2019 IBM and the Environment Report

30th Annual
Environmental Report

Letter from the IBM President

As we publish this 30th edition of IBM's annual corporate environmental report, the world is in crisis: we are in the midst of a pandemic, a global economic contraction, and the heartbreaking persistence of racial inequality.

In times like these, it would be easy for business leaders to neglect their responsibility for environmental protection, including the existential threat of climate change. But that would be a terrible mistake. In fact, this confluence of crises has delivered urgent lessons about the relationship between human activity and the health of our planet.

Consider this: Just ten days after India's nationwide coronavirus lockdown, residents of Punjab saw the Himalayas for the first time in a generation. With no tourist activity for weeks, the canals of Venice ran clear and blue. And rates of asthma across Europe dropped dramatically. Smog in Los Angeles dissipated.

These events are the unintended consequences of COVID-19 lockdowns around the world, and proof that, given the chance, the world begins to recover with stunning speed. These crises have opened our eyes, however temporarily, to what is possible. And that's why I believe this moment constitutes a renewed mandate for change; an opportunity to not just rebuild, but to build back smarter: making our world more sustainable by reinforcing our commitment to environmental leadership.

Core to these efforts will be accountability: setting goals, and measuring progress against those goals, with complete and transparent reporting. For this reason, I'm proud to say that the annual IBM and the Environment Report remains a model of excellence.

In fact, IBM has been a leader in corporate sustainability for half a century. We issued our first corporate environmental policy statement in 1971, and since that time have made significant progress in managing waste, conserving energy, using renewable electricity, reducing carbon dioxide emissions, and helping our clients build sustainable futures. This work will continue unabated, through the difficult times we face today, and in the better times ahead.

Jim Whitehurst
IBM President
July 2020

Highlights from IBM's 30 years of environmental reporting

The PERI Guidelines

In 1994, IBM and nine other companies published the Public Environmental Reporting Initiative (PERI) Guidelines for voluntary corporate environmental reporting across industry sectors, helping set the stage for what is now a routine practice.

Materials: from CFCs to PFOS

IBM eliminated CFCs and other Class 1 ozone-depleting substances from its operations in 1993; ethylene-based glycol ethers in the mid-1990s; certain perfluorinated compounds (PFOS and PFOA) in 2010; and others in between.

Position on climate change

IBM first published its position on climate change in 2007, saying then, unequivocally, that "climate change is a serious concern that warrants meaningful action on a global basis." We supported the Paris Agreement in 2015 and reaffirmed our support in 2017.

Product energy efficiency

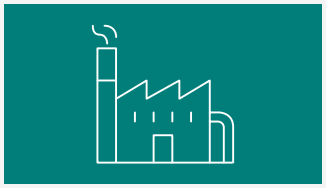
IBM was a charter member of the U.S. Environmental Protection Agency's ENERGY STAR program in 1992 and was Partner of the Year twice during the 1990s. IBM currently has 3 server products and 11 storage systems certified to ENERGY STAR criteria.

Energy conservation

Since 1990, IBM has conserved 7.7 million megawatt-hours of electricity, avoided 4.5 million metric tons of carbon dioxide (CO_2) emissions, and saved $646 million. Using less energy for the same task has always been paramount at IBM for addressing climate change.

Renewable electricity

IBM made its first contracted purchases of renewable electricity in 2001 and began reporting on its consumption of renewable electricity in 2003. Today, 47% of the total electricity IBM consumes comes from renewable sources (contracted and grid-supplied).



CO_2 emissions reduction

IBM began reporting its CO_2 emissions in 1995. In 2000, IBM established its first operational CO_2 emissions reduction goal. We are now reporting against our 4th generation goal and have achieved a 39.7% reduction in our CO_2 emissions against a 2005 baseline.

Remedial responsibilities

IBM continues to dependably remediate groundwater at certain former sites, fulfilling its responsibilities from decades ago when it operated as a vertically integrated manufacturer.

Waste recycling

In 1990, IBM reported that it sent 35% of nonhazardous waste for recycling and that its goal was 50%. Today, IBM sends nearly 89% of its nonhazardous waste for recycling.

Product reuse and recycling

IBM began publicly reporting the amount of end-of-life products it collected for reuse and recycling in 1995. Since then, we have collected and processed nearly 2.4 billion pounds, and today, we send less than 1% to landfill or for incineration as waste.

Solutions

From 1990 through 2020, IBM has been reporting how information technology can and should be deployed to underpin new solutions to the world's most difficult environmental challenges. Our work today with the United Nations Environment Programme underscores this.

This is IBM's 30th annual corporate environmental report. The report is one of the most sustained examples of corporate environmental reporting across global industry.

Our history of reporting is important because it underscores IBM's commitment to environmental results, transparency, and leadership. You cannot publish an environmental report for 30 years without an unwavering commitment.

A brief look back: In addition to being one of the first multinational companies to produce its own environmental report, IBM also led the creation of the first cross-industry guidelines for voluntary corporate environmental reporting back in the early 1990s. Working with nine other companies and representatives of the Coalition for Environmentally Responsible Economies (CERES), we developed the Public Environmental Reporting Initiative (PERI) Guidelines in 1993 and formally published them in 1994. These pioneering guidelines marked a beginning of what has since become a common business practice for many companies.

As more companies communicate about their environmental performance, it remains essential for those communications to be transparent. Today, we believe there is an opportunity for some increased transparency in corporate environmental reporting, particularly when it comes to claims related to climate change. In the Energy and Climate Change section of this report, we state our point of view and the practices we will follow.

Finally, IBM has created and sustained the infrastructure necessary to extend our leadership into the future. An unsung hero throughout our 30 years of environmental reporting – and before then – is our global Environmental Management System. IBM's global Environmental Management System ensures internal integration of the environmental imperative into our business practices and engages people whose day-to-day job is not the environment per se, but whose decisions and work can impact the environment. It institutionalizes environmental responsibility into the fabric of our business and our company's culture. We are proud to have been the first company to earn a single global registration to the ISO 14001 standard for environmental management systems back in 1997 and to have retained it ever since. Unsung as it may be, we know just how much a global Environmental Management System matters.

You can rely upon IBM to uphold its commitment to environmental leadership. In the cover letter for our first environmental report published in 1990, then Chairman and CEO John Akers stated, "The IBM company has always taken its environmental responsibilities seriously. And we always will. Our continuing resolve is to conduct our business in the safest way possible and to use our technology to help preserve the Earth's fragile ecosystem." That message is as true today as it was 30 years ago.

Wayne S. Balta
Vice President, Corporate Environmental Affairs
& Product Safety
Chief Sustainability Officer
July 2020

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About this report

This report marks the 30th consecutive year that IBM has published an annual environmental report. The data in this report covers our 2019 fiscal year (January 1 to December 31, 2019). Monetary figures are in U.S. dollars.

In 2019, IBM acquired the software and hybrid cloud company Red Hat. Red Hat continues to operate its infrastructure independently and is not subject to IBM's current environmental goals, including those for energy and carbon dioxide emissions reduction. Therefore, the data in this report does not include information from Red Hat's operations. Additional information can be found in the Red Hat Community and Social Responsibility 2019 Report.

Our energy and greenhouse gas emissions goals and reporting cover all activities taking place in IBM-owned or leased facilities. These facilities include IBM data centers located in facilities managed by third parties where IBM does not procure the energy or control the operations of the buildings – also known as co-location data centers.

Unless otherwise specified, all environmental performance data included in this report applies to IBM's operations. IBM's environmental data is subject to internal and external audits in line with our global environmental management system (EMS) and International Organization for Standardization (ISO) 14001 and 50001 certifications at the corporate level.

For more information about our EMS, related audits and certifications, and environmental sustainability initiatives, please visit our IBM and the Environment website. Details about IBM's other corporate responsibility initiatives can be found in our annual Corporate Responsibility Report.

IBM's role in the origins of corporate environmental reporting

Today, there are many guidelines, frameworks, and methodologies for corporate environmental reporting. The practice of reporting on environmental performance has not only become routine but continues to grow. That was not always the case. In the early 1990s, IBM led, along with nine other companies, a significant voluntary initiative to create the first cross-industry framework for voluntary corporate environmental reporting – the Public Environmental Reporting Initiative (PERI) Guidelines.

IBM had begun a dialogue during the early 1990s with the Coalition for Environmentally Responsible Economies (CERES). That dialogue resulted in an effort to develop and promote cross-industry guidelines for voluntary corporate environmental reporting. IBM welcomed nine additional companies to join in this work – Amoco, British Petroleum, Dow Chemical, DuPont, Northern Telecom, Phillips Petroleum, Polaroid, Rockwell, and United Technologies. Together, they reviewed questions that were being asked by socially conscious investors; studies by industry groups like the Global Environmental Management Initiative and the Business Council for Sustainable Development; and the practices of individual industry sectors and their trade associations.

As the definition of new cross-industry guidelines for environmental reporting came to fruition, the companies realized the work they had done – with significant contributions from CERES and its representatives – was ready to be shared. In May 1993, the first draft of the PERI Guidelines was released to additional companies and trade associations for review. The reaction was encouraging. After incorporating relevant feedback, the companies published the updated PERI Guidelines in May 1994.

Since that time, the PERI Guidelines have been superseded by more comprehensive environmental frameworks. However, their development at a time when cross-industry voluntary corporate environmental reporting was in its infancy made an important mark. Three years later in 1997, for example, the Global Reporting Initiative (GRI) was formed. The GRI further developed guidelines for corporate environmental reporting and more – guidelines which inform the reporting of IBM and others to this day.

The PERI Guidelines outlined the following 10 components for public environmental reporting:

01 Organizational profile

02 Environmental policy

03 Environmental management

04 Environmental releases

05 Resource conservation

06 Environmental risk management

07 Environmental compliance

08 Product stewardship

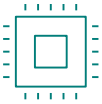
09 Employee recognition

10 Stakeholder involvement

2019 highlights

Climate Leadership Council

Became a founding member of the Climate Leadership Council in 2019, supporting its bipartisan plan for a carbon tax with corresponding carbon dividend.



Energy conservation

Implemented 1,660 energy conservation projects, delivering annual energy savings equal to 3.2% of our total energy use and surpassing our corporate goal of 3%.

Renewable electricity

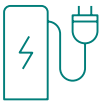
Increased our use of renewable electricity which now accounts for 47% of the company's total electricity consumption versus our goal of 55% by 2025.

CO_2 emissions

Reduced IBM's CO_2 emissions by 39.7% against a 2005 baseline, nearly meeting our 4th-generation goal of 40% reduction by 2025.

z15 mainframe

Introduced the IBM z15™ mainframe which uses 20-30% less power than a comparably configured IBM z14® when equipped with the intelligent Power Distribution Unit (iPDU) power option.



Battery breakthrough

Unveiled a new rechargeable battery technology with potentially faster charging time, higher power density, and longer life than today's lithium-ion batteries, while eliminating the use of heavy metals.

Product reuse and recycling

Processed 20,800 metric tons of end-of-life products and product waste, and more than 95% (by weight) was reused, resold, or recycled.

Waste recycling

Sent 88.8% (by weight) of nonhazardous waste for recycling.

External disclosure

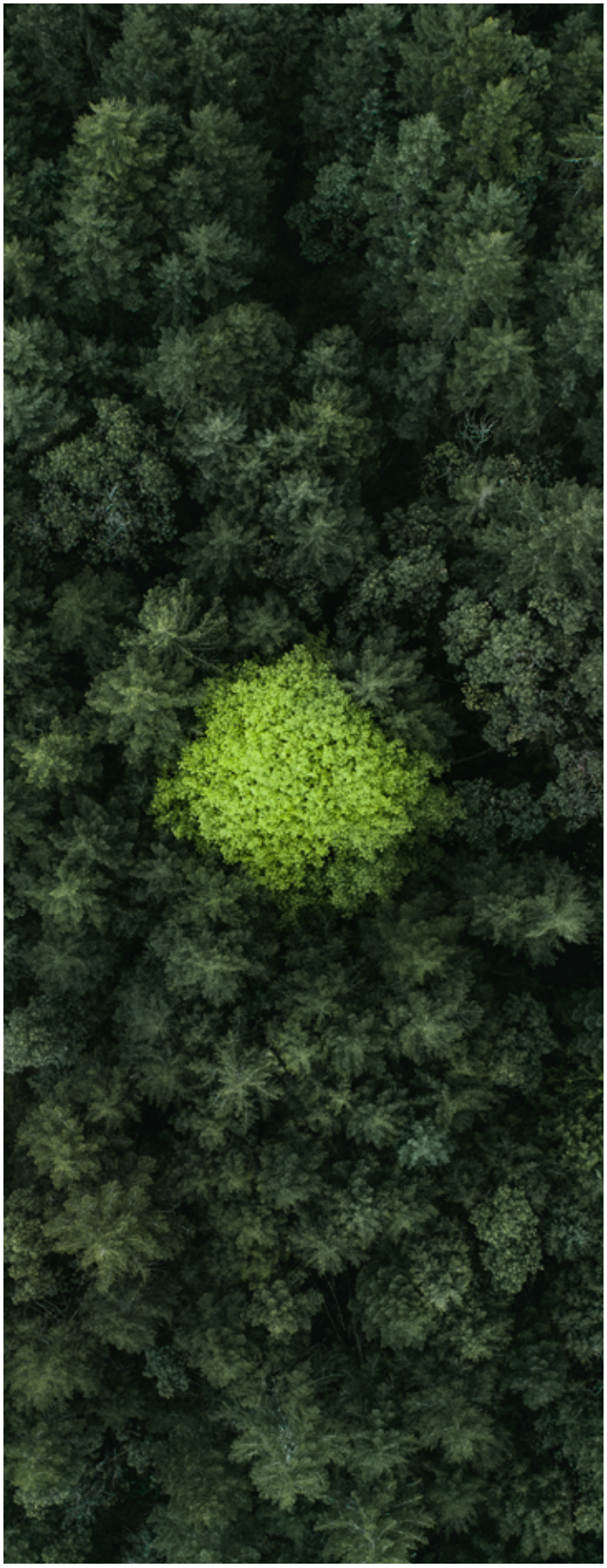
Submitted information voluntarily for 15 third-party environmental reporting organizations, answering approximately 450 questions.

Employee engagement

Created a Global Environmental Business Resource Group to connect our community of IBMers passionate about the environment.

Global governance and management system

IBM has established and maintained a strong worldwide Environmental Management System (EMS) for decades. Through this EMS, we manage our operations around the globe to minimize their potential impact on the environment.



Governance

The Vice President of Corporate Environmental Affairs and Product Safety is the top environmental executive of IBM. This person is authorized to set IBM's strategy for environmental affairs, including those matters related to climate change, and to establish the company's environmental requirements, goals, and management system to drive consistent execution across IBM's global operations and achieve results consistent with environmental leadership.

The Directors and Corporate Governance Committee of the IBM Board of Directors oversees IBM's environmental programs and performance and is responsible for reviewing and considering IBM's position and practices on issues related to corporate responsibility such as protection of the environment, corporate citizenship, and philanthropic contributions. The Vice President of Corporate Environmental Affairs and Product Safety meets with the board committee annually to discuss IBM's environmental programs, performance, challenges and emerging issues.

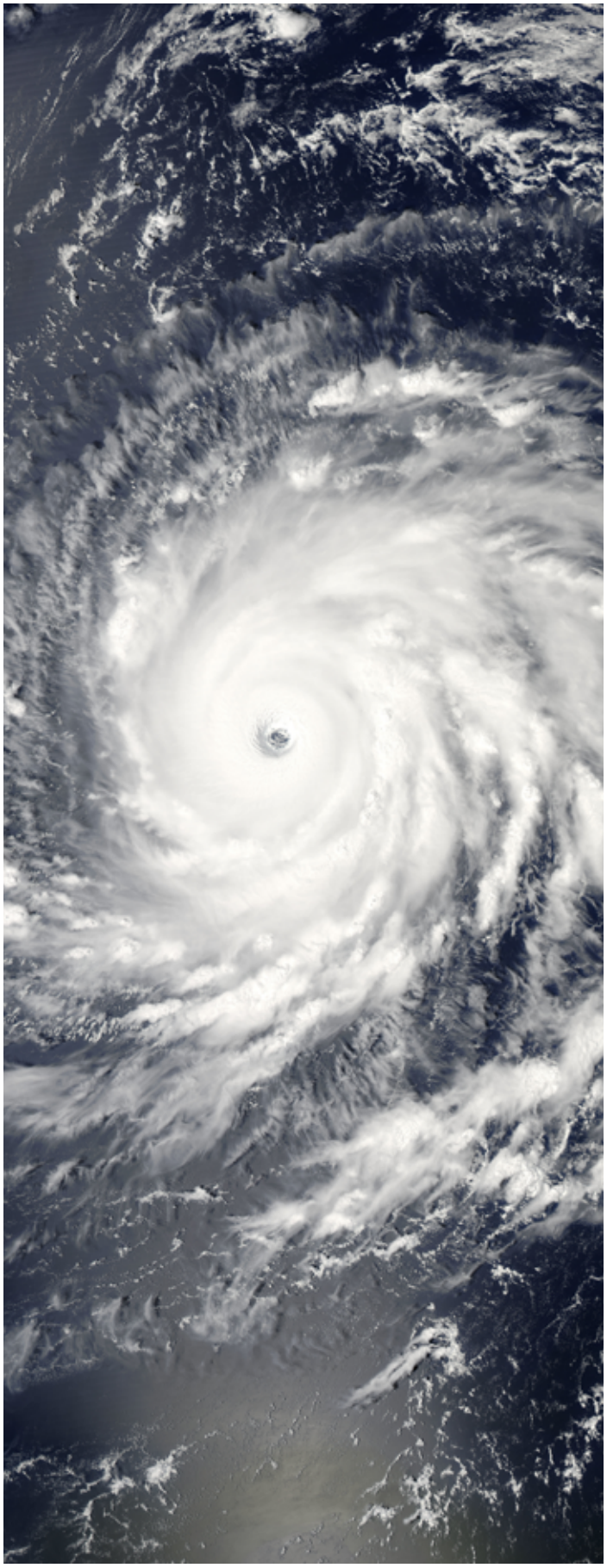
Environmental Management System

IBM's corporate environmental policy provides the strategic framework for the company's global EMS. The policy outlines 11 objectives that address environmental considerations of our business. Our EMS has been in place for over 30 years and integrates corporate environmental directives which govern IBM's conduct and operations worldwide.

The global nature and scope of IBM's EMS is unique among the IT industry and across industries. In 1997, IBM became the first major multinational company to earn a single global registration of its EMS to the International Organization for Standarization (ISO) 14001 environmental management systems standard and we have since expanded and maintained this registration. The scope of IBM's EMS covers IBM's hardware product design and development, manufacturing, procurement, and global logistics operations worldwide. It also covers our Global Asset Recovery Services and our Global Services organizations.

IBM has long recognized the importance of energy and materials in its operations and their potential impacts on the environment. In 1974, IBM issued a formal corporate policy that called for the conservation of energy and materials in all of IBM's activities. IBM's energy conservation requirements are integrated into the company's global EMS. When ISO issued the ISO 50001 standard on energy management systems in June 2011, IBM achieved verification of conformity of our EMS against this newly published standard within one year of its release and has maintained it ever since.

IBM employs a variety of mechanisms to monitor and measure the effective implementation of its EMS requirements. These include comprehensive annual self-assessments by business functions, internal audits conducted by IBM's corporate audit function, and ISO 14001 audits conducted by third-party auditors. Learn more here.



Risk identification and management

IBM's overall enterprise risk management process considers environmental risks, including those related to climate change, and helps establish plans for business continuity and asset protection. In addition, our global EMS also includes a process for identifying and assessing significant environmental aspects of our business.

IBM considers risks as identified by the Financial Stability Board Task Force on Climate-related Financial Disclosures (TCFD) in its risk management process. IBM senior management assesses the significance of environmental and climate-related risks. They also manage these risks and provide regular updates to the IBM Board of Directors and its Directors and Corporate Governance Committee.

Furthermore, IBM has established internal objectives and targets for energy conservation, procurement of renewable electricity, carbon dioxide emissions reduction and other key environmental performance indicators. Performance against these objectives and targets is routinely monitored, and results are reviewed annually by the Board's Directors and Corporate Governance Committee.

IBM began publicly reporting environmental expenses and estimated savings related to environmental programs in its 1997 environmental report.

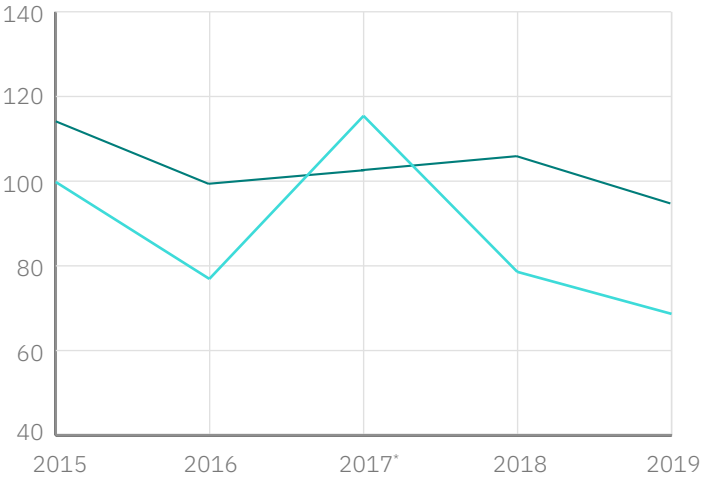
Environmental investment and return

IBM's experience has shown that annual savings from its focus on conservation, pollution prevention and design for the environment typically exceed environmental expenses, thereby demonstrating the value of proactive environmental programs.

In 2019, IBM invested $7.1 million of capital and spent $61.5 million in operating expense to build, maintain and operate its worldwide environmental protection infrastructure and programs.

IBM estimates savings it has realized from its environmental leadership practices. These include savings from energy, material and water conservation; recycling; packaging improvements; and reductions in waste. Ongoing savings from previous years' initiatives are not carried over in this calculation, yielding very conservative estimates. In addition, IBM estimates the avoidance of costs that likely would have occurred if its EMS were not in place. This cost avoidance is difficult to quantify, so a reasonable attempt has been made to estimate it. In 2019, IBM's combined, estimated environmental savings and cost avoidance totaled $94 million, resulting in an estimated net savings of $25.4 million for the company.

IBM environmental investment, savings and cost avoidance ($M)



*In 2017, total environmental expenses associated with IBM's operations were significantly higher than in other years, mainly driven by the pre-payment of hazardous waste treatment costs in one of our facilities, which covered the period until 2021.

Accidental releases

IBM locations around the world report environmental incidents and accidental releases to IBM management through the company's Environmental Incident Reporting System (EIRS). IBM's environmental incident reporting criteria are equal to or more stringent than applicable legal reporting requirements, and every event meeting IBM's criteria must be reported through the EIRS. All IBM locations must have a documented incident prevention program and reporting procedure.

In 2019, 18 accidental releases of substances to the environment related to IBM operations were reported through the EIRS — eight releases to air, eight releases to land and two releases to water. Emissions to air were seven releases from refrigerants used in building cooling, and one release of gas used in a building fire prevention system. Of the eight releases to land, four were diesel fuel, three were chemically treated water from cooling tower systems, and one was heating oil. The two releases to water were chemically treated water from a cooling tower system. All environmental releases were promptly and effectively managed, root causes were investigated, and appropriate corrective actions were taken. We continue to investigate additional controls and preventative measures that can be implemented to reduce the number of accidental releases.

Fines and penalties

One measure of a company's environmental performance is its record of fines and penalties. In 2019, IBM received 43 agency inspections at its locations worldwide with no resulting fines or penalties. Over the past five years, IBM has not been required to pay any environmental fines.

IBM Chairman's Environmental Award

Arvind Krishna, IBM CEO, receives the 2019 IBM Chairman's Environmental Award on behalf of IBM Hybrid Cloud from Ginni Rometty, IBM Chairman. (At the time of the 2019 award, Arvind Krishna was Senior Vice President, Hybrid Cloud.)

IBM established its Chairman's Environmental Award Program in 1991 to encourage leadership and recognize achievement and progress in environmental affairs by IBM's internal organizations.

For nearly 30 years, the IBM Chairman's Environmental Award has promoted the contributions of IBM's business units toward the objectives of IBM's corporate environmental policy. Recipients are selected based on their leadership, initiatives and results.

IBM's Hybrid Cloud organization received the 2019 IBM Chairman's Environmental Award.

The focus of the competition for 2019 was on the environmental accomplishments of IBM's business units over the past three years in the areas of energy conservation, prevention of pollution, waste minimization and recycling, water conservation, and other environmental topics.

IBM's cloud strategy is focused on delivering a hybrid cloud platform that enables businesses to use a mix of on-premise, public and privately-operated cloud environments for their data and applications.

Around the world, the IBM Hybrid Cloud team put its expertise to work in pursuit of environmental leadership.

A few highlights:

— Hybrid Cloud consolidated 42 data centers down to just 6 (a 300,000 square foot reduction), reducing the number of servers from 70,000 to 20,000. This achieved a 67% reduction in energy consumption (160,000 megawatt-hours/year), avoiding carbon dioxide emissions of 61,000 metric tons per year.

— SmartRural is a precision agriculture company that helps farmers make more efficient use of their resources and protect their crops via analytics and machine learning. By migrating its analytics platform to the IBM Cloud®, SmartRural achieved better crop yields, a 25% reduction in water use, and a 50% reduction in fertilizer use.

— Hybrid Cloud's solution for the NCE Seafood Innovation Cluster in Norway predicts infestation of salmon by sea lice with 70% accuracy, saving the Norwegian salmon industry 7 million salmon per year. One of NCE's customers was able to reduce hydrogen peroxide treatments by 59% as a result.

While only one organization is selected each year to receive the IBM Chairman's Environmental Award, the competition highlights the company's worldwide commitment to environmental leadership. It also ensures the leader of every major IBM business unit regularly assesses the unit's contribution to the environment.

Stakeholder engagement and voluntary collaborations

At IBM, we proactively engage and collaborate with stakeholders from a cross-section of nongovernmental organizations (NGOs), governments, investors, communities and other interested parties.

IBM publicly discloses information on its environmental strategy, goals and targets, performance, and continual improvement activities widely through this report and other external voluntary reporting programs.

Our community outreach programs include support of and participation in local environmental projects and education efforts, including Earth Hour, Earth Day, and World Environment Day. IBM also engages employees through site environmental awareness events and local clean air activities focused on the use of public transportation. Five IBM sites have achieved Wildlife Habitat Council's Conservation Certification recognizing their wildlife habitat management and conservation education programs.

In 2019, IBM created a Global Environmental Business Resource Group (eBRG) to connect our global community of IBMers that are passionate about the environment. Through our Global eBRG, we want to inspire, engage and support employee activities that contribute to IBM's environmental goals and initiatives, and facilitate sharing of best practices and ideas across our employee population globally. The IBM Global eBRG is a topical area under IBM's BRG program. BRGs are volunteer, cross-department, employee-led groups that focus on a common interest or a certain constituency.

Another important element of IBM's stakeholder engagement is our voluntary collaborations with clients, universities and other organizations. Some examples:

— **Climate Leadership Council:** IBM became a founding member of the Climate Leadership Council in 2019 and publicly supported the Council's plan for a carbon tax, with the proceeds of that tax — a "carbon dividend" — to be returned to citizens. This plan would place an economy-wide $40/ton fee on carbon dioxide emissions, increasing by 5% above inflation every year, sending a powerful signal to encourage technological innovation and accelerate actions to reduce emissions.

- **The Nature Conservancy and charity: water:** In June 2019, IBM and The Weather Company, an IBM Business, launched Forecast: Change, a new initiative to help combat freshwater scarcity in communities around the globe. Freshwater scarcity is a global issue that impacts human food security, the health of the environment, and our global economy. IBM contributed funding, services and technology to The Nature Conservancy and charity: water to help raise awareness around and expand their efforts of providing access to clean drinking water for people in climate-distressed areas. A major milestone was recently achieved with charity: water when 100 million liters of clean and safe water was made available for the first time to more than 16,000 residents of Cambodia and Niger, West Africa.

- **Pennsylvania State University and the University of Pittsburgh:** IBM has a long tradition of collaborating with academic institutions regarding environmental sustainability. Since 2013, IBM has served on the Sustainability Advisory Board for the Smeal College of Business at Pennsylvania State University. Advisory board members lend their experience and serve as conduits to students and faculty for the latest corporate developments in sustainable business practices. And in 2019, IBM and Verizon became founding members for the college's new Center for the Business of Sustainability. Likewise in 2019, IBM became a founding corporate partner for the Center for Sustainable Business within the Joseph M. Katz Graduate School of Business and College of Business Administration at the University of Pittsburgh. Its mission is to maximize the value of investments in sustainable business strategies for companies and their stakeholders.

- **Call for Code:** Created by David Clark Cause and supported by Founding Partner IBM and Charitable Partner United Nations Human Rights in 2018, the Global Initiative invites developers and problem solvers around the world to build solutions that fight back against the most pressing issues of our time. The 2020 Call for Code Global Challenge is focused on climate change with the themes of water sustainability, energy sustainability and disaster resiliency. An additional focus of COVID-19 was added as the pandemic emerged. Together with The Linux Foundation, top solutions are open sourced and deployed.

Examples of IBM's voluntary collaborations

Government

- European Union Code of Conduct for Energy Efficiency in Data Centres
- United Nations Environment Programme
- U.S. Environmental Protection Agency ENERGY STAR Program

Environmental NGOs

- Center for Climate and Energy Solutions
- charity: water
- Environmental Law Institute
- The Nature Conservancy
- Wildlife Habitat Council
- World Environment Center

Industry partnerships

- Call for Code
- Climate Leadership Council
- Renewable Energy Buyers Alliance
- The Green Grid

Universities

- Pennsylvania State University
- University of Pittsburgh

IT for the environment: Tackling marine litter

"The collaboration with IBM and Soul Machines demonstrates the enormous potential of AI for good."

– Shereen Zorba
Head, United Nations Environment Programme Science-Policy-Business Forum on the Environment

IBM has been passionate about protecting our planet for a long time. We are equally passionate about applying the most advanced IT to global environmental challenges. And recognizing the enormity of these challenges, we believe strong partnerships across the public and private sectors and society at-large are essential to deliver sustained results. One current example is our work with the United Nations Environment Programme (UNEP) to demonstrate how IT can be used to address marine litter.

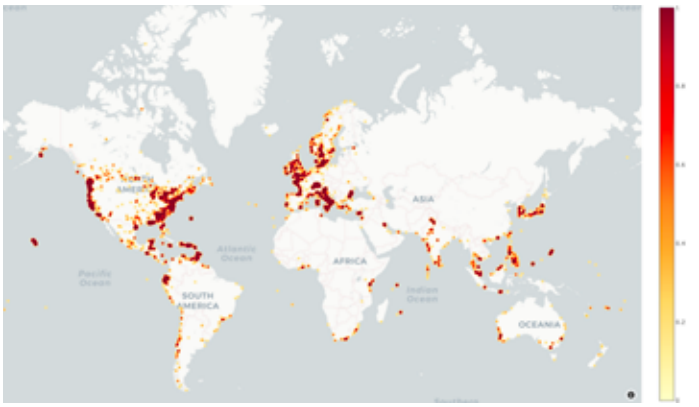
In 2017, IBM joined UNEP's Science-Policy-Business (SPB) Forum on the Environment as a founding member, committing to working with UNEP and its stakeholders to accelerate the adoption of IT to assist in sound policy making, solutions development and global collaboration. Under the auspices of the SPB Forum, IBM, in collaboration with UNEP, completed a proof of concept for a multi-stakeholder digital platform on marine litter in June 2020.

Marine litter represents a serious threat to our environment and in particular, aquatic life. One of the targets associated with the U.N. Sustainable Development Goal 14 is a reduction in marine pollution by 2025. The corresponding indicator is an index of coastal eutrophication and floating plastic debris density. One significant challenge UNEP is confronted with is how to track progress in marine litter reduction when they have not been able to establish a baseline to measure against.

Technologists and scientists from IBM's Data and AI Group worked with UNEP and its various stakeholders involved in addressing marine litter, including the Wilson Center, to understand the present-day challenges. Our Data Science and AI Elite team created a prototype that demonstrates how modeling and analytics can help with establishing a marine litter baseline. In addition, our technologists showed how intelligent organization and AI can fundamentally change the way data, analyses and insights are accessed.

The prototype applies IBM Cloud Pak® for Data tools to organize and analyze data from disparate and unstandardized sources. Through an autonomously animated, humanistic avatar (powered by our partners at Soul Machines), users can interface with the digital platform through natural language conversations that enable an emotional connection between the user and the issue of marine litter. The interface uses IBM Watson® Assistant and Watson Discovery to interpret the intent of a user and retrieve the relevant information from UNEP's vast repository and other sources, making the data easy to consume, in an intuitive way. The prototype also introduces a collaboration sandbox, a virtual space for connecting stakeholders, enabling them to collaborate and create solutions with shared ownership and trust.

IBM presented the prototype on June 8, 2020, at UNEP's Major Groups and Stakeholders Consultations, a preparatory forum for the fifth session of the U.N. Environment Assembly in 2021.



Estimated baseline marine litter density for the worldwide coastline using Bayesian Inferential Modeling by cataloguing and integrating marine debris datasets[1] from 2015-18 offered by Earth Challenge, a citizen science consortium led by Earth Day Network, the Wilson Center, and the U.S. Department of State.

Sam, a digital assistant for marine litter.

[1]Earth Challenge dataset is a combined dataset for the National Oceanic and Atmospheric Administration's Marine Debris Monitoring and Assessment Project (MDMAP), Ocean Conservancy's Trash Information and Data for Education and Solutions (TIDES) cleanup database, and the European Environmental Agencies Marine Litter Watch (MLW) dataset.

On the importance of consuming renewable electricity

By Jay Paidipati

Jay Paidipati
IBM Global Energy Manager and leader of the Global Real Estate Energy Center of Excellence

Climate change represents a serious threat to our planet that requires companies to take responsible action. That is why in 2018 IBM updated its goal, committing to procure 55% of the electricity we consume worldwide from renewable sources by 2025.

IBM has been a leader in environmental protection for over 50 years. Our long-standing commitment to energy conservation dates back to the 1970s when we issued a corporate-wide policy on energy conservation and set our first energy conservation goal. Today, we still focus on energy conservation, but there is no way around the fact that sustaining IBM's business requires consumption of energy. As such, reducing carbon dioxide emissions associated with our operations compels us to identify and procure renewable electricity to reduce our use of electricity generated from burning fossil fuels. It's the right thing to do for the planet. In addition, our clients and employees want to be affiliated with a company that is committed not only to doing well but to doing good.

There is no one-size-fits-all approach to renewable electricity procurement success, as IBM operates in 170 countries, and renewable electricity is not available at all locations. We do, however, adhere to two principles when purchasing renewable electricity.

First, we endeavor to purchase renewable electricity where it makes both business and environmental sense. In some locations, the price premium for purchasing renewable electricity can be significant. Our goal is to identify cost competitive renewable electricity sources to purchase wherever possible. However, sometimes we must and do pay extra to purchase renewable electricity.

Second, we purchase renewable electricity from sources in the actual grid regions where we operate. The reason is simple. In order to reduce our dependence on electricity generated from fossil fuels, we must have reliable electricity sources available to replace it. Purchasing renewable electricity in the grid regions where we operate signals to our electricity providers IBM's desire for them to develop and make more renewable electricity available for us to consume. For example, in New York, we purchase renewable electricity generated by the Niagara Falls hydropower plant to supply power to some of our facilities in that state. In Texas, one of our IBM Cloud co-location data centers is supplied with 100% Texas-based wind power. At IBM's Embassy Manyata Campus in Bangalore, India, IBM procures 20% of our electricity from local solar power suppliers.

Our Global Real Estate organization is responsible for procuring electricity at locations managed by IBM. We look for and inquire about availability and pricing of renewable electricity with every procurement cycle. This constant focus allows us to maintain an ongoing understanding of the market and capture attractive opportunities. We work with energy suppliers in regulated and deregulated markets as well as landlords at locations where they procure electricity to increase our consumption. IBM also actively works with industry peers and NGOs to influence policies that will lead to greater access to renewable electricity for companies of all sizes.

Our dedication continues to pay off. During 2019, electricity generated from renewable sources made up 47% of IBM's global electricity consumption, up from 37.9% in 2018.

Solar array at IBM's
Boulder, Colorado facility

Energy and climate change

IBM has long recognized the urgency to limit global warming and we execute a climate protection strategy that leads by example with demonstrable results.

IBM first published its policy position on climate change in 2007. IBM recognizes that climate change is a serious concern that warrants timely, meaningful action on a global basis to reduce the atmospheric concentration of greenhouse gases (GHGs) in accordance with scientific judgement. We believe all sectors of society, the economy and governments worldwide must participate in solutions to climate change.

In 2015, IBM voiced its support for the Paris Agreement and reaffirmed its support in 2017. In 2019, IBM became a founding member of the Climate Leadership Council and publicly supported the Council's plan for a carbon tax, with the proceeds of that tax — a "carbon dividend" — to be returned to citizens.

Energy and climate goals

In 2018, IBM established a second-generation goal for the use of renewable electricity and a fourth-generation goal to reduce carbon dioxide (CO_2) emissions. We also updated our longstanding energy conservation goal. These goals are to:

— Conserve energy equal to 3% of IBM's annual energy consumption.

— Procure 55% of the electricity IBM consumes worldwide from renewable sources by 2025.

- Focusing on consumption, this includes renewable electricity in the grid mix IBM receives from utilities or energy retailers, and renewable electricity for which IBM specifically contracts over and above the renewables in the grid mix.
- We do not include the purchase of unbundled Renewable Energy Certificates for electricity IBM will not actually consume.

— Reduce operational CO_2 emissions associated with IBM's energy consumption 40% by 2025 against base year 2005, adjusted for acquisitions and divestitures.

Our energy and emissions goals and reporting cover all activities taking place in IBM-owned or leased facilities. These facilities include IBM data centers located in facilities managed by third parties where IBM does not procure the energy or control the operations of the buildings – also known as co-location data centers.

From 1990 through 2019, IBM conserved 7.7 million MWh of electricity, avoiding 4.5 million metric tons of CO_2 emissions and saving $646 million. We can report these results for 30 years because that is how long we have been measuring them.

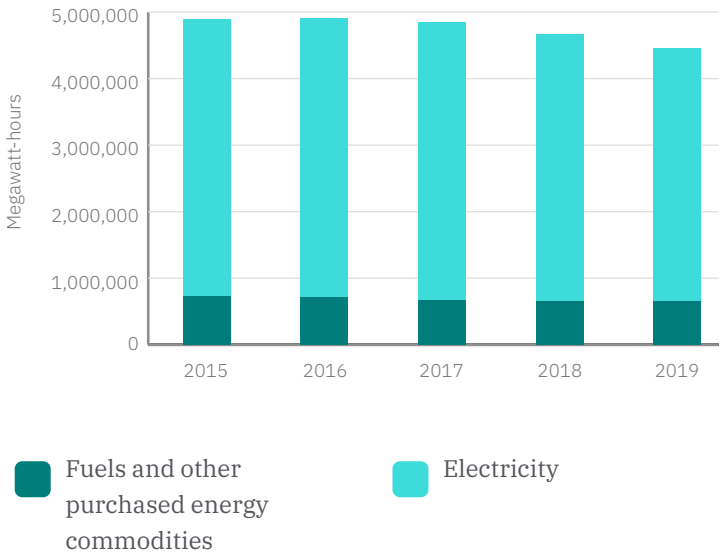
Energy conservation

We recognize that the most effective way to reduce our CO_2 emissions is to make our operations more efficient and thereby reduce our consumption of energy.

Energy consumption

In 2019, IBM consumed 3,806,000 megawatt-hours (MWh) of electricity and 650,000 MWh of fuel and other purchased energy commodities (e.g., chilled water, hot water and steam) worldwide. Our total energy consumption was reduced by 4.5% versus 2018. Since 2016, IBM's total energy consumption has been on a downward trend due to our ongoing focus on energy conservation and operational efficiency.

IBM total energy consumption



Energy conservation projects

IBM implemented 1,660 energy conservation projects at nearly 230 locations globally in 2019. These projects delivered annual energy savings of 136,000 MWh, equal to 3.2% of our total energy use during 2019 and surpassing the corporate goal of 3%. They also avoided 47,000 metric tons of CO_2 emissions and saved $14.4 million in expense. The avoided emissions were equivalent to removing more than 10,000 passenger vehicles from the road during the year.

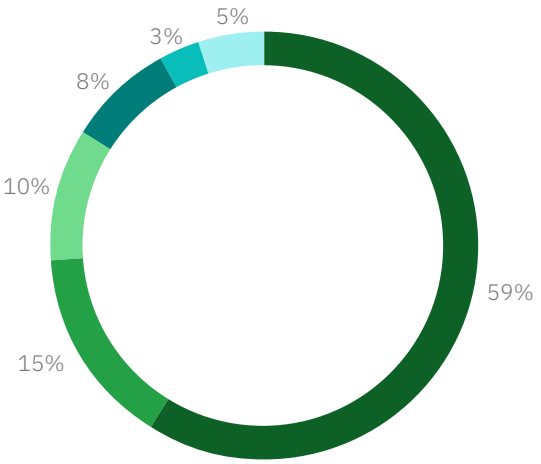
In measuring performance against IBM's energy conservation goal, we only include the first year's savings from projects. Accordingly, IBM's total energy savings and CO_2 emissions avoidance from these projects are actually much greater than this simple summation of the annual results. We do not include reductions in energy consumption resulting from downsizings, the sale of operations or cost-avoidance actions, such as fuel switching and off-peak load shifting, in our energy conservation results.

Most of IBM's 2019 energy conservation savings occurred in data centers (59% of the total amount conserved) where we completed over 700 projects at more than 150 locations. These projects reduced energy use by 81,000 MWh while saving $9.1 million. Of that amount, 63% of the savings were achieved by refreshing IT equipment with more energy-efficient technologies, and by increasing consolidation and virtualization of IT workloads. Virtualizing IT workloads involves having individual systems support multiple applications or images, reducing the amount of equipment required to complete a set of tasks. The rest of the savings achieved in data centers came

from cooling efficiency improvements. For example, IBM reduced the energy demand of fans which deliver cooling by up to 70% by deploying software tools that remotely and automatically adjust the fans to match IT system utilization levels and their heat output.

The remaining conservation savings were achieved across IBM's research, manufacturing and office space by implementing scheduled maintenance, lighting retrofits, and improving the efficiency of building infrastructure. We have deployed IBM's Internet of Things and analytics solution called IBM Smarter Buildings at 25 major IBM campuses covering 190 buildings and encompassing 41% of IBM's global energy consumption. During 2019, this tool enabled the identification of energy conservation opportunities resulting in the avoidance of 11,000 MWh of energy and $800,000 in expense.

2019 energy conservation savings by project type



- Virtualization and cooling efficiency projects in data centers
- Heating, ventilation and air conditioning projects
- Central utility plant efficiency projects
- Lighting efficiency projects
- Building controls projects
- Other projects

Data center energy efficiency

IBM has a diverse portfolio of data centers supporting our clients and our internal operations worldwide. We take a holistic approach to managing and improving the energy efficiency of our data centers – from improving existing space to derive more workload per area, equipment and energy utilized, to building or leasing new, higher-efficiency space.

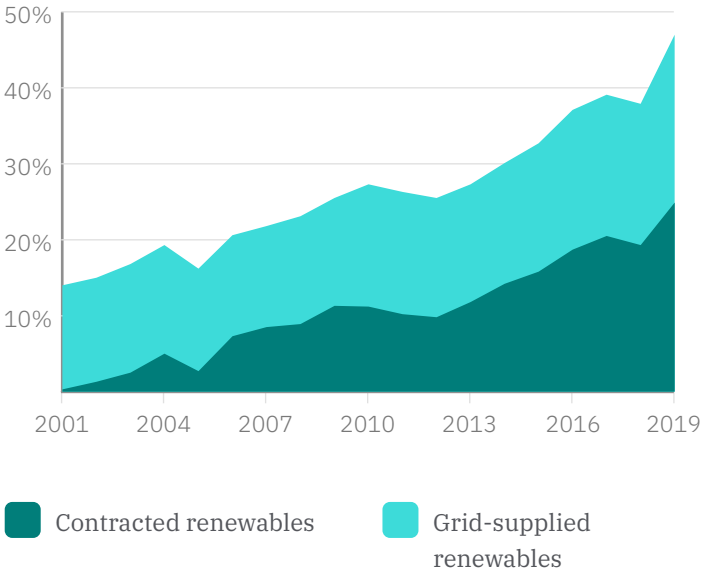
IBM calculates the Power Usage Effectiveness (PUE) at many of the data centers we manage and obtains PUE data from landlords of co-location data centers. PUE is the ratio of the total energy consumed by the data center divided by the energy consumed by the IT equipment. The closer the value is to 1, the more efficient the cooling delivery. Using available PUE data for raised-floor space representing 67% of our global data center electricity consumption, we calculated our 2019 average PUE to be 1.7. The PUE range of reporting facilities was 1.1 to 3.5.

As one of the longest-term providers of service in the IT industry, IBM's data center portfolio consists of multiple spaces with building infrastructure of varying ages. Improving data center efficiency requires thoughtful planning and execution to meet operational objectives and commitments to clients. IBM has made – and will continue to make – significant investments to reduce energy demand and improve the PUE of our data centers.

Renewable electricity consumption

In 2019, 47% (1,790,000 MWh) of the electricity consumed across IBM's operations came from renewable sources, and we are on track to meet our goal of 55% by 2025. Of this total, IBM directly contracted to purchase 25% through its electric utilities and retail providers in 19 countries, which avoided 287,000 metric tons of CO_2 emissions. In addition, 22% of IBM's electricity consumption came from renewable sources that were part of the mix of electricity our facilities automatically received from the grid. The remaining 53% (2,016,000 MWh) of IBM's electricity consumption came from conventional sources such as fossil fuels and nuclear power. For more information about how IBM calculates its consumption of renewable electricity, please visit our website.

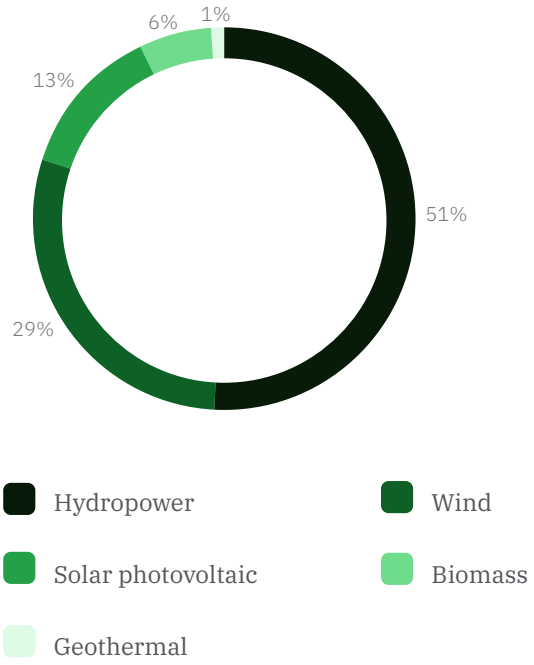
IBM's use of renewable electricity as percent of global electricity consumption



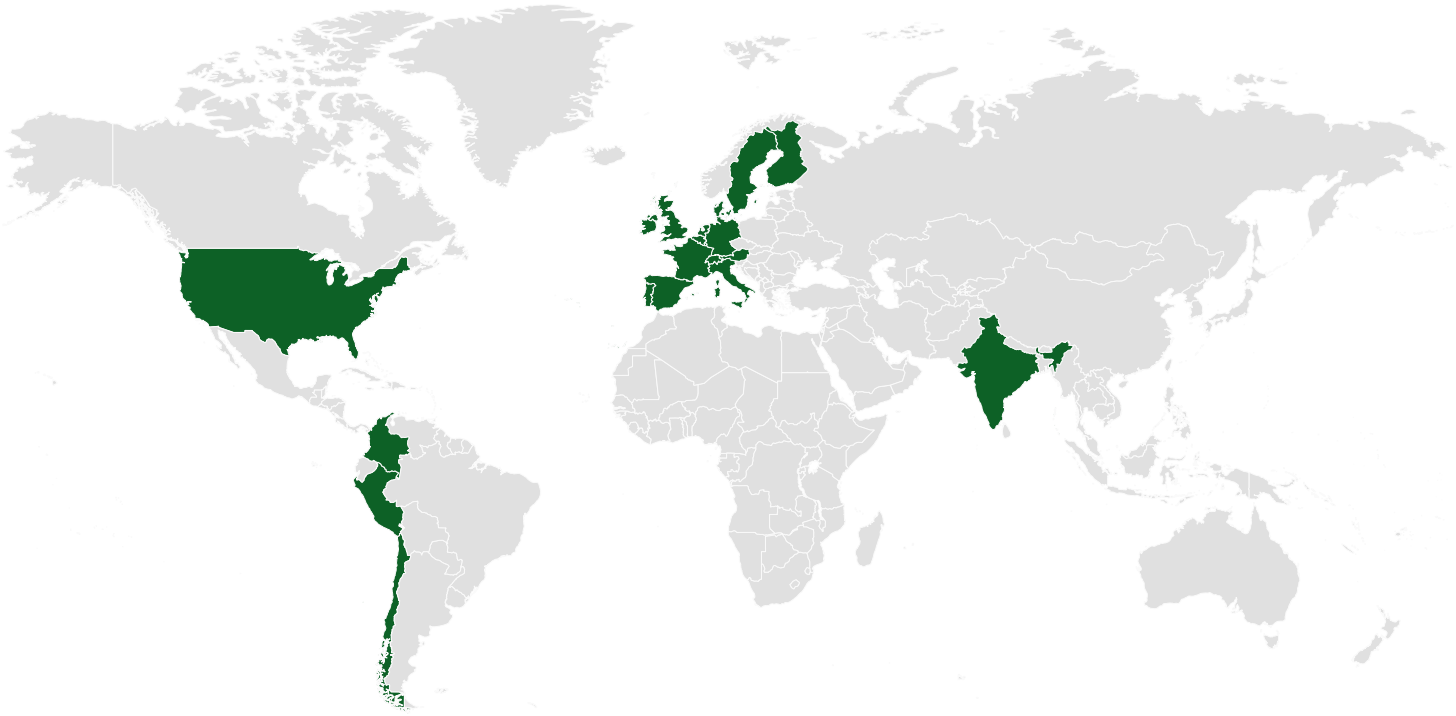
IBM significantly increased its consumption of contracted renewable electricity through purchases in Colombia, India, Spain and the United States. In addition, working through the landlord, one of our co-location data centers in Texas is now supplied with 100% wind power.

IBM procures renewable electricity generated from wind, large and small hydropower plants, biomass, and solar installations around the globe. We report all of our contracted renewable electricity purchases and their associated CO_2 emissions avoidance – whether from new or existing generation sources, "additional" or otherwise – without discriminating against large hydropower installations. All purchases signal to suppliers our desire for them to maintain and broaden their renewable electricity offerings.

IBM consumption of renewable electricity by source



19 countries where IBM directly contracts for renewable electricity



- United States
- Colombia
- Peru
- Chile
- United Kingdom
- Ireland
- Portugal
- Spain
- France
- Germany
- Italy
- Belgium
- Denmark
- Netherlands
- Sweden
- Finland
- Switzerland
- Austria
- India

In 2019, 50% of the electricity consumed in our data centers came from renewable sources.

Data center renewable electricity consumption

As part of IBM's global renewable energy strategy, we endeavor to increase the consumption of renewable electricity at our data centers. In 2019, 50% of the electricity consumed in our data centers came from renewable sources, including both contracted and grid-supplied – up from 40% in 2018. In 2019, 34 IBM data centers were supplied with 100% renewable electricity, although they still depend on backup power from fossil fuels when renewable sources become interrupted.

Three large IBM data centers have installed solar arrays in partnership with our local energy suppliers. In late 2018, two solar arrays went into operation at IBM's data centers located in Bastogne and Vaux-sur-Sŭre, Belgium. During 2019, these two installations generated approximately 2,800 MWh of solar power. Our third on-site solar array – a 10 megawatt project – is hosted at IBM's Boulder, Colorado, facility. The array went into production in July 2019 and by year-end it had produced 5,700 MWh of solar power.

IBM does not retain the ownership of the Renewable Energy Certificates (RECs) associated with the power generation from these three projects. Therefore, IBM does not claim the use of any renewable electricity or any resultant decrease in its GHG emissions associated with the physical consumption of the renewable electricity from these projects. Nonetheless, IBM's role in making these on-site solar projects a reality has directly contributed to increased generation of renewable electricity in Belgium and Colorado.

Renewable electricity procurement strategy

IBM's strategy is to purchase renewable electricity that is generated in the grid regions where our consumption of electricity occurs. This approach enables IBM to actually consume the renewable electricity it purchases when the time of its generation and our consumption coincides, and creates incentives for our electricity suppliers to increase their renewable electricity generation in the places where we actually have demand for such power. IBM does not rely upon the purchase of unbundled RECs to offset its consumption of electricity from fossil fuels.

It is not possible in today's market, or in the foreseeable future, for IBM's business operations to actually consume 100% renewable electricity given our presence in over 170 countries along with the need for uninterrupted power, which is usually only made possible today by the use of fossil fuel and nuclear generation sources.

In the interest of transparency, we categorize our procurement of renewable electricity as either physical consumption or matched consumption with bundled RECs.[1] Both categories represent scenarios in which an IBM facility and a renewable generation asset are connected to the same grid region (allowing electrons to actually flow from generation source to point of consumption).

- Physical consumption means the time of generation and consumption coincide. In this scenario, IBM is able to consume renewable power real-time, as it is generated.
- Matched consumption with bundled RECs means the time of generation and consumption do not coincide. This is the case, for example, when there is more renewable power being generated than what IBM needs to consume at a certain point in time. In this example, the excess renewable power is consumed by others within our same grid region.

We allocate our renewable electricity consumption among these two categories as follows, based upon our understanding of the sources and profiles of their output:

- Biomass – 100% physical consumption
- Geothermal – 100% physical consumption
- Hydropower – 70% physical consumption and 30% matched consumption
- Wind power – 40% physical consumption and 60% matched consumption
- Solar power – 20% physical consumption and 80% matched consumption

Allocation of renewable electricity during 2019 in MWh

Total renewable electricity reported	**1,789,988**
By delivery type	
Grid-supplied	841,608
On-site generation*	0
Contracted purchases	948,380
By category	
Physical consumption	1,029,462
Matched consumption with bundled RECs	760,526
Unbundled RECs	0

*Although IBM consumes power from on-site solar arrays installed at three of our locations, we do not claim that consumption within our reported metrics because our local power suppliers retain ownership of the RECs.

For more details on IBM's renewable electricity purchasing strategy, please visit our website.

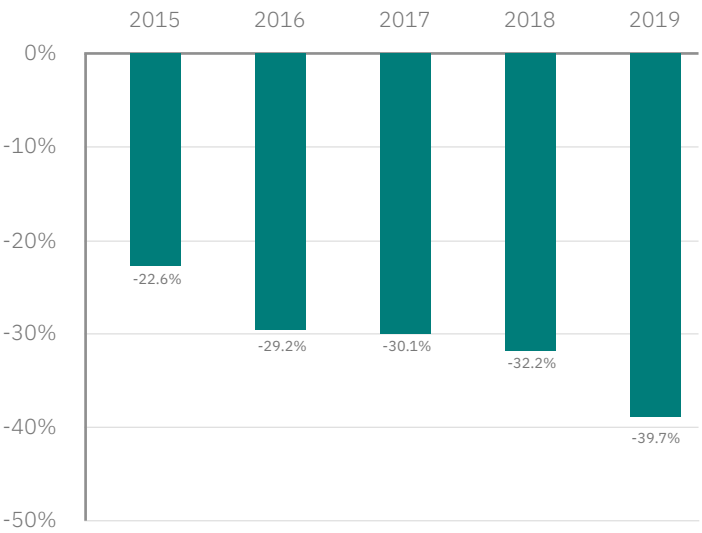
[1]Even when IBM procures off-site renewable electricity that is generated in the grid region where we are physically located and consuming, we cannot say with certainty that the energy which actually comes to us was not generated from fossil fuels. That is because the time when renewable electricity is generated (when the sun shines or the wind blows) may not exactly coincide with the time when we are consuming energy. For that reason, our reporting will disclose what we assume for physical consumption (when the time of generation and consumption coincide) and matched consumption (when generation and consumption occur at different times, but still within the same grid region).

Operational CO_2 emissions

IBM's current CO_2 emissions reduction goal is to reduce emissions by 40% by 2025 against base year 2005, adjusted for acquisitions and divestitures, and covers emissions associated with energy used to power our global operations. This includes emissions associated with the generation of electricity consumed at IBM data centers which are located in facilities managed by third parties.

In 2019, our operational CO_2 emissions were reduced by 11.1% versus 2018 to 1,222,000 metric tons. This corresponds to a 39.7% reduction against base year 2005, nearly meeting our 2025 goal. These reductions were the result of IBM's decreased energy consumption, increased consumption of renewable electricity, and an overall lower carbon intensity of many electric grids where IBM consumes electricity.

IBM's CO_2 emissions reductions against base year 2005 adjusted for acquisitions and divestitures



Goal: 40% reduction by 2025

IBM's operational CO_2 emissions associated with energy consumption in metric tons

	2015	2016	2017	2018	2019
Direct emissions associated with IBM's use of fuels for operations, such as heating	99,258	90,995	84,061	82,314	80,364
Emissions associated with IBM's purchased electricity and energy commodities	1,354,301	1,155,833	1,076,882	963,304	822,616
Emissions associated with the generation of electricity consumed by IBM's data centers located in third-party managed facilities	115,682	189,636	257,042	329,409	318,989
Total emissions covered by IBM goal	**1,569,241**	**1,436,464**	**1,417,985**	**1,375,027**	**1,221,969**
Reduction of operational CO_2 emissions against 2005 base year	**-22.6%**	**-29.2%**	**-30.1%**	**-32.2%**	**-39.7%**

The emissions covered by IBM's goal capture 97% of IBM's total Scope 1 and Scope 2 GHG emissions. They also include Scope 3 emissions associated with our electricity consumption at co-location data centers. Scope 1 emissions categories that are excluded from the goal are those resulting from the use of fuels for transportation and from the use of refrigerants and chemicals with a global warming potential. However, these emissions are included in IBM's overall GHG emissions inventory, available on our website. The website also includes estimates of emissions in five Scope 3 categories for which we were able to make rough approximations. IBM does not attempt to estimate Scope 3 emissions in other categories.

Although broad approximations of Scope 3 emissions can be helpful in identifying where the greatest amounts of GHG emissions may be generated during the lifecycle of a general process, product, or service on a macro level, the assumptions that must be made to estimate Scope 3 emissions in most categories do not enable credible, factual numbers. For more details about IBM's position on Scope 3 GHG emissions, please visit our website.

Transparency in carbon reporting

IBM believes in being fully transparent in the reporting of our climate-related results. Claims regarding "percent renewable," carbon neutral, net zero, and carbon negative can be confusing if they rely upon purchasing certificates or offsets.

At IBM, we will not use the purchase of unbundled Renewable Energy Certificates (RECs) to claim we are "x% renewable" or "powered by x% renewable energy" if we cannot credibly consume the electricity those certificates represent, or if we are not otherwise consuming renewable electricity to which we would apply the purchase of such certificates. If we claim to be "100% renewable" at a facility, we do so on the basis that we are purchasing renewable electricity equal to our electricity demand at the facility and in the grid region where that facility is located. Under this approach, our "100% renewable" claim considers both physical consumption and matched consumption of renewable electricity, recognizing that we will still rely upon backup power from fossil fuels at times when the renewable sources become interrupted.

The term "carbon neutral" also warrants increased transparency. Our view is that we will not be truly carbon neutral in the present tense as long as we continue to have CO_2 emissions that are not contemporaneously negated. When CO_2 is emitted it remains in the atmosphere for a long time. In the absence of carbon capture and sequestration technologies or carbon removal technologies deployed at a large, pervasive scale, the idea that we can instantly take away an emission right now by purchasing commonly available offsets – typically related to forestry – and therefore be of a neutral, zero, or negative impact in the present tense requires sufficient transparency. Credible offsets related to forestry are valuable and important in the fight against climate change, and financially supporting them is good as long as they are additional, permanent, not double counted, and result in no leakage elsewhere. However, purchasing them usually does not contemporaneously negate a present-day emission. Moreover, purchasing offsets to be "carbon neutral" does not necessarily compel an actual reduction in a company's emissions.

For IBM, transparency in carbon reporting therefore involves these practices:

— We will disclose energy consumption and CO_2 emissions (on a rolling 5-year basis) whenever we report "percent renewable" or "carbon neutral." That is because the amount of electricity consumption and CO_2 emissions provides essential context for "percent renewable" and "carbon neutral."

— When claiming we are a certain percent renewable, we will disclose how we calculate that percentage, including:

- How much renewable electricity comes to us routinely from the grid where we are physically located and consuming electricity.
- How much renewable electricity comes from on-site generation.
- How much renewable electricity comes from our contracted purchases in the grid regions where we are physically located and consuming electricity.
- How much, if any, use of renewable electricity is claimed based upon purchasing unbundled Renewable Energy Certificates.

— If we purchase offsets in an amount which equals or exceeds our emissions – thereby meeting a definition of carbon neutral, net zero, or carbon negative – we will do so in an effort to fund projects which might eventually store or save emissions, rather than as a means to imply our impact has now become neutralized or zero. We will disclose:

- The names and locations of the offset projects we rely upon.
- How each project is supposed to store or save emissions.
- The amount of emissions each project is estimated to store or save, when those storage or savings are supposed to occur, and how long they are supposed to last.

Climate change represents a serious threat to our planet that must be addressed right now. Transparent communications are essential to secure popular support for action.

Conservation and pollution prevention

We continue to seek opportunities to reduce our use of natural resources and the generation of wastes from our operations.

Water conservation

The preservation of water resources and the protection of watersheds are important areas of focus for IBM. Our first water conservation goal was established in 2000 and addressed water use in our microelectronics manufacturing operations. With the divestiture of IBM's semiconductor manufacturing operations in 2015, our water use decreased significantly. Our current water use is primarily associated with cooling and humidity control at offices and data centers, domestic consumption at the workplace, building fire protection systems, and landscape irrigation.

In 2016, IBM established its latest water conservation goal to achieve year-to-year reductions in water withdrawals at larger IBM locations and data centers in water-stressed regions. We use the World Resources Institute's Aqueduct Water Risk Atlas, which highlights regions around the world where water resources are stressed to meet human and ecological demand. We identify IBM locations in areas of "high" or "extremely high" baseline water-stress and incorporate this with site specific criteria to determine the locations subject to our water conservation goal.

In 2019, water withdrawals at these IBM locations decreased by 2% versus 2018. Reductions resulted from better management of water used in building heating, ventilation and air conditioning systems, adjustments to humidification equipment for regulating environmental conditions in data centers, efficiency enhancements to deionized water purification systems, improved maintenance of water pipelines, installation of water saving devices in restrooms, and water awareness initiatives at our locations.

In addition, these locations avoided water withdrawals through actions such as reuse of rejected deionized water from purification equipment, and recycling of site wastewater for use in evaporative cooling systems and in landscape irrigation systems. In 2019, on-site reuse of process water and recycling of treated wastewater at these locations was equivalent to 5% of their total water use.

Annual reduction in water withdrawals at IBM locations in water-stressed regions

	2016	2017	2018	2019
% of total withdrawals from previous year	6.6%	2.9%	0.4%	2.0%

Some IBM locations outside of water-stressed regions also implemented water conservation measures that avoided withdrawals of water. For example, our facility in Bromont, Canada, implemented water reduction and reuse projects that decreased annual water consumption by over 18,000 cubic meters per year. Water conservation activities included the reuse of the deionized water discharged from laboratory equipment, water use setting adjustments to semiconductor cleaning tools, and replacement of fire protection water pipelines. These water conservation activities avoided 11% of the location's total annual water use.

Paper and paper/wood-based packaging

IBM established its voluntary environmental goal for the responsible sourcing of paper and paper/wood-based packaging in 2002. It requires that the paper and paper/wood-based packaging directly procured by IBM must come from suppliers that source from sustainably managed forests where such sources exist.

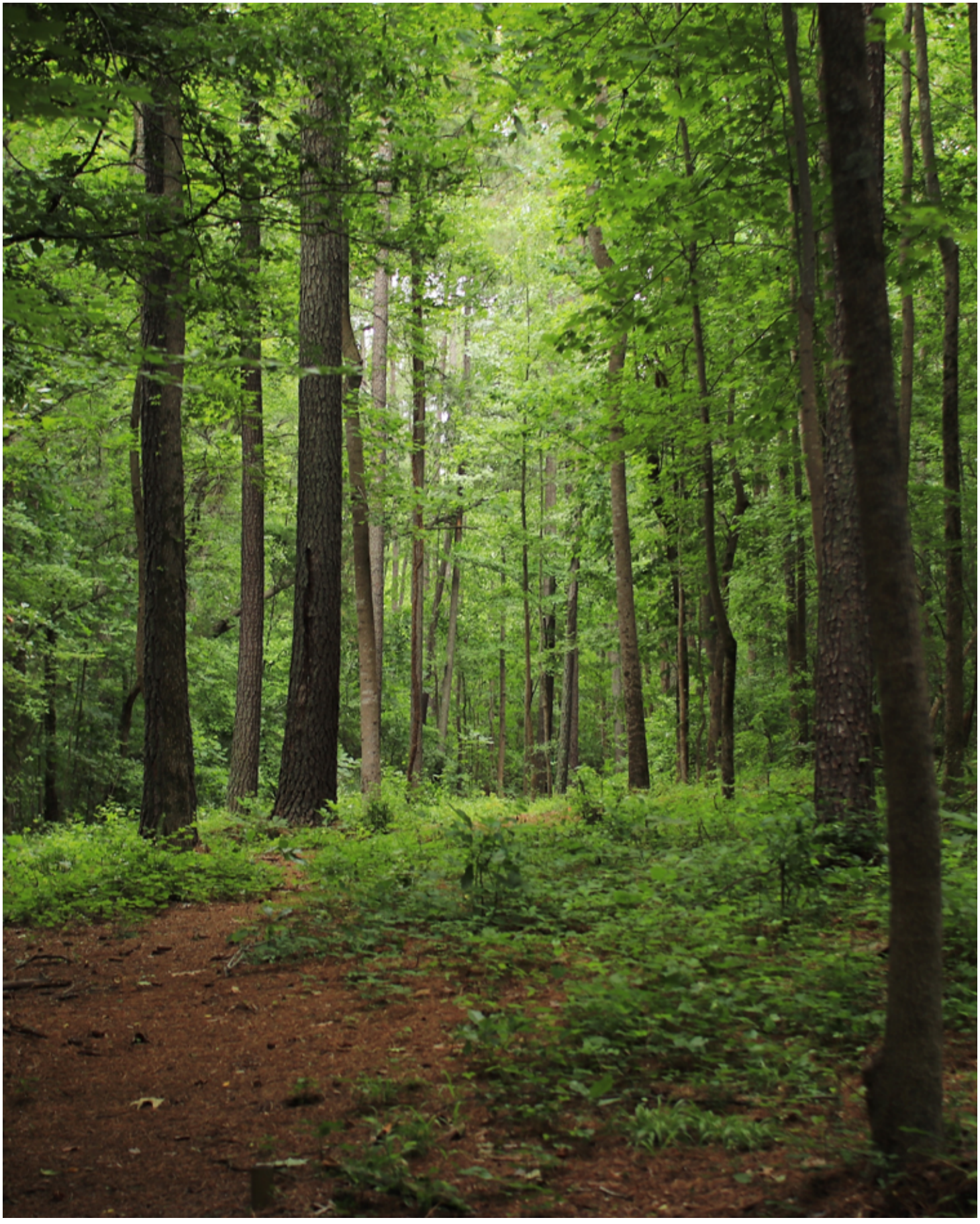
In 2019, over 99% of the paper and paper/wood-based packaging IBM directly procured worldwide came from suppliers that warranted that the source was derived from sustainably managed forests.

Percentage of total worldwide spend meeting IBM's paper and paper/wood-based packaging goal

	2015	2016	2017	2018	2019
Percentage of total annual spend meeting the goal	97.1%	97.0%	98.4%	98.7%	99.6%

We enhanced our goal in 2016 to require suppliers either to disclose their sources for paper and paper/wood-based packaging to IBM, or to provide evidence that their sources have been certified to be from sustainably managed forests by an accredited third-party certification scheme. Examples of such third-party certification schemes include the Forest Stewardship Council, Programme for the Endorsement of Forest Certification, Sustainable Forestry Initiative and the Canadian Standards Association Group Sustainable Forest Management System standard.

Requirements in support of this goal are incorporated into our standard supplier specifications for procuring paper and paper/wood-based packaging.



Waste avoidance and management

The best way to prevent pollution is to reduce the generation of waste at its source. This has been a basic philosophy behind IBM's pollution prevention program since 1971. For the waste that is generated, we focus on preventing pollution through a comprehensive, proactive waste management program. IBM's waste management hierarchy defines our strategic management practice in order of preference as: (1) prevention, (2) reuse, (3) recycling, (4) recovery, (5) other treatment, and (6) land disposal.

Plastic waste prevention

We are working with our cafeteria service providers globally to reduce the amount of plastic waste generated in these operations. Single-use plastic items such as straws, cups, cutlery, plates, bags and food containers are being eliminated or replaced with reusable options or more environmentally preferable alternatives.

These efforts are currently under way in more than 20 countries globally. For example, we removed 77 plastic items across 15 IBM cafeteria locations in the United States, eliminating about 19.5 metric tons (MT, 43,000 pounds) of plastic annually. In Canada, plastic cups, straws, "clamshell" food containers, and sandwich cases have been replaced by more environmentally preferable alternatives in several locations, eliminating about 7.6 MT (16,900 pounds) of plastic annually.

Nonhazardous waste

IBM established its first voluntary environmental goal to recycle nonhazardous waste streams in 1988. Since then, we have expanded the goal to include nonhazardous chemical waste, end-of-life IT equipment from our own operations, IBM-owned equipment that is returned by customers at the end of a lease, and nonhazardous waste generated by IBM at larger leased locations.

Our current goal is to send 75% (by weight) of the nonhazardous waste IBM generates worldwide to be recycled. In 2019, we sent 88.8% of the 35,700 MT of nonhazardous waste that we generated for recycling. This represents a 0.7% decrease from 2018 largely due to several construction projects where the associated waste was sent to landfill. Materials recovered from nonhazardous waste and sent to be recycled included: paper and cardboard, metals, plastics, wood, construction debris, cafeteria waste and end-of-life IT equipment. Disposition methods that are not considered recycling include incineration (i.e., without energy recovery), landfilling and treatment, such as aqueous treatment or biodegradation of organics.

Total annual nonhazardous waste quantity and recycling performance (Metric Tons x 1,000)

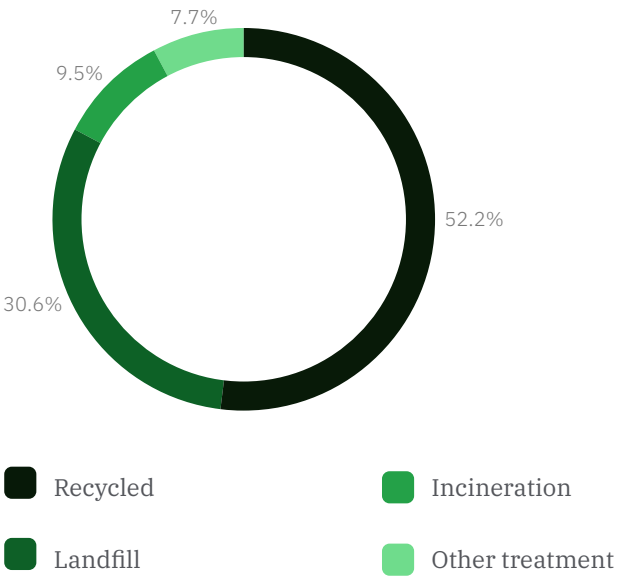
	2015	2016	2017	2018	2019
Total sent for recycling	45.6	38.4	32.4	30.6	31.7
Total generated*	53.5	44.5	36.9	34.2	35.7
% recycled (by weight)	85.2%	86.3%	87.8%	89.5%	88.8%

*Nonhazardous waste does not include sanitary wastewater transported to publicly owned treatment systems.

Hazardous waste

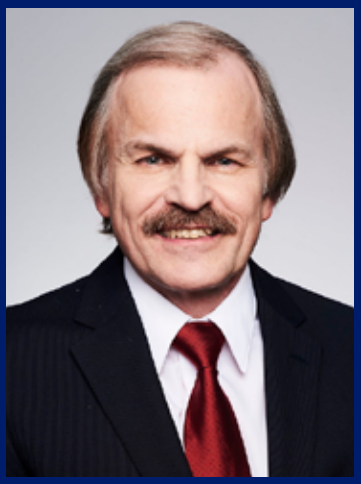
IBM does not generate large quantities of hazardous waste. In 2019, IBM generated 1,146 MT of hazardous waste, of which 52.2% was recycled. When prevention, reuse and recycling are not available or practicable, other recovery methods are utilized. Landfill and incineration are only used when other solutions are not available or when mandated by laws or regulations. For example, of the total amount of hazardous waste sent to landfills, approximately 66% was sludge from an industrial wastewater treatment plant which is required by law to be sent to a secure hazardous waste landfill.

Hazardous waste treatment methods



On IBM z15 energy efficiency

By Bill Kostenko



Bill Kostenko
IBM Fellow and Chief Engineer of Data Center and IBM Z System Hardware

Single frame IBM z15 system

The ability to execute a trillion web transactions[1] per day – with the data privacy, security, and resiliency capabilities to keep those transactions operational and secure – has made the IBM mainframe the ideal platform for the world's most critical computational tasks. In addition, IBM Z® can scale capacity while reducing energy consumption. For clients in banking, government, health care, commerce, telecommunications and other essential industries, energy-efficient data centers have become a key area of focus as they aim to reduce their energy usage and associated carbon dioxide emissions to achieve their sustainability goals. That is why my team came in and transformed the mainframe with the release of the IBM z15 in 2019. This continues the long tradition of reinvention that has helped maintain the mainframe's leadership for today's and tomorrow's new and most demanding workloads.

To start, the z15 delivers greatly improved, system-level energy efficiency. We began with a highly energy-efficient processor chip design, continued with improved internal power conversion and cooling efficiency, and ended with a new energy-efficient, fully integrated, intelligent Power Distribution Unit (iPDU) system level power option. As a

[1]Performance result is extrapolated from IBM internal tests running in a z15 LPAR with 36 or 39 dedicated IFLs and 256 GB memory, a z/VM 7.1 instance in SMT mode with 4 guests running SLES 12 SP4. With 36 IFLs each guest was configured with 18 vCPU. With 39 IFLs 3 guests were configured with 20 vCPU and 1 guest was configured with 18 vCPU. Each guest was configured with 64 GB memory, had a direct-attached OSA-Express6S adapter, and was running a dockerized NGINX 1.15.9 web server. The guest images were located on a FICON-attached DS8886. Each NGINX server was driven remotely by a separate x86 blade server with 24 Intel Xeon E5-2697 v2 @ 2.7GHz cores and 256 GB memory, running the wrk2 4.0.0.0 benchmarking tool (https://github.com/giltene/wrk2) with 48 parallel threads and 1024 open HTTPS connections. The transferred web pages had a size of 644 bytes.

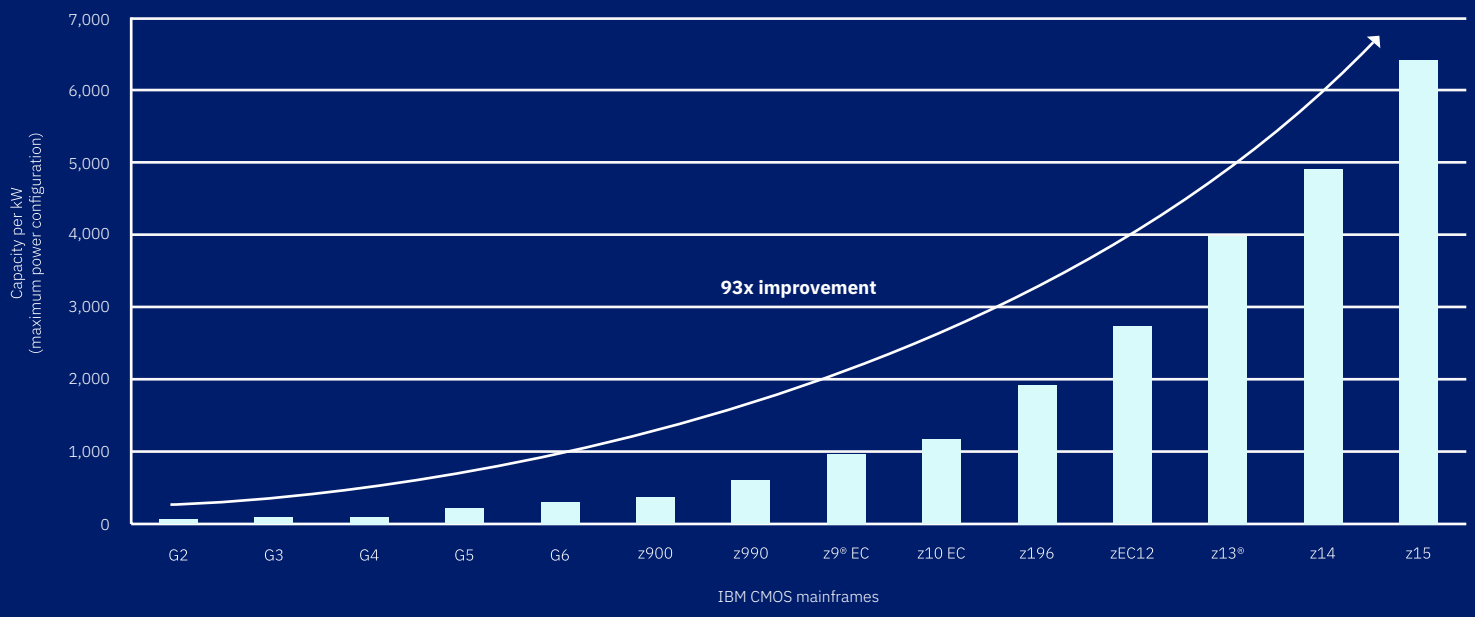
result, the z15 has 31% more performance per watt than the IBM z14 for the maximum configuration system. Moreover, the newest member of the z15 family can consume 59% less power than comparable x86 systems running workloads with the same throughput.[2]

The z15 also has a new, configurable physical footprint of one, two, three or four, data center-friendly frames. This allows it to be integrated directly into traditional and new data center IT equipment aisles, typically requiring half the floorspace of its predecessor, as well as to readily interface with the latest structured I/O cabling and power systems. In addition, the new footprint easily fits into new, advanced data center cooling air containment strategies. This enables cooling energy and hardware savings (on the order of 30%) at the data center level beyond our system level energy efficiency improvements.

IBM Z has a 24-year history of improved mainframe system capacity per watt. But that is where the z15's similarity to previous mainframe generations ends. In the past, for a comparably configured machine (processors, I/O, memory), the actual power consumption of the systems has stayed nearly the same, or even risen slightly for successive generations of products, while of course delivering more performance and capability. The z15, when equipped with the iPDU system level power option consumes 20-30% less power than a comparably equipped z14 system. That's quite an accomplishment.

The end result – the z15 is the most energy-efficient, reliable, capable and secure mainframe ever.

History of IBM Z CMOS systems capacity per kilowatt (kW)



[2]Compared LinuxONE III LT2 model consists of two CPC drawers containing 64 IFLs, and one I/O drawer to support both network and external storage versus 49 x86 systems with a total of 1,080 cores. LinuxONE III LT2 power consumption was based on 40 power draw samples for workloads on 64 IFLs running at 90% CPU utilization. x86 power consumption was based on 45 power draw samples for three workload types running from 10.6% to 15.4% CPU utilization. x86 CPU utilization rates were based on data from 15 customer surveys representing development, test, quality assurance, and production levels of CPU utilization and throughput. Each workload ran at the same throughput and SLA response time on LinuxONE and x86. Power consumption on x86 was measured while each system was under load. LinuxONE III LT2 performance data and number of IFLs was projected from actual LinuxONE Rockhopper II performance data. To estimate LinuxONE III LT2 performance, a 3% lower throughput adjustment based on the LinuxONE III LT2/LinuxONE Rockhopper II MIPS ratio was applied. Compared x86 models were all 2-sockets containing a mix of 8-core, 12-core and 14-core Xeon x86 servers. External storage is common to both platforms and is not included in power consumption. Assumes LinuxONE and x86 are running 24x7x365 with 42 development, test, quality assurance, and production servers and 9 high availability servers.

Design for the environment

We design our products to be energy efficient, incorporate recycled content and environmentally preferable materials, and facilitate reuse and recycling at their end-of-life.

Product design

IBM established its product design for the environment (DfE) program in 1991. IBM's DfE objectives and requirements are implemented through our global Environmental Management System (EMS), internal standards, product specifications and applicable IBM offering management processes.

Regulatory requirements affecting electrical and electronic equipment continue to proliferate globally and are increasingly complex. Integrated within IBM's global EMS, we have robust processes and state-of-the-art tools that help ensure our continued compliance with worldwide environmental laws and regulations. In 2019, we identified 179 new or modified product-related environmental laws and regulations and acted upon them as necessary to meet their requirements. For additional information on IBM's product compliance processes, please see our IBM and the Environment website.

Information on product environmental attributes such as energy efficiency, materials content, chemical emissions, design for recycling, end-of-life management, and packaging are documented in IBM's Product Environmental Profile (PEP) tool and reviewed at various checkpoints during the development process. Compliance management tools, such as the Product Content Declaration for IBM Suppliers, support the assessments required for a complete PEP prior to product release.

IBM DfE objectives

Develop, manufacture and market products that:

- are increasingly energy efficient
- incorporate recycled content and environmentally preferable materials and finishes
- can be upgraded, refurbished, remanufactured and reused to extend product life
- can be dismantled, recycled and disposed of safely

Materials

At IBM, we take a precautionary approach in selecting materials that we use in our products and processes, endeavoring to select materials that are safe for their intended use and that have the least impact on the environment. Prior to using new chemicals or materials in processes or technologies, IBM requires those chemicals or materials to undergo an extensive environmental, health and safety evaluation called an upstream chemical review. This has been a long-standing practice within IBM to ensure that we are using the least hazardous chemicals possible for a specific application, and it is a key element of IBM's approach to chemical management.

IBM's precautionary approach to materials and process stewardship is informed by our global chemical management staff, industrial hygienists and toxicologists. As a result, IBM has proactively prohibited or restricted the use of many hazardous substances in our products and processes well in advance of potential regulatory actions. In addition, as part of IBM's precautionary approach to chemical management and worker safety, IBM has a process for deriving occupational exposure limits (OELs) for chemical substances when there is no established OEL or when IBM environmental, health and safety professionals believe the current OEL is not protective of employee health.

In 2019, IBM had three POWER9-based server products and 11 storage products certified to ENERGY STAR.

Product energy efficiency

One of IBM's product energy efficiency goals is to improve the computing power delivered for each kilowatt-hour of electricity consumed for new server products as compared to equivalent, previous-generation products. IBM's latest POWER9™-based servers, the S922, S924 and E950, improved the work delivered per unit of power consumed – as measured by the Standard Performance Evaluation Corporation (SPEC) Server Efficiency Rating Tool (SERT) – by 30-60% over previous-generation POWER8®-based servers. In 2019, IBM introduced its next-generation mainframe enterprise platform, the IBM z15. The z15 uses 20-30% less power than a comparably configured IBM z14, and improves computing power delivered for each kilowatt-hour of electricity consumed by 31%.

IBM also has a goal to certify at least two-thirds of eligible IBM Power® Systems server products and at least one storage product in each eligible Storage Networking Industry Association (SNIA) taxonomy category to the U.S. Environmental Protection Agency's ENERGY STAR program criteria. In 2019, IBM had five POWER9-based servers eligible for ENERGY STAR and certified three (models S922, S924 and E950). IBM has 11 storage products certified to ENERGY STAR and at least one storage product certified from each of the three eligible SNIA taxonomy categories.

IBM Power Systems Servers

IBM's POWER9 processor-based servers are designed to deliver unprecedented performance for high performance computing, analytics, and artificial intelligence (AI). This increased performance provides an opportunity for clients to reduce the number of servers required to perform a given workload and the energy demand and consumption of their data centers. IBM Power Systems servers can make material improvements in the efficiency of data center operations.

The IBM Power System AC922 is designed specifically for AI workloads. It is built with advanced I/O interfaces and with hardware and software that are optimized and fine-tuned for AI acceleration with NVIDIA graphic processing units. It is also the backbone of the Department of Energy's Summit supercomputer.

The AC922 (8335-GTH) has a SERT weighted geo-mean active energy efficiency score that represents a 43% better energy efficiency performance per work delivered than the POWER8-based S822LC (8335-GTB) with similar configurations.[1] Some contributing factors for this increase include the removal of memory buffers and Auxiliary Processing Accelerators (APAs) in the system which can consume up to 35 watts when the system is idling.

[1] **8335-GTH low end configuration:** 2x16 cores, 16x16GB DIMMs, 2x7.2k RPM disk drives and no integrated APAs. **8335-GTB with configuration:** 2x10 cores, 32x8GB DIMMs, 2x7.2k RPM disk drives and 2x NVIDIA pascal APAs integrated (non-removable).

IBM Storage

IBM offers a broad range of storage products — including the IBM FlashSystem® 900, the Storwize® family, the DS8880 enterprise storage family, and tape systems — to address our clients' needs. These products are supported by software-defined storage and capacity optimization methods (COMs) through IBM Spectrum® Scale storage offerings that maximize the utilization of available storage capacity and assign data to the storage tier commensurate with the importance of the data. COM functions include software-based data management capabilities such as Easy Tier®, thin provisioning, data compression and deduplication, and storage virtualization. These capabilities can reduce the storage hardware and energy footprint as well as the capacity required to accomplish a given storage task.

Client examples:

— One client upgraded its storage system with a suite of IBM Spectrum Storage solutions, including IBM Spectrum Control, IBM Spectrum Protect, IBM Spectrum Scale and IBM Spectrum Virtualize. The client implemented an IBM Elastic Storage® server to support its data retention strategy, gaining a scalable, cost-effective platform for backups. The company also deployed IBM FlashSystem A9000R, with grid-scale, all-flash storage technology designed for data at scale. To accommodate 200% data growth while keeping its storage footprint low, the client relies on the deduplication and data compression features offered by IBM FlashSystem A9000R solutions which achieved a 2.5 to 1.0 ratio of data compression and 35% higher storage performance with a commensurate reduction in energy consumption.

— Another client experienced rapid growth of its business, and it was essential that they have the necessary IT infrastructure to overcome the performance limitations created by rapid growth and to support country specific tax and labor regulations. To do this, the client upgraded its SAP ERP Central Component solution to the latest enhancement package and implemented the country specific SAP Tax Declaration Framework module. The client chose to host the new solution on two IBM Power System E870C servers. For storage, the company selected an IBM System Storage™ DS8870 array to maximize efficiency and flexibility. The client deployed its IBM hardware as Infrastructure-as-a-Service for added flexibility and rapid scalability. By implementing this new solution, the client accelerated its core business processes by 98% and reduced its database storage requirements by 62% with commensurate reduction in energy consumption.

IBM Supercomputers

IBM's Summit and Sierra supercomputers are ranked second and third on the Top500 list of the world's fastest supercomputers. Summit is also ranked eighth on the Green500 list of the world's most energy-efficient supercomputers, where IBM occupies four of the top 10 spots.

In March 2020, IBM spearheaded the development of the COVID-19 High Performance Computing Consortium along with the White House Office of Science and Technology Policy and the U.S. Department of Energy. The consortium brings together the federal government, industry, and academic leaders who are volunteering free compute time and resources in support of COVID-19 research. More details on the COVID-19 High Performance Computing Consortium can be found on our website.

Product packaging

IBM has focused on the environmental attributes of its product packaging since the late 1980s. A key priority is to design products which can be shipped with a minimum amount of packaging materials. Beyond that, whenever possible, we choose packaging materials that have the least adverse impact on the environment, collaborating with suppliers to use recycled and recyclable materials and to promote reuse.

Our corporate environmental requirements for product packaging are embedded in various engineering specifications and procurement documents, which extend their reach beyond IBM to include our supply chain and other business partners.

All product packaging suppliers that pack or ship products to customers on behalf of IBM worldwide must submit packaging environmental data to IBM, along with other relevant compliance and performance data. Suppliers that do not conform to an IBM specification or other requirement must submit and implement improvement plans to close out the identified issues within an agreed timeframe.

IBM's strategy for reducing the environmental impact of our packaging includes:

— Minimizing the environmental impact of packaged products through the efficient use of materials and improved product ruggedness.

— Implementing sustainable packaging designs through efficient form and function, use of recyclable and/or renewable materials, while maintaining overall low cost to ensure economic viability.

— Implementing solutions that reduce the amount of packaging required and costs while maintaining the essential protective quality of the product-packaging system.

In 2019, our product packaging engineers redesigned the packaging associated with our z14 (model ZR1) and z15 systems. The new crate is designed with less wood, reducing weight by 27% from the previous version. This change will save an estimated 140 metric tons of material and approximately $409,000 in transportation costs annually. In addition, because the crates are designed to be robust, U.S. domestic and Canada shipments can reuse them, typically for five shipments. This reuse is estimated to help avoid the purchase of an additional 136 metric tons of crates and save $224,000 annually.

During 2020, IBM's product packaging engineers are investigating opportunities to minimize waste from plastic packaging by eliminating any remaining non-essential plastics, increasing recycled content, and using alternative materials that can be commercially recycled.

For additional information on IBM's packaging programs, please visit our IBM and the Environment website.

From 1995, when we first began including product recovery in our annual corporate environmental report, through the end of 2019, IBM documented the collection and processing of approximately 1.08 million metric tons (about 2.38 billion pounds) of product and product waste.

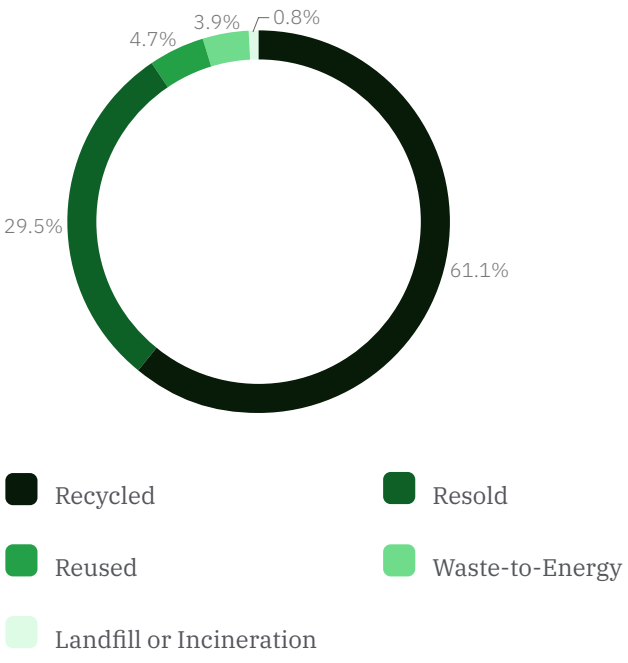
Product reuse and recycling

IBM develops products with consideration for their reuse, recyclability and recoverability, to extend product life and minimize the amount of product waste sent to landfills or for incineration. IBM began offering product takeback programs for clients in Europe in 1989 and has extended and enhanced these activities over the years. Today, IBM's Global Asset Recovery Services organization offers Asset Recovery Solutions to commercial customers in many countries generating business value from reusing IT assets.

When assets cannot be directly reused, they are refurbished or remanufactured and then certified using rigorous processes and original manufacturing standards. Products may also be rebuilt to meet specific client requirements. This practice reduces the impact of products on the environment by extending the life of existing IT equipment and eliminating the need to manufacture new products. Only after all refurbishment and reuse opportunities are exhausted will the remaining fractions be sent for recycling and recovery operations.

IBM's goal is to reuse or recycle end-of-life products such that the amount of product waste sent by our operations to landfills or to incineration facilities for disposal does not exceed a combined 3% by weight of the total amount processed. IBM's global product end-of-life management operations processed 20,800 metric tons of end-of-life products and product waste in 2019. More than 95% (by weight) was recycled, resold or reused, and only 0.8% was sent by IBM to landfill or incineration facilities for disposal.

Product end-of-life processing methods



On developing a new battery technology

By Young-hye Na

Young-hye Na, Ph.D.
Manager of the Advanced Energy Storage Program at IBM's Almaden Research Center in San Jose, California

Electric vehicles are the wave of the future and will be important in combatting climate change. However, the batteries which they use for storing energy are not without their own environmental and humanitarian challenges. Today's lithium-ion EV batteries rely on heavy metals such as cobalt and nickel to operate, and the rapidly expanding demand for these materials has resulted in dangerous and irresponsible practices at some mines where these materials are sourced. Now there may be a way to power electric vehicles and reduce carbon dioxide emissions without using heavy metals.

Late last year, my team and I unveiled a new type of battery that uses a proprietary combination of a safe electrolyte and an active cathode material that can be extracted from brines. The new research that we are conducting could help manufacturers eliminate the need for heavy metals in battery production, thereby improving the long-term sustainability of many parts of our energy infrastructure.

The performance potential of these new batteries is just as promising as the potential to eliminate the use of heavy metals. Our initial laboratory tests indicate that the IBM battery can be optimized to outperform lithium-ion batteries in several ways, including lower flammability, faster charging with higher power, and higher energy density, which translates to longer time between charges and a greater potential range for EVs.

To more rapidly improve and optimize the system, my team is using an AI approach combining active learning with battery performance prediction to identify safer and higher-performance materials than what are used in today's lithium-ion batteries. The use of machine learning techniques has enabled us to develop insights from millions of data points in our search for cleaner and safer materials. As our research continues, we have partnered with Mercedes-Benz Research & Development North America, battery electrolyte supplier Central Glass, and battery manufacturer Sidus to further develop and refine this new battery chemistry.

When it comes to achieving breakthroughs in batteries – or any area – research and innovation go hand in hand. You have to try new things, which for me meant applying my experience designing materials for water treatment membranes to this next challenge. It's been an exciting journey – one that has the potential to make a real and lasting difference in how we preserve and protect our planet.

Battery tester and cycler at IBM Research

Solutions

Our greatest opportunity to contribute towards the environmental sustainability of our planet comes from the innovative technologies and solutions that we deploy to help our clients and society address environmental challenges.

Digital farming platform

Yara, a global crop nutrition company based in Norway, is on a mission to responsibly feed and protect the planet by advancing more productive and sustainable agriculture to create a world without hunger. The company is combining its 115 years of agronomic expertise, crop knowledge and modeling capabilities with IBM technology – insights from IBM Watson Studio, IBM PAIRS technology, The Weather Company and other services – to bring more knowledge to farmers by building the world's leading digital farming platform. The platform will provide hyperlocal weather forecasts in addition to offering real-time recommendations to farmers tailored to the specific needs of individual fields and crops, helping to increase crop production, save water and decrease the need for fertilizers and pesticides. Learn more at IBM Services®.

AI and sustainable coffee

Besides sunlight, water and soil are a farm's most essential resources, which is why farmers use chemical analysis to test their quality. Knowing what is in their soil allows farmers to better manage water resources and fertilizer usage in an environmentally responsible manner, while maximizing crop production. IBM Research is working with Enveritas, a U.S. nonprofit organization that aims to bring sustainable practices for the economic and social development of coffee farmers around the world, to pilot a study of how the IBM AgroPad could help smallholder coffee farmers save money and improve the sustainability of their operations. AgroPad, an AI-powered paper device the size of a business card, can remotely and quickly analyze soil samples for chemical composition. Results can be uploaded to the IBM Cloud, where farmers can monitor the health of their soil and water over time. Learn more at IBM Research.

Technology for aquaculture

Farmed fish production, or aquaculture, supplies more than half the world's consumption but has lagged agriculture in its use of technology. A team at IBM Research-Europe is developing an aquaculture management platform that integrates a variety of data sources, processed by AI technology, to offer a real-time view of farm dynamics and provide early warnings on risks. "Our goal is to transition the aquaculture industry from ad hoc decision-making based on heuristics and intuition, to real-time informed decisions backed by AI insights and IoT connectivity," says IBM's Fearghal O'Donncha. "This transition has the potential to greatly reduce operational costs while enhancing fish health and ensuring sustainability." Learn more at IBM Research.

IBM Global High-Resolution Atmospheric Forecasting System

Access to accurate and timely weather information can help farmers know when to plant, fertilize, apply pesticides and irrigate. It can also help airlines efficiently route around turbulence and reduce fuel consumption. IBM GRAF, the Global High-Resolution Atmospheric Forecasting System, from The Weather Company, now offers the whole world weather forecasts that update every hour at a 3-kilometer resolution, providing access to information that helps improve decisions for farming and other industries as well as our everyday lives. Learn more at The Weather Company.

Optimizing solar energy and batteries

Addressing climate change will require a shift to renewable energy sources like solar energy. IBM Research–Australia partnered with Selectronic (an inverter manufacturer) and Relectrify (a provider of energy storage), funded in part by the State of Victoria, Australia, to learn how batteries, solar panels, inverters, and cloud-based services can be coordinated to provide the best possible economic return for users.

In addition, IBM Research developed an AI-based forecasting and energy control system that maximizes value from battery storage connected to solar photovoltaic systems. Getting the greatest value from battery storage systems requires careful consideration of when to discharge power to the local electric grid and when it may be advantageous to charge batteries from the grid, such as at night when electricity rates may be lower. These decisions must take into account anticipated solar generation, predicted energy demand, and the local electricity tariff structure, and are best accomplished in an automated way, continually analyzing new information (such as updated weather forecasts) as it arrives. The control system achieves this by combining solar irradiation forecasts via The Weather Company and AI to forecast solar energy generation and optimize battery storage control in a way that is customized to each site. Learn more at ibm.com.

Smarter buildings

The building sector is responsible for nearly 40% of global energy consumption.[1] IBM Research–Australia developed a Building Energy Analytics for Cooling and Heating (BEACH) solution to reduce the energy consumption and related greenhouse gas emissions associated with operating heating, ventilation and air-conditioning systems in commercial buildings.

BEACH, a cloud-based AI and data driven integrated framework, captures the temperature dynamics in different sections of a building, taking into account the impact of weather (leveraging The Weather Company), occupancy and other key system parameters. It then provides recommendations, such as when the HVAC system should be started/stopped or how temperature set-points should be adjusted in different sections of the building, so that energy consumption and costs can be kept to a minimum while delivering the desired thermal comfort conditions. BEACH is currently deployed in a large office building located in northern Australia and the results to date demonstrate that cooling energy consumption can be reduced by up to 15% through the use of this solution. Learn more at IBM Research.

[1] United Nations Environment Programme: Sustainable Buildings and Climate Initiative.

Photo: Credit to USAID

Transboundary water management

Transboundary water sources – aquifers and watersheds spanning two or more countries' borders – often present management challenges. Upstream overuse can cause shortages downstream, for example, or pollution in one country can impact another's water quality. IBM Research–Africa is working with partners to develop a pilot system for managing transboundary water supplies, starting with the Ramotswa Aquifer between South Africa and Botswana. The goal is better data, improved forecasting and deeper analysis that can help guide decisions on water management locally and regionally. Learn more at IBM Research.

Supply chain

IBM is committed to doing business with environmentally responsible suppliers. We work with our global suppliers to enhance their ability to manage environmental responsibilities and encourage them to report transparently on their environmental impacts.

Environmental requirements for IBM suppliers

Since 2010, IBM has required that all of its first-tier suppliers maintain a management system to address their social and environmental responsibilities. Our objective is to help our suppliers build their own capability to succeed in this area. In summary, we require all IBM suppliers to:

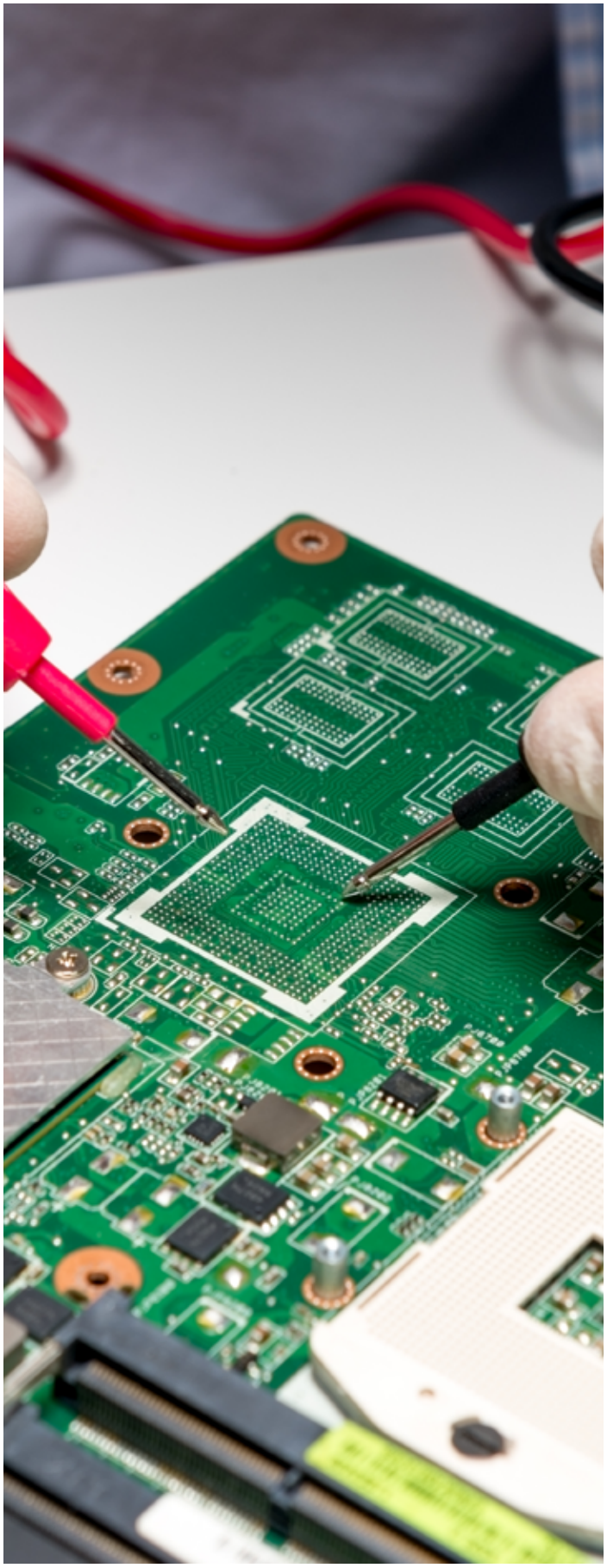
- Define, deploy and sustain a management system that addresses the intersections of their operations with employees, society and the environment.
- Measure performance and establish voluntary, quantifiable environmental goals in the areas of waste, energy and greenhouse gas emissions.
- Publicly disclose results associated with these voluntary environmental goals and other environmental aspects of their operations.
- Conduct self-assessments and audits, as well as management reviews, of their management system.
- Cascade these requirements to their suppliers who perform work that is material to the products, parts and/or services supplied to IBM.

The full set of requirements can be found on IBM's Global Procurement website.

Supplier Code of Conduct

IBM is a founding member of the Responsible Business Alliance (RBA), formerly the Electronic Industry Citizenship Coalition, a nonprofit industry group that helps its members support continuous improvement in the social, environmental and ethical responsibility of their supply chains. We require our suppliers to adhere to the RBA Code of Conduct, which contains environmental requirements as well as provisions on labor, health and safety, ethics, and management systems. We communicate our requirement for RBA Code compliance at the initial stages of supplier onboarding. Each year, a subset of our suppliers is assessed using the RBA's Validated Audit Process to verify their compliance with the code.

For more information on IBM's supplier audit requirements and results, please see our 2019 Corporate Responsibility Report.



Suppliers managing chemicals, wastes and end-of-life equipment

IBM has established additional environmental requirements for suppliers who:

— Execute processes for which IBM has specified or furnished chemicals or process equipment.

— Provide hazardous waste treatment and/or disposal services.

— Recycle and/or recover end-of-life IT products.

Environmental requirements are documented in our internal procedures, as well as in our contracts with these suppliers, and include requirements related to chemical content, chemical management, waste management, spill prevention, health and safety, downstream supplier management and reporting. We evaluate these suppliers prior to entering into a contract with them to confirm that their workplace safety and environmental practices meet our requirements. Suppliers are managed to the same high standards, wherever in the world they operate.

Hazardous wastes are treated, recycled or disposed of at IBM-approved supplier facilities within the country where the wastes are generated, whenever possible. If there are no suppliers in a country that meet IBM's environmental and safety requirements, the waste is shipped to facilities in other countries where those requirements can be met — in compliance with country laws and regulations and in accordance with international treaties. IBM does not ship hazardous wastes from countries that are members of the Organisation for Economic Co-operation and Development (OECD) to countries that are not members of the OECD. In rare cases, IBM will store wastes and product end-of-life materials in properly managed storage facilities, as allowed by law, until suitable processing facilities are available. For more information on IBM's requirements for suppliers managing chemicals, wastes and end-of-life equipment, please visit our IBM and the Environment website.

Supply chain environmental milestones

1972 Established a corporate directive requiring the environmental evaluation of suppliers of hazardous waste services.

1980 Expanded our environmental evaluations of suppliers by establishing a second corporate directive to require the environmental evaluation of certain production-related suppliers.

1991 Further expanded our environmental evaluations of suppliers, adding a requirement that product recycling and product disposal suppliers be evaluated.

1993 Established product environmental compliance specification 46G3772 with environmental requirements for parts and products IBM procures from suppliers.

2002 Added a requirement to assess our suppliers and certain subcontractors they may use to handle recycling and/or disposal operations in countries outside the OECD.

2004 Established environmental and social requirements for all IBM suppliers via IBM's Supplier Conduct Principles and also formed, jointly with other companies, the Electronic Industry Code of Conduct (now the Responsible Business Alliance Code of Conduct).

2005 Created a part and product compliance declaration form (referred to as Product Content Declaration or PCD) to facilitate transfer of part and product compliance information from the supply chain to IBM.

2010 Required all suppliers having a direct relationship with IBM to establish a management system that addresses their social and environmental responsibilities and to cascade these requirements to their suppliers who perform work that is material to the products, parts and/or services supplied to IBM.

2013 Incorporated the assessment of product environmental compliance requirements into the supply chain audit process and introduced reviews via a sampling approach of PCD forms for data integrity.

2014 Expanded our supplier evaluation program to include suppliers providing collective solutions for the management of IBM's end-of-life product waste.

2016 Established an environmental goal to have first-tier suppliers providing product end-of-life management, recycling and disposal services in the U.S., Canada and the European Union achieve third-party certification to an acceptable electronic product recycling standard, or demonstrate compliance with an IBM approved alternative.

2017 Established a three-stage supplier environmental evaluation process, with increasing levels of due diligence, depending on the level of risks associated with the supplier's operation.

Installation of a groundwater monitoring well at the former IBM Montpellier, France, site.

Remediation

At IBM, we take swift actions to clean up environmental contamination found at our current and former sites, and we are committed to taking proactive actions to prevent future contamination.

When groundwater contamination was first discovered at one of IBM's sites in 1977, the company voluntarily initiated groundwater monitoring at all its manufacturing and development locations worldwide. Today, IBM has 2,360 monitoring wells and 86 extraction wells in place at its current and former locations.

In 2019, IBM operated remediation systems that removed approximately 13,000 pounds of solvents from groundwater and soil vapor at three currently operating IBM locations and 12 former IBM locations. IBM also has financial responsibility for remediation at two additional former locations.

Under the U.S. Superfund law, IBM is involved in remediation activities at some non-IBM sites in the United States. The Superfund law creates retroactive responsibility for all parties that may have sent waste or otherwise contributed to contamination at a site, regardless of whether the site's operations and/or the shipments of waste to that site were legal, or even best practices, at the time. As of year-end 2019, IBM had received notification (through federal, state or private parties) of its potential liability at 116 such sites since the beginning of the U.S. Superfund program in 1980. At most of these sites, IBM has either resolved its liability or has demonstrated that it has none. Currently, IBM is participating in remediation activities or bears some financial responsibility at 19 Superfund sites.

When an environmental investigation and/or remediation at a site for which IBM has responsibility is probable, and the costs for future activities can be reasonably estimated, IBM establishes financial accruals for loss contingency. As of December 31, 2019, the total amount IBM accrued for all such environmental liabilities and associated activities was $270 million.

Appendix

Awards and recognition

IBM Austin, Texas:

Austin Green Business Leaders Program — Platinum Level

IBM Boulder, Colorado:

Environmental Leadership Program by the Colorado Department of Public Health — Gold Leader

IBM Bromont, Canada:

ICI on recycle + program — Elite level certification from RECYC-QUÉBEC

IBM Hong Kong:

Class of Excellence Wastewi$e Label from the Hong Kong Environmental Campaign Committee

IBM India:

2019 Bronze Stevie Award for Health, Safety & Environment Program of the Year in Asia, Australia, and New Zealand in the International Business Awards

IBM Guadalajara, Mexico:

Clean Industry recertification from Mexico's Federal Environmental Protection Agency (PROFEPA)

SUSTAINABLE DEVELOPMENT GOALS ACTION AWARDS

2019 United Nations Sustainable Development Goals Action Award citing the use of IBM Blockchain technology by Plastic Bank in reducing ocean plastic.

CLIMATE LEADERSHIP AWARDS 2019
Excellence in Greenhouse Gas Management (Goal Setting Certificate) Recipient

2019 Climate Leadership Award from the Center for Climate and Energy Solutions and The Climate Registry for setting its 4th-generation GHG emissions reduction goal and accompanying 2nd-generation renewable electricity goal. This was IBM's seventh Climate Leadership Award in the program's eight-year history.

2019 Sustainability Initiative of the Year Award from the Business Intelligence Group recognizing "Forecast: Change" from The Weather Company.

2020 Internet Advertising Competition Award for Best Environmental Online Campaign from the Web Marketing Association recognizing "Forecast: Change" from The Weather Company.

Environmental goals and results

	2015	2016	2017	2018	2019
Energy and climate change					
Energy conservation as % of total energy use (goal 3%)	6.1	4.8	3.6	3.3	3.2
IBM total energy consumption in megawatt-hours	4,896,386	4,912,714	4,845,695	4,666,514	4,455,752
Renewable electricity procurement as % of total electricity consumption (goal 55% by 2025)	32.7	37.0	39.0	37.9	47.0
CO_2 emissions reduction as % of 2005 baseline CO_2 emissions (goal 40% by 2025)	22.6	29.2	30.1	32.2	39.7
IBM total operational CO_2 emissions in metric tons	1,569,241	1,436,464	1,417,985	1,375,027	1,221,969

Note: Energy and emissions goals and reporting cover all activities taking place in IBM-owned or leased facilities. These facilities include co-location data centers. Renewable electricity procurement includes contracted purchases and renewable electricity which automatically comes to IBM via routine grid power. CO_2 emissions reduction data is adjusted for acquisitions and divestitures.

Water conservation					
% annual reduction in water withdrawals at data centers and other large IBM locations in water-stressed regions	*	6.6	2.9	0.4	2.0

*Our latest goal was established in 2016.

Nonhazardous waste recycling					
% by weight sent for recycling (goal 75%)	85.2	86.3	87.8	89.5	88.8

	2015	2016	2017	2018	2019
Product reuse and recycling					
% by weight of total IT product waste sent by IBM's product end-of-life operations to landfill or incineration for treatment (goal not to exceed a combined 3% by weight)	0.7	0.6	0.7	0.7	0.8

Product energy efficiency

IBM's product energy efficiency goal is to improve the computing power delivered for each kilowatt-hour of electricity used for each new generation of servers. IBM's latest POWER9-based servers, the S922, S924 and E950, improved the work delivered per unit of power consumed, as measured by the Standard Performance Evaluation Corporation (SPEC) Server Efficiency Rating Tool (SERT), by 30-60% over previous generation POWER8-based servers. In 2019, IBM introduced its next-generation mainframe enterprise platform, the IBM z15. The z15 improves computing power delivered for each kilowatt-hour of electricity consumed by 31% versus the IBM z14.

ENERGY STAR certified products

IBM has a goal to certify at least two-thirds of eligible servers — and at least one storage product in each eligible Storage Networking Industry Association (SNIA) taxonomy category — to the U.S. Environmental Protection Agency's ENERGY STAR program criteria. In 2019, IBM had five POWER9-based servers eligible for ENERGY STAR and certified three (models S922, S924, and E950). IBM has 11 storage products certified to ENERGY STAR and at least one storage product certified from each of the three eligible SNIA taxonomy categories.

IBM corporate environmental policy

IBM is committed to environmental leadership in all of its business activities. IBM has had long-standing corporate policies of providing a safe and healthful workplace, protecting the environment and conserving energy and natural resources — which were formalized in 1967, 1971 and 1974, respectively. They have served the environment and our business well over the years and provide the foundation for the following corporate policy objectives:

— Provide a safe and healthful workplace and ensure that personnel are properly trained and have appropriate safety and emergency equipment.

— Be an environmentally responsible neighbor in the communities where we operate, and act promptly and responsibly to correct incidents or conditions that endanger health, safety, or the environment. Report them to authorities promptly and inform affected parties as appropriate.

— Conserve natural resources by reusing and recycling materials, purchasing recycled materials, and using recyclable packaging and other materials.

— Develop, manufacture, and market products that are safe for their intended use, efficient in their use of energy, protective of the environment, and that can be reused, recycled or disposed of safely.

— Use development and manufacturing processes that do not adversely affect the environment, including developing and improving operations and technologies to minimize waste, prevent air, water, and other pollution, minimize health and safety risks, and dispose of waste safely and responsibly.

— Ensure the responsible use of energy throughout our business, including conserving energy, improving energy efficiency, and giving preference to renewable over non-renewable energy sources when feasible.

— Participate in efforts to improve environmental protection and understanding around the world and share appropriate pollution prevention technology, knowledge and methods.

— Utilize IBM products, services and expertise around the world to assist in the development of solutions to environmental problems.

— Meet or exceed all applicable government requirements and voluntary requirements to which IBM subscribes. Set and adhere to stringent requirements of our own no matter where in the world the company does business.

— Strive to continually improve IBM's Environmental Management System and performance, and periodically issue progress reports to the general public.

— Conduct rigorous audits and self-assessments of IBM's compliance with this policy, measure progress of IBM's environmental affairs performance, and report periodically to the Board of Directors.

Every employee and every contractor on IBM premises is expected to follow this policy and to report any environmental, health, or safety concern to IBM management. Managers are expected to take prompt action.