains 40 percent recycled or renewable content.[1]

To conserve important resources, we work to reduce the material we use and aim to one day source only recycled or renewable materials for our products. And as we make this transition, we remain committed to the responsible sourcing of primary materials. We're proud to be recognized as a worldwide leader in the responsible sourcing of minerals in our products. We map many materials, some to the mineral source, and establish the strictest standards for smelters and refiners. Apple also requires all identified tin, tantalum, tungsten, gold, cobalt, and lithium smelters and refiners to participate in third-party audits.[12] By 2025, we plan to use 100 percent recycled cobalt in all Apple-designed batteries,[13] 100 percent recycled tin soldering and 100 percent recycled gold plating in all Apple-designed rigid and flexible printed circuit boards, and 100 percent recycled rare earth elements in all magnets. Our product designs also consider the safety of those who make, use, and recycle our products, restricting the use of hundreds of harmful substances. Our standards go beyond what's required by law to protect people and the environment.

Aluminum. We use 100 percent recycled aluminum in the enclosure.

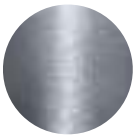
Copper. We use 100 percent recycled copper in multiple printed circuit boards and in multiple thermal module components.

Gold. We use 100 percent recycled gold in the plating of multiple printed circuit boards.



Plastic. We use at least 35 percent recycled plastic in 11 components.

Rare earth elements. We use 100 percent recycled rare earth elements in all magnets, representing 98 percent of the total rare earth elements in the device.



Steel. We use 90 percent recycled steel in the keyboard feature plate.

Tin. We use 100 percent recycled tin in the solder of multiple printed circuit boards.

Smarter chemistry

MacBook Pro 16-inch is free of harmful substances like brominated flame retardants, PVC, phthalates, arsenic in the glass, and mercury.[5] And 100 percent of the materials in MacBook Pro 16-inch are covered by our Regulated Substances Specification. We go beyond what's required by aiming to understand the non-regulated substances in every part of every product—an effort that requires an industry-leading level of transparency through the entire supply chain. We consistently identify the makeup of over 80 percent by mass of Mac devices.

Make

The Apple Supplier Code of Conduct sets strict standards for safeguarding people and the environment in our supply chain. Every year, we assess our suppliers' performance in upholding the standards required by our Code.

We work closely with our suppliers to provide safe and healthy workplaces where people are treated with dignity and respect, and to reduce suppliers' environmental impact. Our requirements apply across our supply chain and include the responsible sourcing of materials. From the strong foundation set by our Code, we go further—from helping suppliers transition to low-carbon electricity, to providing educational opportunities, to supporting suppliers in reducing waste. For more information, see apple.com/supplychain.

Smarter chemicals

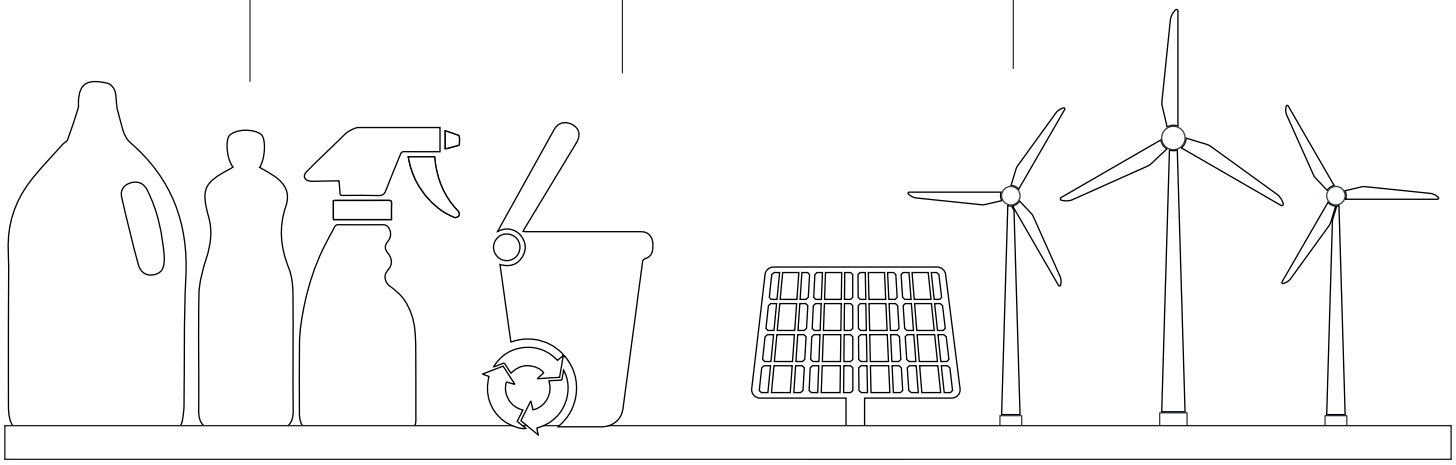
All established MacBook Pro 16-inch final assembly supplier sites use safer cleaners and degreasers in their manufacturing processes, as determined by methodologies like the GreenScreen® assessment.[14]

Zero Waste to Landfill

No established MacBook Pro 16-inch final assembly supplier sites generate any waste sent to landfill.[15]

Supplier energy use

Over 45 percent of manufacturing electricity is sourced from supplier low-carbon energy projects, supported by Apple's Supplier Clean Energy Program.[2]



Package and Ship

MacBook Pro 16-inch packaging is 100 percent fiber-based and contains no plastic except for inks, coatings, and adhesives, a milestone toward our commitment to remove plastics from packaging by 2025.[3]

We are working to improve our packaging across all products, including removing plastics, increasing recycled content, and reducing the volume of our packaging. Our packaging for MacBook Pro 16-inch contains 50 percent recycled content, and we have protected or established enough responsibly managed forests to cover all the new wood fiber we use in our packaging.[4] This ensures working forests are able to regrow and continue to clean our air and purify our water.

As we transport our products from our manufacturers to our consumers, we're prioritizing less carbon-intensive shipping modes than air transport, such as rail and ocean.

100%

of the packaging[3] is fiber-based, due to our work to remove plastic in packaging

50%

recycled content in fiber packaging

100%

of the virgin wood fiber in the packaging is responsibly sourced[16]

Use

MacBook Pro 16-inch uses 50 percent less energy than the requirement for ENERGY STAR.[17]

We design our products to be energy efficient, long-lasting, and safe. MacBook Pro 16-inch uses software and power-efficient components that intelligently manage power consumption. We also run our own Reliability and Environmental Testing Labs, where our products go through rigorous testing before they leave our doors. Our support continues throughout each product's life cycle, with regular software updates to keep devices current. We have also expanded access to safe, reliable, and secure repairs by increasing the number of Apple Authorized Service Providers (AASPs). To address emissions tied to the electricity our products use, we are building low-carbon energy projects and engaging with our customers to educate and provide opportunities to support the decarbonization of the grid.

Energy consumption of ENERGY STAR–rated products

Apple devices consistently rank among the high-performing products rated by ENERGY STAR, which sets specifications that typically reflect the 25 percent most energy-efficient devices on the market. MacBook Pro 16-inch consumes 50 percent less energy than the requirement for ENERGY STAR.[17]

Designed to last

MacBook Pro 16-inch features a durable unibody construction and has undergone rigorous testing for durability.

Made with smarter chemistry

We apply rigorous controls for materials users touch—all based on recommendations from toxicologists and dermatologists.

Apple Trade In

For more information on how to recycle your products at end of life, visit:

apple.com/recycle

Recover

Return your product with Apple Trade In, in-store or online, and we'll ensure it has a long life or recycle it for free.

We design our products to be durable so they are used longer. And we want the materials in our products to live on in other products. That's why we launched Apple Trade In—it provides customers with product end-of-life options. With Apple Trade In, you can get a great value for your current device and apply it toward a new one or get an Apple Store Gift Card. If your device isn't eligible for credit, we'll recycle it for free through product take-back and recycling collection programs.[18] And even after a product reaches the end of its life, the materials within it can serve the next generation of products. We provide or participate in product take-back and recycling collection programs in 99 percent of the countries where we sell products. We work with best-in-class recyclers to maximize the potential of the recycling materials stream and drive our efforts to close the loop on key materials. We define best-in-class recyclers as those capable of recovering materials at high rates and doing so with better environmental and safety performance.

We're also creating Apple Recycler Guides to provide guidance for professional electronics recyclers on how to safely disassemble Apple products to maximize recovery of resources. The guides provide valuable insight into the steps for recycling and locations of materials in the products.

Definitions

Bio-based plastics: Bio-based plastics are made from biological sources rather than from fossil-fuel sources. Bio-based plastics allow us to reduce reliance on fossil fuels.

Carbon footprint: Estimated emissions are calculated in accordance with guidelines and requirements as specified by ISO 14040, ISO 14044, and ISO 14067. There is inherent uncertainty in modeling carbon emissions due primarily to data limitations. For the top component contributors to Apple's carbon emissions, Apple addresses this uncertainty by developing detailed process-based environmental models with Apple-specific parameters. For the remaining elements of Apple's carbon footprint, we rely on industry average data and assumptions. We calculate carbon emissions using the 100-year time horizon global warming potentials (GWP100) from the IPCC Sixth Assessment Report (AR6), including biogenic carbon. Our carbon footprint calculation includes emissions for the following life cycle phases in CO_2 equivalency (CO_2e):

- **Production:** Includes the extraction, production, and transportation of raw materials, as well as the manufacture, transport, and assembly of all parts and product packaging.
- **Transport:** Includes ground, air, and sea transportation of the finished product and its associated packaging from manufacturing site directly to customers or regional distribution hubs. Regional transport is modeled using average distances.
- **Use:** Apple assumes a three-year period for power use by first owners for iOS and watchOS devices and a four-year period for macOS, iPadOS, and tvOS devices. Product use scenarios are based on historical customer use data for similar products. Energy use is simulated in various ways; for example, by modeling daily battery drain or through performing activities like movie and music playback. Geographic differences in the power grid mix have been accounted for at a regional level.
- **End-of-life processing:** Includes transportation from collection hubs to recycling centers and the energy used in mechanical separation and shredding of parts.

  For more information on our product carbon footprint methodology, visit apple.com/environment/answers.

Low-carbon electricity: Refers to both renewable electricity as well as other fossil-free projects that Apple considers "low-carbon" but not "renewable," like nuclear and large-impact hydroelectricity projects, which may be included as a result of low-carbon electricity provided by the grid. Apple accounts for the carbon impact of building and operating these projects, and so considers them to be low-carbon but not zero-carbon.

Low-carbon materials: Refers to materials created using production techniques with reduced carbon impact, such as Elysis (a patented technology that eliminates direct greenhouse gas emissions from the traditional aluminum smelting process) or aluminum smelted using hydroelectricity instead of coal.

Recycled materials: Recycling makes better use of finite resources by sourcing from recovered rather than mined materials. Recycled content claims for materials used in our products have been verified by an independent third party to a recycled content standard that conforms to ISO 14021.

Renewable materials: We define bio-materials as those that can be regenerated in a human lifespan, like wood fibers or sugarcane. Bio-materials can help us use fewer finite resources. But even though bio-materials have the ability to regrow, they are not always managed responsibly. Renewable materials are a type of bio-material managed in a way that enables continuous production without depleting the earth's resources. That's why we focus on sources that are certified for their management practices.

Supplier Clean Energy Program: Since the electricity used to make our products is the largest contributor to our overall carbon footprint, we're helping our suppliers decarbonize their Apple production, including by transitioning electricity use to 100 percent renewable sources.

Carbon Footprint

Greenhouse gas emissions were calculated using a life cycle assessment (LCA) methodology in accordance with ISO 14040, ISO 14044, and ISO 14067 standards and based on MacBook Pro 16-inch. The LCA boundary for this product includes the physical product and all of its components, packaging, as well as all in-box accessories (such as charging cables or power cords).

Greenhouse gas emissions	MacBook Pro 16-inch 512GB
Total product footprint	**279 kg CO_2e**
Apple emissions from utility-purchased electricity (scope 2)	0 kg CO_2e
Life cycle product emissions (scope 3)	279 kg CO_2e
• Production	69%
• Transportation	6%
• Product use	25%
• End-of-life processing	<1%
GHG reductions achieved[7]	↓45%

Note: Percentages may not total 100 due to rounding.

We've calculated the product carbon footprint for the following configuration.

Configuration	MacBook Pro 16-inch 1TB M4 Max
1TB	303 kg CO_2e

We model different configurations of our products to show the potential range of carbon emissions. This carbon footprint data is accurate as of launch. There is inherent uncertainty in modeling carbon emissions due primarily to data limitations. For the top component contributors to Apple's carbon emissions, Apple addresses this uncertainty by developing detailed process-based environmental models with Apple-specific parameters. For the remaining elements of Apple's carbon footprint, we rely on industry-average data and assumptions.

For more information on our product carbon footprint methodology, visit apple.com/environment/answers.

Endnotes

[1] Product recycled or renewable content is the mass of certified recycled material relative to the overall mass of the device, not including packaging or in-box accessories.

[2] We estimate the percentage of electricity-related emissions in our manufacturing that is sourced from low-carbon electricity by attributing to our carbon model low-carbon energy procured by our suppliers in the prior fiscal year, based on the supplier manufacturing allocations at time of product launch. This calculation assesses the suppliers for MacBook Pro 16-inch with 512GB. Included in this number is only low-carbon electricity that Apple or its suppliers have procured as part of Apple's Supplier Clean Energy Program.

[3] Breakdown of U.S. retail packaging by weight. Adhesives, inks, and coatings are excluded from our calculations of plastic content and packaging weight.

[4] For more information about our work to protect and create responsibly managed forests, please read our Environmental Progress Report.

[5] Apple's Regulated Substances Specification describes Apple's restrictions on the use of certain chemical substances in materials in Apple products, accessories, manufacturing processes, and packaging used for shipping products to Apple's end customers. Restrictions are derived from international laws or directives, regulatory agencies, eco-label requirements, environmental standards, and Apple policies. Every Apple product is free of PVC and phthalates except for AC power cords in India, Thailand (for 2-prong AC power cords), and South Korea, where we continue to seek government approval for our PVC and phthalates replacement. Apple products comply with the European Union Directive 2011/65/EU and its amendments, including exemptions for the use of lead such as high-temperature solder. Apple is working to phase out the use of these exempted substances for new products where technically possible.

[6] MacBook Pro 16-inch achieved a Gold rating in the United States and Canada, in accordance with IEEE 1680.1 or UL 110, and is listed as such on the Electronic Product Environmental Assessment Tool (EPEAT) Registry. EPEAT registers computers, displays, and mobile phones based on environmental requirements in these standards. For more information, visit www.epeat.net.

[7] Carbon reductions are calculated against a product-specific business-as-usual scenario as modeled by Apple: 1) No use of clean electricity for manufacturing or product use, beyond what is already available on the latest modeled grid (based on regional emissions factors). 2) Apple's carbon intensity of key materials as of 2015 (our baseline year for our 2030 product carbon neutrality goal). Carbon intensity of materials reflects use of recycled content and production technology. 3) Apple's average mix of transportation modes (air, rail, ocean, ground) by product line across three years (fiscal years 2017 to 2019) to best capture the baseline transportation emissions of our products.

[8] We calculate emissions savings from the use of recycled or low-carbon materials in our products by comparing the carbon intensity of key materials today with their 2015 baseline for Apple products or using industry average data. We currently only quantify the carbon savings from the use of recycled aluminum, titanium, stainless steel, lithium, cobalt, tungsten, and gold in select parts for select products. This means the actual emissions avoided from recycled materials are likely larger. We plan to improve our accounting of recycled content over time.

[9] We estimate the percentage of electricity-related emissions in our manufacturing that is sourced from clean electricity by attributing to our carbon model clean energy procured by our suppliers in the prior fiscal year, based on the supplier manufacturing allocations at time of product launch. Included in this number is only clean electricity that Apple or its suppliers have procured as part of Apple's Supplier Clean Energy Program.

[10] Greenhouse gas emissions were calculated using a life cycle assessment methodology in accordance with ISO 14040, 14044, and 14067 standards and based on MacBook Pro 16-inch with 512GB storage configuration. The life cycle assessment boundary for this product includes the physical product and all of its components, packaging, as well as all in-box accessories.

[11] Renewable energy emissions are too small to be visible on the chart.

[12] We map materials in our supply chain and publish a list of identified tin, tantalum, tungsten, gold (3TG), cobalt, and lithium smelters and refiners in our supply chain. Third-party assessments seek to confirm sourcing practices and are part of our responsible sourcing program. In addition, our efforts consider a broad range of risks, including social, environmental, human rights, and governance risks.

[13] All cobalt in the battery claims or references use mass balance allocation.

[14] Chemicals that meet GreenScreen® benchmark 3 or 4 or other equivalent methodologies like U.S. EPA Safer Choice are considered safer and preferred for use. GreenScreen® is a comprehensive hazard assessment tool that evaluates substances against 18 different criteria. For more information, visit www.greenscreenchemicals.org.

[15] All established final assembly supplier sites—those that have been Apple suppliers for more than one year—for MacBook Pro 16-inch are third-party verified as Zero Waste by UL LLC (UL 2799 Standard). UL requires at least 90 percent diversion through methods other than waste to energy to achieve Zero Waste to Landfill (Silver 90–94 percent, Gold 95–99 percent, and Platinum 100 percent) designations.

Endnotes

[16] Responsible sourcing of wood fiber is defined in Apple's Responsible Fiber Specification. We consider wood fibers to include bamboo.

[17] Energy consumption and energy efficiency values are based on the ENERGY STAR Program Requirements for Computers, including the max energy allowance for MacBook Pro 16-inch. For more information, visit www.energystar.gov. ENERGY STAR and the ENERGY STAR mark are registered trademarks owned by the U.S. Environmental Protection Agency.

MacBook Pro 16-inch is tested with a fully charged battery and powered by the 140W USB-C Power Adapter with the USB-C to MagSafe 3 Cable (2m).

- Off: Lowest power mode of the system. System is shut down.
- Sleep: Low power state that is entered automatically after 10 minutes of inactivity (default), or by selecting Sleep from the Apple menu. Wake for network access enabled.
- Idle—Display on: System is on and has completed loading macOS. Display brightness was set as defined by ENERGY STAR Program Requirements for Computers and Auto-Brightness was turned off. Connected to Wi-Fi.
- Power adapter, no-load: Condition in which the 140W USB-C Power Adapter with the USB-C to MagSafe 3 Cable (2m) is connected to AC power, but not connected to the system.
- Power adapter efficiency: Average of the 140W USB-C Power Adapter with the USB-C to MagSafe 3 Cable (2m) measured efficiency when tested at 100 percent, 75 percent, 50 percent, and 25 percent of the power adapter's rated output current.

	Power consumption for MacBook Pro 16-inch with M4 Pro		
Mode	**100V**	**115V**	**230V**
Off	0.23W	0.24W	0.25W
Sleep	0.40W	0.40W	0.41W
Idle—Display On	6.43W	6.53W	6.58W
Power adapter, no load	0.04W	0.04W	0.05W
Power adapter efficiency	86.8%	87.9%	87.8%

	Power consumption for MacBook Pro 16-inch with M4 Max		
Mode	**100V**	**115V**	**230V**
Off	0.23W	0.23W	0.25W
Sleep	0.43W	0.45W	0.43W
Idle—Display On	7.35W	7.47W	7.59W
Power adapter, no load	0.04W	0.04W	0.05W
Power adapter efficiency	86.8%	87.9%	87.8%

[18] Trade-in values vary based on the condition, year, and configuration of your trade-in device, and may also vary between online and in-store trade-in. You must be at least 18 years old. In-store trade-in requires presentation of a valid, government-issued photo ID (local law may require saving this information). Additional terms from Apple or Apple's trade-in partners may apply.

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