

A close-up photograph of a green leaf, showing a network of veins. The veins are a lighter shade of green, creating a complex, branching pattern against the darker green background of the leaf. The lighting is bright, highlighting the texture and structure of the leaf.

2017 IBM and the Environment Report



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Actions and results

Corporate responsibility regarding the environment is an imperative. A company's environmental stature, however, depends upon not only aspiration but also actions and results.



Corporate environmental sustainability must also transcend changes in public policy, personnel, business cycles, and—in the IT industry—constant changes in technology. All of this must occur while understanding and addressing the ways in which a company's global operations intersect with diverse environmental challenges. To do this well, it's essential to routinely work with leaders across government, business, nongovernmental organizations, and academia.

The people of IBM have dependably pursued environmental leadership in this manner for decades. Numerous milestones along IBM's journey attest to this. It was in 1971 that IBM issued its first formal corporate policy for environmental protection. And it was in the early 1990s that IBM pioneered the practice of voluntary corporate environmental reporting.

Today, I am proud to say this is the 28th consecutive year in which IBM has published a voluntary annual corporate environmental report. This year's report, like those which preceded it, contains extensive information about IBM and the environment. Here are a few highlights:

- We recertified our global environmental management system to the updated 2015 edition of the ISO 14001 standard. (Twenty years ago, in 1997, IBM became the first major company in the world to earn a single global registration to ISO 14001.)
- We achieved our third carbon dioxide (CO₂) emissions reduction goal four years early. As of year-end 2017, we reduced the CO₂ emissions attributable to IBM at its managed locations by 42.9 percent versus 2005—compared to our goal of 35 percent.

- 41.4 percent of IBM's global electricity supply across its managed spaces came from renewable sources. We procured electricity from renewable sources for 22.9 percent (exceeding our goal of 20 percent by 2020). The remaining 18.5 percent came from the grid mix IBM routinely receives. This does not rely upon purchasing unbundled Renewable Energy Certificates.
- In March 2018, IBM earned the Climate Leadership Award from the Center for Climate and Energy Solutions and The Climate Registry. This is the sixth time in the award program's seven-year history that IBM has been recognized.

You'll also read about ways in which IBM applies its expertise in business and technology to help clients with solutions to environmental problems. As the world's premier enterprise technology company, IBM's cognitive solutions and cloud platform enable analytics, Internet of Things, artificial intelligence and blockchain to be deployed for innovative solutions.

More than anything else, however, it is the people of IBM who deliver our company's environmental performance, solutions and results. We are continually grateful to them.

Wayne S. Balta
Vice President
Corporate Environmental Affairs & Product Safety
June 2018

Year in review

In 2017, IBM continued to demonstrate environmental leadership through strong execution of its environmental management system (EMS) and continued improvement against key performance goals and metrics.

Environmental management system

IBM's single global [ISO 14001 EMS accreditation](#) includes its manufacturing and chemical-using research locations as well as several IBM organizations at the individual country level. IBM also has 16 entities worldwide certified to the ISO 50001 standard on energy management systems. In 2017, we completed an update to our global EMS to transition our certification to the 2015 edition of the standard.

Audits and compliance

In 2017, IBM received 73 governmental agency inspections at facilities worldwide with no resulting fines or penalties. IBM locations reported eight accidental releases of substances to the environment related to IBM operations through our Environmental Incident Reporting System — five releases to air, two releases to land and one release to water. None of the releases was of a duration or concentration sufficient to cause long-term environmental impact.

Metrics and key performance indicators

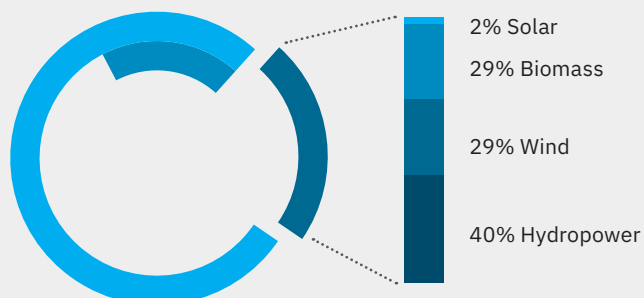
IBM monitors its performance across a range of environmental issues that have been determined to be significant for IBM's business, and has established environmental targets associated with several key issues.

Energy conservation, renewable electricity and CO₂ emissions reduction

In 2017, IBM's energy conservation projects across the company delivered annual savings equal to 4.2 percent of our total energy use at IBM-managed locations, surpassing the corporate goal of 3.5 percent. IBM-managed locations are places where IBM is responsible for procuring energy and managing facilities infrastructure and operations. These projects, numbering more than 2,000 and implemented at over 500 global locations, avoided the consumption of 173,000 megawatt-hours (MWh) of energy, an associated 64,000 metric tons of carbon dioxide (CO₂) emissions, and saved \$16.1 million in expense.

Electricity sources at IBM-managed locations

- 77.1% Grid-purchased electricity (GPE)
- 18.5% Grid-supplied renewables (part of GPE)
- 22.9% Contracted renewable purchases



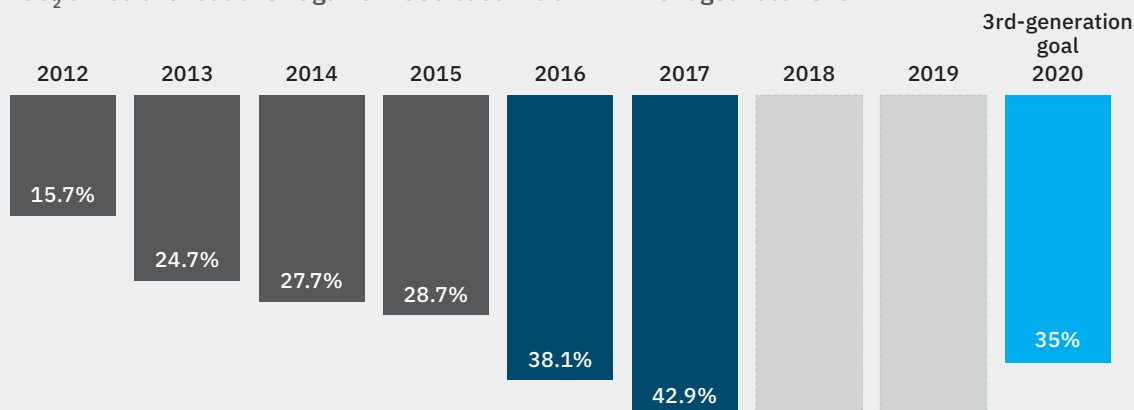
IBM's energy conservation projects delivered annual savings equal to 4.2 percent of its total energy use in 2017 — surpassing our goal of 3.5 percent.

IBM contracted with its utility suppliers to purchase approximately 779,000 MWh of renewable electricity, representing 22.9 percent of our global electricity consumption at IBM-managed locations in 2017. These purchases once again exceeded IBM's goal to procure 20 percent of the electricity it consumes from renewable sources by 2020, over and above the renewable electricity that was part of what IBM received via the grid. When we include what IBM received via the grid, 41.4 percent of the electricity consumed in IBM's managed locations was sourced from renewable assets.

From 2016 to 2017, IBM reduced CO₂ emissions attributable to IBM at its managed locations by 96,000 metric tons (7.7 percent) to 1,158,000 metric tons. As of year-end 2017 (as shown below), we reduced CO₂ emissions attributable to IBM at its managed locations by 42.9 percent versus 2005, compared to our goal of 35 percent by 2020.



Operational CO₂ emissions reduction against 2005 baseline at IBM-managed locations



IBM recovered and sent 87.8 percent (by weight) of its nonhazardous waste to be recycled – surpassing our goal of 75 percent.

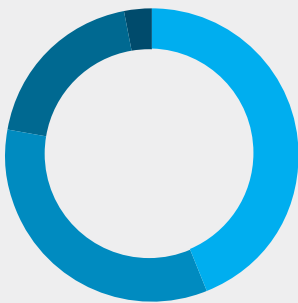
Water conservation

In 2016, IBM established a new water conservation goal to achieve year-to-year reductions in water withdrawals at 45 data centers and other large IBM facilities located in water-stressed regions. In 2017, withdrawals at these locations were reduced by 2.9 percent versus 2016.

Hazardous and nonhazardous waste management

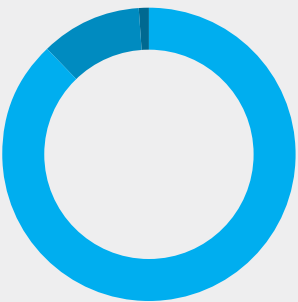
IBM’s total hazardous waste generation in 2017 increased by 7 percent (by weight) from 2016, to 1,460 metric tons. This increase was caused by the disposal of hazardous waste generated by a water leak from a fire suppression system at one of our facilities. The water was contaminated with diesel fuel from an emergency generator located within the area where the leak occurred. The contaminated water was contained, avoiding any release to the environment. If hazardous waste generated as a result of this incident were removed, IBM would have seen a 16 percent reduction in hazardous waste generation in 2017.

In 2017, our worldwide operations generated approximately 36,900 metric tons of nonhazardous waste, a decrease of about 7,600 metric tons from 2016. IBM recovered and sent 87.8 percent (by weight) of its nonhazardous waste to be recycled – surpassing our goal of 75 percent.



2017 water use at IBM locations in water-stressed regions

- 45% Domestic water use
- 31% Heating, ventilation and air conditioning (HVAC) systems
- 19.5% Landscape irrigation
- 4.5% Manufacturing processes



2017 total generated nonhazardous waste worldwide by treatment method
(% by weight of 36,900 metric tons processed)

- 87.8% Recycle
- 10.8% Landfill and incineration
- 1.4% Other treatments

Note: Total generated nonhazardous waste excludes sanitary wastewater sent to publicly owned treatment systems.

Product end-of-life management (PELM)

IBM's global PELM operations processed 26,500 metric tons of end-of-life products and product waste in 2017. Of this total, we sent 0.7 percent directly to landfill or incineration as a disposal treatment, better than our goal of not-to-exceed 3 percent (by weight). In addition, 52.2 percent was sent for recycling as materials, 39.6 percent was resold as products, 4.4 percent was product reused by IBM, and 3.1 percent was incinerated for energy recovery.

Products and solutions

IBM's innovative products, services and solutions enable our clients to conserve natural resources and reduce the environmental impacts associated with their operations.

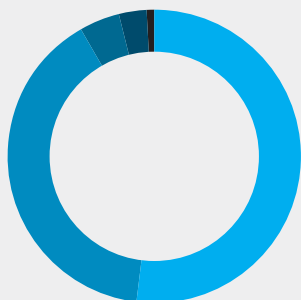
In 2017, IBM released its POWER9™-based Power Systems™ Accelerated Compute (AC922) server for high-performance computing analytics and artificial intelligence. When compared to comparable IBM POWER8® products, IBM POWER9-based servers have Server Efficiency Rating Tool (SERT) weighted geometric active efficiency scores up to three times higher — which represents three times the performance or work delivered without any increase in power use. The SERT was created by the Standard Performance Evaluation Corporation. IBM also introduced its next-generation mainframe, the IBM z14™ server, in 2017. On average, the IBM z14 server delivers 23 percent or more work per kilowatt depending on the choice of components and cooling method.

IBM has a goal to qualify its new server and storage products to the U.S. Environmental Protection Agency's ENERGY STAR program criteria where practical, and where criteria have been developed for the specific server or storage product type. As of May 2018, IBM had five Power Systems servers and seven storage products certified to the ENERGY STAR requirements.

For more information on IBM's products and solutions, please see the [product stewardship](#) and the [solutions for environmental sustainability](#) sections of this report.



IBMers Chi Xiong, Norma Sosa and Will Green prepare a methane sensor to [detect leaks](#) in natural gas production systems.



2017 product end-of-life management operations

(% by weight of 26,500 metric tons processed)

- 52.2% Recycled
- 39.6% Resold
- 4.4% Reused
- 3.1% Waste-to-energy
- 0.7% Landfill and incineration

Commitment to environmental leadership

A decades-old commitment to environmental leadership is an impressive legacy. And, at IBM, we are very proud of our past accomplishments. But we also take pride in sustaining this legacy, and we are always looking to enhance what IBM began half a century ago with the issuance of our first corporate directive regarding pollution control. Thomas J. Watson, Jr. was the CEO at the time, and his vision for the future of the business and its relationship to the environment remains our guidepost.

Today, we have a new Watson—a set of cognitive applications helping clients achieve remarkable outcomes and accelerating discovery using innovative, unique data connections. We have come a long way in this journey and we embrace the future with great anticipation for creating solutions and technologies to improve the environment and our quality of life.

In our own operations, we have seen first-hand what can be achieved with a sustained focus on the environment. That focus has driven impressive and quantifiable results. The following highlights demonstrate our history of commitment and leadership:

1967—IBM issued its first formal directive on pollution control, disposal of liquid wastes, and wastewater treatment.

1971—IBM CEO Thomas J. Watson Jr. formalized the company's commitment to environmental protection in our first Corporate Environmental Policy.

1972—IBM issued a corporate directive requiring the environmental evaluation of suppliers of hazardous waste services. That directive was later expanded to include product recycling and disposal suppliers, and certain production-related suppliers.

1973—IBM established its global energy conservation program and developed the methodology leading to its first conservation goal in 1975.

1974—IBM issued a corporate policy on energy and materials conservation and recycling.

1978—IBM began a global program to monitor groundwater quality at its manufacturing and development locations and to perform groundwater remediation as needed.

1988—IBM established its first nonhazardous waste recycling goal.

1989—IBM set a goal to eliminate chlorofluorocarbons (CFCs) and carbon tetrachloride from all its products and manufacturing processes by the end of 1993.

1990—IBM began its annual corporate environmental reporting which has continued annually since that date.

1991—IBM established its product stewardship program as a proactive and strategic approach to the environmental design and management of our products.

1991—IBM began the Chairman's Environmental Award Program recognizing achievement and progress in environmental affairs on the part of IBM's organizations. The award is presented annually by IBM's chairman.

1992—IBM became a charter member of the U.S. Environmental Protection Agency's ENERGY STAR computer program and helped to develop the first ENERGY STAR criteria for personal computers.

1997— IBM was the first major multinational company to earn a single global registration to the ISO 14001 environmental management system standard.

2000— IBM established a water conservation goal, which was first focused on the significant use of water in our microelectronics manufacturing operations, then in early 2016 focused on reductions in water withdrawals at IBM locations in water stressed regions.

2000— IBM established its first operational carbon dioxide (CO₂) emissions reduction goal when we helped the World Wildlife Fund create its Climate Savers program.

2004— IBM established environmental and social requirements for all IBM suppliers via IBM's Supplier Conduct Principles and supporting audit program.

2010— IBM eliminated perfluorooctane sulfonate (PFOS) and perfluorooctanoic acid (PFOA) in its manufacturing, development and research processes.

2016— IBM achieved and exceeded its third-generation CO₂ emissions reduction goal four years early.

2016— IBM achieved and exceeded its 2020 renewable electricity goal four years early.

2018— IBM earned a Climate Leadership Award from the Center for Climate and Energy Solutions and The Climate Registry, in partnership with Bloomberg Philanthropies. This was the sixth time in the award program's seven-year history that IBM was recognized.



Ann McCabe, interim executive director, The Climate Registry, Andres Rodriguez, program manager, IBM Corporate Environmental Affairs, Wayne Balta, vice president, IBM Corporate Environmental Affairs and Product Safety, and Bob Perciasepe, president, Center for Climate and Energy Solutions.

Global governance and management system

IBM implements its environmental, energy and chemical management programs through a global environmental management system that governs IBM's conduct and operations worldwide.

Global environmental management system

Our [corporate environmental policy](#) provides the strategic framework for the company's global environmental management system (EMS). This policy calls for environmental leadership in all of the company's business activities. Achieving leadership is enabled through the implementation of our EMS, which integrates corporate directives governing IBM's conduct and operations worldwide. These directives cover areas such as energy conservation and climate protection, product stewardship, pollution prevention, chemical and waste management, and environmental evaluation of suppliers—as well as incident prevention, preparedness, response and reporting. It is through the consistent implementation of this EMS that IBM ensures operations are executed with the same protective standards for the environment in every country where IBM conducts business. Highlights of our management system and resulting environmental performance are outlined below.

Employee and management responsibility

Every employee is expected to follow IBM's corporate environmental policy and report any environmental, health or safety concerns to IBM management. Managers are expected to take prompt action when faced with a potential violation of the policy or directives. IBM executives are responsible for the environmental performance of their businesses' functions or locations. In addition, IBM's Business Conduct Guidelines, our code of business conduct and ethics for all IBM employees, includes a section

highlighting employee responsibilities for protecting the environment.

Our environmental programs and performance are routinely monitored, and results are reviewed annually by all levels of management, up to the Directors and Corporate Governance Committee of IBM's Board of Directors, to ensure the ongoing suitability, adequacy and effectiveness of IBM's global EMS for IBM's activities, products and services. Formed in 1993, the Directors and Corporate Governance Committee reviews IBM's position and practices on significant issues of corporate responsibility, including protection of the environment.

Environmental goals

Environmental goals are an important part of IBM's EMS. We maintain a range of environmental goals designed to address significant environmental aspects and the impacts of our operations, and to drive continual improvement of our environmental performance, including goals on energy and water conservation, renewable electricity, carbon dioxide emissions reduction, product stewardship and waste management. These voluntary goals and our performance against them are discussed in their respective sections of this report, and a summary of key goals and their outcomes are provided in the list of IBM's environmental [key performance indicators](#).

ISO 14001 standard on environmental management systems

IBM formalized its environmental programs and commitment to leadership with the issuance of its Corporate Policy on IBM's Environmental Responsibilities in 1971, a quarter-century before the first International Organization for Standardization (ISO) 14001 environmental management systems standard was published in September 1996. In 1997, IBM became the first major multinational company to earn a single global registration of its EMS to the ISO 14001 standard. We achieved this credential within just one year of the finalization of the first edition of the standard, in part due to the results already delivered under our environmental policy and the early implementation of our environmental management programs.

IBM formalized its environmental programs in 1971 with the issuance of its Corporate Policy on IBM's Environmental Responsibilities.

The initial registration covered IBM's manufacturing, product design and hardware development operations across our business units worldwide. We have since expanded our global ISO 14001 registration to include additional entities such as our research locations that use chemicals, several country organizations and their non-manufacturing locations, as well as our Global Asset Recovery Services, Global Procurement and Global Logistics organizations.

As our business model has evolved to include more services offerings, we have updated our EMS to address environmental opportunities and challenges in the services area. IBM's single global ISO 14001 EMS accreditation, with a complete list of registered entities worldwide, can be viewed on IBM's [ISO 14001](#) webpage.

We have sustained this certification for 20 years. In 2017, we completed an update to our global EMS to transition our certification to the 2015 edition of the ISO standard.

ISO 50001 standard on energy management systems

IBM issued a formal corporate policy in 1974 that called for the conservation of energy and materials in all of IBM's activities. Since the issuance of that policy, we have improved our global energy management program and integrated it into the company's global EMS.

When ISO issued the ISO 50001 standard on energy management systems in June 2011, IBM initiated activities to achieve verification of conformity of our EMS against this newly published standard. Within one year of the issuance of the ISO standard, we achieved ISO 50001 registration of our energy management program at the corporate level as an integral component of IBM's global EMS. Our approach recognizes and leverages the fact that IBM's existing EMS addresses both environmental and energy management programs.

Following our successful ISO 50001 EMS registration at the corporate level, many of IBM's major energy-consuming locations and one country organization received registration of their specific energy management programs under IBM's single global ISO 50001 certification. As of year-end 2017, 16 entities were registered under IBM's global ISO 50001 certification—12 in the Americas, three in Europe and one in the Asia Pacific region.

Public disclosure

IBM has long supported public disclosure of information on our environmental programs and performance. This report marks IBM's 28th consecutive year of annual corporate environmental reporting.

In addition to disclosing information on our environmental programs and performance through this report and IBM's annual Corporate Responsibility Report, we also provide a report based on the Global Reporting Initiative and supply information through a number of other voluntary reporting platforms such as CDP, EcoVadis and OneReport. For more details on IBM's environmental reporting, see the IBM [environmental reporting, disclosure and verification](#) webpage.

Stakeholder engagement

At IBM, engaging and collaborating with stakeholders from a cross-section of nongovernmental organizations (NGOs), governments, investors and other interested parties are integral to our worldwide EMS. We publicly disclose information on our environmental strategy, goals and targets, performance, and continual improvement activities widely through our voluntary reporting programs. In addition, IBM has a formal system for tracking and responding to inquiries from interested parties on environmental issues.

IBM's community outreach programs include support of and participation in local environmental projects and education efforts, including Earth Hour, Earth Day, and World Environment Day, as well as site environmental awareness events and local clean air activities focused on the use of public transportation.

IBM also engages companies in its supply chain on environmental initiatives. For example, IBM is a founding member of the Responsible Business Alliance (RBA), formerly the Electronic Industry Citizenship Coalition, a nonprofit industry group that helps manufacturers support continuous improvement in the social, environmental and ethical responsibility of their supply chains. IBM requires its 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.

Another important element of IBM’s stakeholder engagement strategy is our collaborative work with business partners, clients, universities and other organizations to apply IBM technologies and solutions to solve environmental problems. You will find examples of IBM’s collaborative innovation throughout this report and in this report’s section on [solutions for environmental sustainability](#).

Voluntary partnerships and initiatives

IBM is strongly committed to participation in voluntary environmental programs, and we have founded or joined many voluntary initiatives and partnerships with governments and environmental NGOs over the years.

Some current examples of government partnerships include the U.S. Environmental Protection Agency’s (EPA) ENERGY STAR program and the EU Code of Conduct for Energy Efficiency in Data Centres.

Examples of partnerships with environmental NGOs include our membership in the Center for Climate and Energy Solutions, the Business Renewables Center, The Green Grid, our participation in Best Workplaces for Commuters, and the Clean Power Council. We also work with and support organizations such as The Conservation Fund, the Environmental Law Institute, and the World Environment Center. During 2017, IBM joined the U.S. Water Partnership whose mission is to address global water challenges, with a special focus on developing countries where needs are greatest.

IBM has also been a longstanding member of the Wildlife Habitat Council (WHC), a nonprofit organization dedicated to protecting and enhancing wildlife habitat. The WHC helps large landowners, particularly corporations, manage their open lands in an ecologically sensitive manner for the benefit of wildlife. Five IBM sites in the United States currently have their wildlife habitat management and conservation education program certified by the WHC—IBM sites in Boulder, Colorado, and Research Triangle Park, North Carolina; two sites in San Jose, California (IBM Research—Almaden and our Silicon Valley Laboratory); and our corporate headquarters in Armonk, New York.

Environmental investment and return

Over the past five years, IBM has spent \$65.8 million in capital and \$441.3 million in operating expense to build, maintain and upgrade the infrastructure for environmental protection at its plants and labs, and to manage its worldwide environmental programs.

Environmental capital and expense worldwide (\$M)	2013	2014	2015	2016	2017
Capital cost	17.0	20.3	16.7	7.3	4.5
Operating expense	92.3	86.4	83.1	68.6	110.9
Totals (\$M)	109.3	106.7	99.8	75.9	115.4

IBM has tracked environmental expenses related to our facilities, corporate operations and site remediation efforts for more than 30 years, and began publicly disclosing this information in our IBM and the Environment Report in 1992. In 2017, total environmental expenses and capital costs associated with IBM’s operations were \$115.4 million. Operating expense went up by 61.7 percent from 2016 to 2017, primarily due to a payment of approximately \$38 million to cover the disposal of polychlorinated biphenyl (PCB)-containing capacitors and ballasts in Japan over the next five years. IBM stored these locally generated PCB-containing wastes for over 17 years until disposal facilities in Japan could be constructed and put into operation. The government-approved facilities in Japan have now become operational, allowing IBM to begin proper disposal.

IBM estimates savings it has realized from its environmental leadership practices. These include savings from recycling; packaging improvement initiatives; waste reduction programs; and from energy, material and water conservation. Ongoing savings from previous years' initiatives are not carried over in this calculation, yielding conservative estimates.

In addition, IBM estimates the avoidance of costs that likely would have occurred if IBM's EMS were not in place. This cost avoidance is difficult to quantify, so a reasonable attempt has been made to estimate. In 2017, IBM's combined, estimated environmental savings and cost avoidance worldwide totaled \$102.6 million.

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 and leadership performance.

2017 environmental expenses worldwide (\$M)

Superfund and former IBM site remediation	30.3
Personnel	24.1
Waste and materials recycling	5.7
Waste treatment and disposal	3.4
Surface water and wastewater management operations	3.3
Consultant and legal fees	1.1
Laboratory fees	0.9
Permit fees	0.4
Groundwater protection operations	0.1
Other environmental operations*	41.6
Total	110.9

* Includes the payment of approximately \$38 million to cover the disposal of PCB-containing capacitors and ballasts in Japan.

2017 estimated environmental savings and cost avoidance worldwide (\$M)

Energy conservation and cost avoidance	48.6
Compliance cost efficiency*	22.2
Location pollution prevention operations	12.4
Potential fines, penalty and litigation avoidance**	8.5
Corporate operations***	5.1
Spill remediation cost avoidance****	2.6
Superfund and site remediation efficiencies	2.2
Packaging improvements	1.0
Total	102.6

* Compliance cost efficiency considers costs avoided through proactive efforts to stay ahead of environmental regulations and requirements.

** The estimation for the avoidance of potential fines, penalties and litigation does not include potential business interruption or fines related to noncompliance with product environmental laws and regulations (e.g., EU REACH or RoHS requirements).

*** Savings or costs avoided by having internal professional staff and tools versus using external consultants and tools.

**** These savings are estimated considering IBM's actual experience with remediation costs.

Chairman's Environmental Award Program

IBM established the Chairman's Environmental Award Program in 1991 to encourage leadership and recognize achievement and progress in environmental affairs by IBM's internal organizations. For more than 25 years, the Chairman's Environmental Award has promoted the contributions of IBM's business units toward the objectives of IBM's Corporate Environmental Policy.

Recipients of the Chairman's Environmental Award are selected based on their degree of leadership, initiative and results in contributing to IBM's [environmental policy](#) objectives. Performance against these criteria is evaluated against each nominee's opportunity to contribute given its mission and operations.

IBM Research received the 2017 Chairman's Environmental Award. With 12 labs located across six continents, IBM Research achieves industry-leading breakthroughs and drives the development of technologies that enable and deliver innovative solutions for IBM and its clients, including innovations to help address environmental challenges.

During the previous three years covered by its Chairman's Environmental Award nomination, IBM Research achieved the following results:

- Demonstrated exceptional application of IBM's strategic imperatives—especially our data, cloud and cognitive capabilities—to target the critical issues of air quality, renewable energy forecasting, energy optimization, and resilience.
- Executed innovative and repeatable solutions that address a broad range of environmental issues and societal concerns:
 - Green Horizons—Enabled the municipal government of Beijing, China, to improve air quality and forecast the dependability of renewable energy. Expanded to New Delhi, India, Johannesburg, South Africa, and additional cities across China.
 - Liquid Gold wastewater project in Spain—Deployed data and mathematical optimization to improve wastewater treatment. A pilot project for a Spanish water management company achieved a 13.5 percent reduction in electricity use, a 14 percent reduction in chemical use, and a 17 percent reduction in sludge production.
 - SuperMUC Phase 2 supercomputer in Munich, Germany—Invented a new hot-water cooling technology that allowed the supercomputer to be built in a more compact manner while consuming 40 percent less energy and saving \$1.25 million in annual energy costs.
 - The Jefferson Project at Lake George, New York—Employed Internet of Things, analytics, cloud, and cognitive technologies to understand the resilience of this large freshwater lake to circulation and environmental stresses from weather, adjacent land use, and contaminants based upon over 100 million data points collected across a network of sensor platforms.
- Earned five external awards, filed 36 patent applications, and published 21 papers on environmental sustainability and innovation.

While only one organization is selected each year to receive the Chairman's Environmental Award, the competition highlights the company's worldwide commitment to environmental leadership.



IBM Chairman Ginni Rometty presents the 2017 Chairman's Environmental Award to IBM Research Director Arvind Krishna.

Energy conservation and climate protection

In 1973, IBM began its formal energy conservation program and in 2000 set its first carbon dioxide (CO₂) emissions reduction goal when we helped the World Wildlife Fund create its Climate Savers program. In 2007, IBM published its position on climate change: IBM recognizes that climate change is a serious concern that warrants meaningful action on a global basis to stabilize the atmospheric concentration of greenhouse gases (GHGs). We believe that all sectors of society and the economy, as well as governments worldwide, must participate in solutions to climate change.

Climate change

IBM has been a leader in addressing climate change through our energy conservation and climate protection programs for decades. IBM's leadership is defined by our:

- Long-standing global commitment
- Comprehensive and multifaceted programs covering the company's operations, products and services
- Leading-edge innovations and client solutions
- Significant results, both early and ongoing, benefiting IBM, our clients and the world

A five-part strategy

We have a long-standing commitment to climate protection and execute a five-part strategy to reduce the GHG emissions related to our operations:

1. Designing, building, updating and operating facilities, including data centers and product development and manufacturing operations, that optimize their use of energy and materials and minimize GHG emissions
2. Purchasing electricity generated from renewable sources where it makes both business and environmental sense
3. Requiring our suppliers to maintain an environmental management system that includes inventories of energy use and GHG emissions, reduction plans and public reporting of results
4. Managing business travel
5. Increasing the efficiency of IBM's logistics operations

In addition, IBM's strategy includes designing energy-efficient products and providing services and solutions that help our clients reduce their own energy use and climate impacts.

We consider energy and material conservation to be the cornerstone of our climate protection efforts. IBM does not use emissions offsets to become "carbon neutral" for our operations. Our efforts to reduce IBM's GHG emissions are focused on delivering results by devoting available resources to actions, products and solutions that actually increase energy efficiency and reduce GHG emissions for both IBM and our clients, rather than merely offsetting them.

Conserving energy

IBM formalized its energy conservation and management program in 1974 and has continued it unabated ever since. Energy conservation is a major component of our comprehensive, multifaceted climate protection program because the release of CO₂ by utility companies powering our facilities, or from our use of fuel for heating and cooling, represents the greatest potential climate impact associated with our operations.

In 2017, IBM's energy conservation projects across IBM-managed locations globally delivered annual savings equal to 4.2 percent of our total energy use, surpassing the corporate goal of 3.5 percent. IBM-managed locations are places where IBM is responsible for procuring energy and managing facilities infrastructure and operations.

From 1990 through 2017, IBM conserved 7.4 million MWh of electricity, avoiding 4.4 million metric tons of CO₂ emissions.

These projects saved and avoided the consumption of 143,000 megawatt-hours (MWh) of electricity and 105,000 million British thermal units (MMBtu) of fuel oil and natural gas, and an associated 64,000 metric tons (MT) of CO₂ emissions. The conservation projects also saved \$16.1 million in energy expense.

In measuring performance against IBM’s energy conservation goal, we recognize only completed projects that actually reduce or avoid the consumption of energy in our operations. Reductions in energy consumption from down-sizings, the sale of operations, and cost-avoidance actions such as fuel switching and off-peak load shifting are not included in the results for measuring performance against achieving this goal. Moreover, the results cited above are conservative in that they include only the first year’s savings from projects. Ongoing conservation savings beyond the first year are not included in the results. Accordingly, the total energy savings and CO₂ emissions avoidance from these conservation actions is actually greater than this simple summation of the annual results. From 1990

through 2017, IBM conserved 7.4 million MWh of electricity, avoiding 4.4 million MT of CO₂ emissions and saving \$616 million.

IBM energy consumption

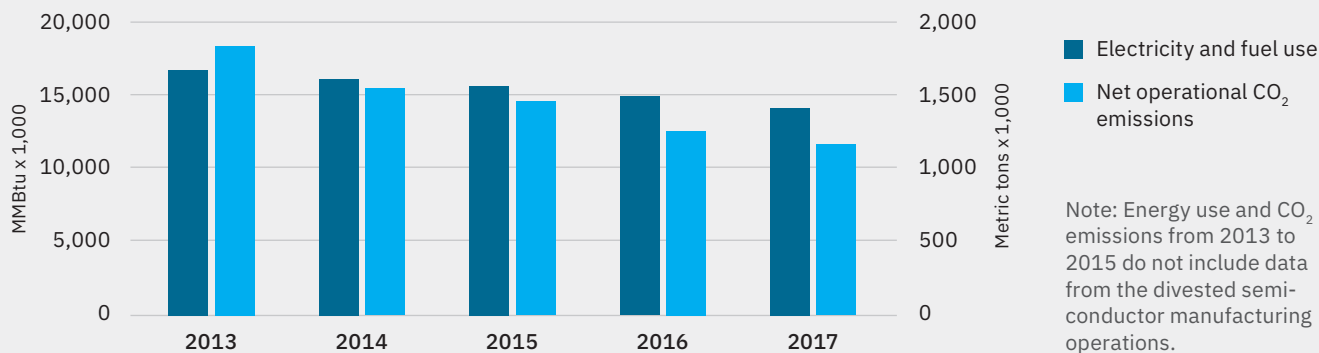
In 2017, IBM consumed 3,405,000 MWh of electricity and 2,300,000 MMBtu of fuels to operate its managed facilities. Year-to-year, energy consumption was down 6.5 percent due to our conservation projects, implementation of standard, global energy conservation strategies at our facilities, movement of client workloads to more efficient infrastructure, and other operational improvements.

IBM also has operations in co-location spaces where IBM installs and operates server, storage and network information technology (IT) equipment, and a landlord manages the facilities infrastructure and procures and supplies commodities such as electricity and chilled water. Energy consumption in these spaces was 581,000 MWh of electricity in 2017.

Managing IBM’s energy program

Our global energy management program leverages the expertise of more than 50 IBM energy management professionals deployed worldwide. The team has created best-practices checklists that set minimum expectations for building systems and operations, including controls and equipment for lighting, heating/ventilation/air conditioning

Energy use and net operational CO₂ emissions associated with IBM-managed locations



(HVAC), central utility plants, compressed air, data center and IT systems, cafeterias and office systems.

All IBM-managed locations using 2,000 MWh per year or more of energy must complete the checklists, perform a gap analysis and develop an energy conservation implementation plan a minimum of every four years. The energy management program is buttressed by several enterprise-level databases that collect, store and analyze energy-use data, results of conservation projects, completed checklists and key performance indicators. The analyses from these databases enable monthly metrics reporting to management and the identification of opportunities for improvement. The continuous review of energy use and conservation performance has facilitated attainment of the strong results noted above.

More than 2,000 energy conservation projects involving a range of energy efficiency initiatives delivered savings at more than 500 locations around the globe in 2017. Examples include:

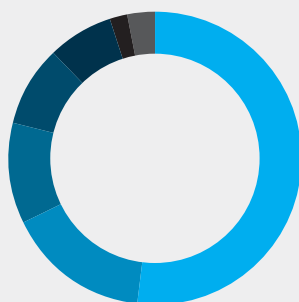
- Projects to match building lighting and HVAC with occupancy schedules, or to upgrade equipment efficiency through recommissioning equipment or installing new equipment, were implemented at 200 locations, reducing annual energy use by 40,700 MWh and saving \$4 million.
- Central utility plant projects were implemented at 51 locations, reducing annual energy use by 15,200 MWh and saving \$1.3 million.
- IBM installed its Smarter Buildings solution at 72 additional buildings, reducing annual energy use by 35,000 MWh and saving \$1.7 million. The Smarter Buildings solution has now been installed at 24 major IBM campuses, encompassing 227 buildings responsible for 36 percent of our global energy consumption.
- Data center cooling projects and server and storage virtualization and consolidation projects reduced annual energy use by nearly 90,000 MWh and saved \$9.6 million.

Applying analytics to drive further efficiencies

The IBM energy management and data center teams leverage analytics-based monitoring to minimize energy use and optimize operating performance at many IBM-managed locations. By looking at the whole data set through a single lens, the IBM Smarter Buildings solution enables early identification of individual faults and broader patterns of equipment- or manufacturer-specific problems or root causes that transcend multiple system types (e.g., inappropriate maintenance schedule). This holistic view of the energy-consuming systems allows resources and investment to be prioritized for further optimization of energy performance. Overall, the solution saves 5 to 15 percent of the overall energy operating costs at the locations and buildings where it is used.

Data centers

IBM manages a diverse portfolio of data centers worldwide in support of our clients and our internal operations. We also operate IT labs that support our hardware and software development and testing operations.



2017 energy conservation savings by project category

- 52% Data centers
- 16% Heating, ventilation and air conditioning
- 11% Building controls
- 9% Central utility plant
- 7% Lighting
- 2% Continuous commissioning
- 3% Other

We take a holistic approach to managing our data centers—improving existing space to derive more workload per area, equipment and energy resources utilized, and building new, high-efficiency space required to meet the needs of our clients.

In 2017, we completed 299 projects to improve cooling efficiency at 89 data center locations, reducing energy use by nearly 20,000 MWh while saving over \$2.3 million. Some examples of projects included:

- Installed thousands of blanking panels, wall panels between racks, cable cutout plugs, and cold-aisle containment systems, reducing the mixing of hot and cold air and increasing cooling efficiency.
- Shut down 140 Computer Room Air Conditioning (CRAC) units, reducing energy use. For the period 2011-2017, IBM increased the average raised-floor temperature in its data centers by more than 2.5 degrees Celsius by shutting down CRAC units and rebalancing data center airflow.

Achieving these savings while maintaining the reliability of the data center operations required the use of analytics-based IT systems to monitor the data center temperature profile and identify and mitigate hot and cold spots.

IBM also continues to expand its cloud computing offerings. At year-end 2017, IBM operated nearly 60 cloud data centers in 19 countries. IBM is building its cloud data centers using standard installation templates for a highly efficient IT infrastructure. These data centers are typically designed to operate at a power usage effectiveness (PUE) of 1.5 or lower at full IT capacity. 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. The templates address cold-aisle containment to optimize cooling delivery, and are updated with each new generation of IT technology.

Data center power usage performance

IBM collects meter readings or uses estimating protocols to calculate the PUE at many of the data centers we manage. Using data reported from IBM's managed data center locations, representing over 60 percent of data center energy consumption, we calculated the average PUE for IBM's raised-floor space to be 1.66, a 2 percent reduction from 2016. The PUE range for the reporting facilities was 1.3 to 2.64. Data centers are highly complex systems. As client accounts move in and out of the data center and increase or decrease their workloads, and as existing server, storage and network equipment is refreshed with new technologies, data center equipment layout changes. Depending on how cooling delivery is adjusted in response to these changes, PUE can increase or decrease.

As one of the longest-term providers of service in the IT industry, IBM's data center portfolio consists of spaces and equipment of varying vintages. Improving the energy efficiency of these data centers 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 energy efficiency in our data centers.

Voluntary data center energy efficiency initiatives

In January 2012, the European Commission awarded 27 IBM data centers in 15 European Union (EU) countries "Participant" status in the EU Code of Conduct (CoC) for Energy Efficiency in Data Centres program. Over the last five years, we have registered additional data centers, bringing the total number of data centers participating in this program to 38 in 18 countries. IBM's [registered data centers](#) represent the largest portfolio from a single company to receive this recognition. The registered locations include more than 60 percent of IBM's IT delivery and resiliency services data center space in the EU. The EU CoC for Energy Efficiency in Data Centres is a voluntary initiative that aims to promote energy efficiency performance standards for data centers.

In addition to the EU CoC for Energy Efficiency in Data Centres program, IBM is involved with the U.S. Environmental Protection Agency's ENERGY STAR and The Green Grid (industry collaboration) data center energy efficiency initiatives. These initiatives have established recommended operating criteria and metrics that inform and encourage data center operators and owners to reduce energy consumption in a cost-effective manner without compromising the objectives of mission-critical operations.

System virtualization and cloud computing

Virtualizing server and storage systems allows individual systems to support multiple applications or images, making greater use of the full capabilities of the IT equipment and executing more workloads in less space with less energy.

Storage and server virtualization consolidation projects avoided nearly 70,000 MWh and \$7.3 million of annualized consumption and cost in 2017. IBM continues to virtualize and consolidate workloads from multiple servers and storage systems with low utilization onto new or underloaded systems, reducing energy use and expense. In 2017, we increased the number of virtualized images by more than 13 percent, the average number of images per virtualized server by 15 percent, and the number of virtualized servers by 6 percent—improving the overall efficiency of our installed base of servers. Implementation of server and storage virtualization has been a key contributor in reducing the overall electricity consumption of our data centers and labs over the past five years.

Cloud computing can also be an efficient model for providing IT services, optimizing hardware utilization and virtualization technologies across the server, storage and network infrastructure. In 2017, the IBM software development organizations responsible for IBM Watson®, blockchain, artificial intelligence and other IBM software-based solutions completed the transition of their work to a cloud-based platform, reducing the number of data center locations by three-quarters and energy consumption by 29 percent, while increasing the workloads they manage. In addition, many IBM enterprise clients are moving some of their applications to the IBM Cloud platform to take advantage of improved energy efficiency.

In 2017, 41.4 percent of our global electricity supply for IBM-managed locations was generated from renewable sources.

Renewable electricity

In 2017, IBM contracted with its utility suppliers to purchase approximately 779,000 MWh of renewable electricity, representing 22.9 percent of our global electricity consumption by IBM-managed locations. These purchases exceeded IBM's goal to purchase 20 percent of its electricity consumption from renewable sources by 2020, over and above the quantity of renewable electricity provided as part of the mix of electricity that we purchase from the grid. IBM avoided 275,000 MT of CO₂ emissions through these purchases.

We purchased contracted renewable electricity in 20 countries: Australia, Austria, Belgium, Brazil, Chile, Denmark, Finland, France, Germany, India, Ireland, Italy, the Netherlands, Peru, Portugal, Spain, Sweden, Switzerland, the United Kingdom and the United States.

In March 2018, IBM finalized a power purchase agreement to acquire all of the electricity—roughly 10,000 MWh per year—generated by a 6-megawatt solar array to be constructed at IBM's Boulder, Colorado, facility. The array is expected to go into production by early 2019.

We procure renewable electricity generated from wind, large and small hydro, biomass, and solar installations around the globe. We report all of our contracted renewable electricity purchases—whether from new or existing generation sources, “additional” or otherwise, without discriminating against large hydro installations—and their associated CO₂ avoidance. Our rationale is that all purchases signal to suppliers our desire for them to maintain and broaden their renewable electricity offerings. We value all economically accessible renewable generation sources and their availability from our utility suppliers.

Total consumption of renewable electricity

Combining our contracted renewable electricity purchases and the amount of renewable electricity IBM received as part of the grid mix, 41.4 percent of our global electricity supply for IBM-managed locations was generated from renewable sources in 2017. The percentages of the electricity we consumed, both contracted and grid-supplied purchases that came from renewable sources were: Europe 67 percent, Latin America 63 percent, North America 28 percent, and Asia Pacific 18 percent.

Purchases of renewable electricity for data centers

IBM locates most of its IT operations in data centers managed by the company. Overall, one-third of IBM's managed data centers obtained some or all of their electricity from contracted renewable-generation sources in 2017.

Including both contracted and grid-supplied renewables, nearly 50 percent of the electricity procured for IBM's managed data center operations came from renewable-generation sources.

IBM also locates some data center operations in co-location data centers. For these co-location data centers, 14.5 percent of electricity supply came from renewable-generation sources in the grid in 2017. Combined with the landlord-contracted renewable purchases at the facilities that support our operations, IBM co-location data centers received a total of 27.4 percent of their total electricity consumption from renewable-generation sources in 2017.

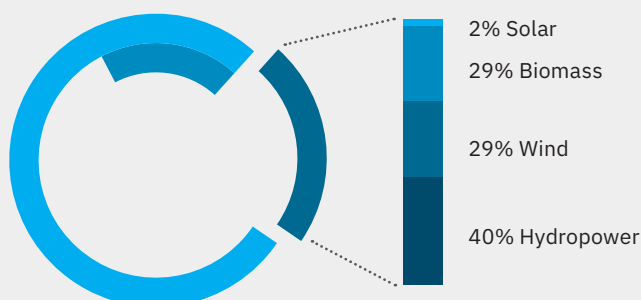
IBM's strategy and approach regarding renewable electricity purchases

IBM's strategy is to procure renewable electricity that is generated in the grid regions where IBM's facilities are located. When possible, we match our purchases to the physical consumption of our facilities so that we are consuming the electricity at the same time that the renewable electricity is being generated. However, output from wind and solar facilities varies depending on the time of day and the weather conditions. As such, we must rely on electricity generated from conventional sources (i.e., fossil fuels) to ensure business continuity. When our consumption exceeds the output from renewable sources, we may use "bundled" Renewable Energy Certificates (RECs) to offset the CO₂ emissions associated with the electricity we consume from conventional sources. Our intent is to procure renewable electricity and its zero-emissions attributes from the grid regions in which our facilities operate, either by directly matching our physical consumption or using bundled RECs to offset emissions.

We do not use "unbundled" RECs, supplied from renewable generation projects in grid regions outside of our energy consuming locations, to offset the emissions from our use of conventionally generated electricity. The reason is simple: IBM would not actually be using the renewable electricity that the purchase of unbundled RECs helped to fund. It also obfuscates the need for hard public policy decisions and investments across the energy value chain that must be made to genuinely increase the quantity and availability of renewable electricity delivered to the grid.

Electricity sources at IBM-managed locations

- 77.1% Grid-purchased electricity (GPE)
- 18.5% Grid-supplied renewables (part of GPE)
- 22.9% Contracted renewable purchases



We would certainly like to be able to power our operations with 100 percent renewable electricity, and we are committed to expanding our procurement of renewable electricity for our global operations. However, we recognize that it is not possible in today's market or in the foreseeable future to actually power IBM's operations reliably with 100 percent renewable electricity, given the company's vast and diverse presence in over 170 countries along with the need for uninterrupted power usually made possible by fossil fuels.

Our strategy and approach make it clear to our electricity suppliers that we want them to increase the quantity and availability of renewable electricity in their offerings. IBM continues to work with industry peers, utilities, NGOs and other renewable energy industry participants to develop new contracting methods and to identify and capture new opportunities to procure electricity generated from renewable sources. In 2017, we were active in the World Resources Institute's Special Clean Power Council. The Council, comprised of leading U.S. electric utilities and several of their major commercial and industrial customers, began engaging in a two-year effort to facilitate the

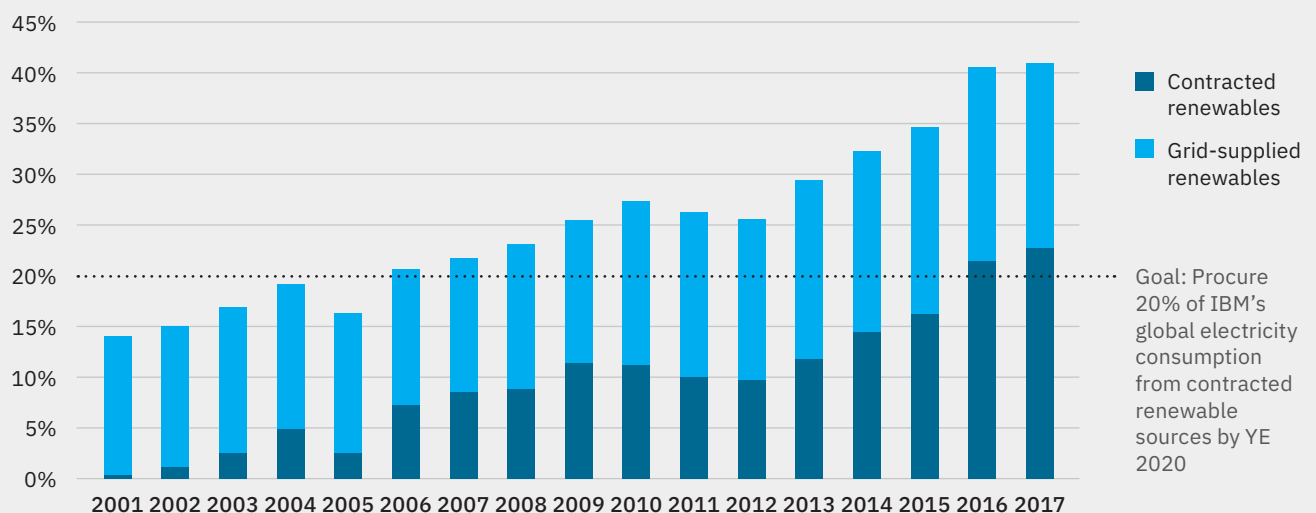
transition to low-carbon energy supply and enabling technologies to reduce the GHG emissions associated with power generation. We are also members of the Business Renewables Center and the Renewable Energy Buyers Alliance, groups committed to broadening and expanding the availability of renewable electricity to corporate buyers.

Transparency in communicating our use of renewable electricity

There is a difference between purchasing RECs and actually using renewable electricity. A complete understanding of a company's use of renewable electricity requires a high degree of transparency in how renewable electricity and REC purchases are reported. IBM supports and exercises full transparency in disclosing its use of renewable electricity. We believe renewable electricity purchases may logically be broken down and reported under three categories:

- **Physical or matched consumption:** Renewable electricity is generated in the grid region where the consuming facility is located and at the same time that the facility is consuming electricity. The electricity can

Use of renewable electricity as a percent of global electricity consumption at IBM-managed locations



be physically delivered or it can be matched to the facility’s consumption.

- **Matched offsets:** In this case, renewable electricity is generated in the same grid region where the consuming facility is located, but it occurs at a time when the facility is not able to consume it or when the amount of renewable electricity generated exceeds or lags the demand from the facility. In this case, the RECs are separated from the renewable electricity and bundled with the electricity generated from conventional sources (i.e., fossil fuels) that is actually consumed by the facility. There is a physical nexus between the generator and the user as both are in the same grid region.
- **Unbundled RECs:** In this case, as an electricity provider generates renewable electricity, its RECs are separated or “unbundled” from the renewable electricity with which they are affiliated. The electricity is sold into the grid region in which it is generated, but the “unbundled” REC is sold to a consumer of conventional electricity (i.e., fossil fuels) who is located in a different grid region in order for the purchaser of these unbundled RECs to offset the emissions associated with the conventionally generated electricity that it actually consumed. There is no physical connection between the facility generating the renewable electricity and the facility purchasing the unbundled RECs.

The table below shows the renewable electricity procured by IBM during 2017, broken into the three categories discussed above. We used [publicly available information](#) to estimate the quantity of renewable electricity in our grid supply, and developed the following assumptions for allocating renewable electricity to the categories of (a) physical or matched consumption and (b) matched offsets (using bundled RECs) for solar and wind generation, based on our knowledge of their characteristics such as output profiles and shape curves:

- Wind — 40 percent physical or matched consumption and 60 percent matched offsets

- Solar — 20 percent physical or matched consumption and 80 percent matched offsets
- Hydropower and biomass — 100 percent physical or matched consumption

Using representative data for the average utilization of the wind and solar generation to determine the percentage of renewable output that can be matched to consumption is a conservative approach. We will continue to refine our estimating methodology going forward.

**Allocation of renewable electricity
IBM received during 2017**

Total MWh received (contracted purchases and grid-supplied)	1,408,029
Percent of renewable electricity in IBM’s total electricity supply	41.4%
• Percent obtained through contracted purchases	22.9%
• Percent supplied through the grid	18.5%
Renewable electricity by category	
• Physical or matched consumption	80.7%
• Matched offsets	19.3%
• Unbundled RECs	0%

IBM has a high percentage of physical or matched consumption because almost three-quarters of IBM’s contracted and grid-supplied renewables come from hydropower or biomass generation sources.

Challenges and opportunities in procuring renewable electricity

Through our efforts over the years to increase purchases of renewable electricity to power our operations, we have identified a number of factors that impact a company’s ability to procure renewable electricity for consumption. These factors include:

- Size of electricity demand of individual consuming facilities: A smaller demand presents a greater challenge to execute contracted purchases.

- Ownership of the facilities (e.g., owned, leased): Leased locations have more constraints in negotiating contracted purchases.
- Number of countries in which a company's facilities operate (consume electricity): As the number of countries increases, procurement becomes more challenging as many countries do not currently offer renewable electricity for commercial purchase.
- Type of electricity market (e.g., regulated, unregulated) serving the facilities and availability of renewables from service providers.

Many of IBM's clients require their data center operations to be supported from facilities in specific countries or geographical regions to ensure response times and provide backup should a disruptive event occur at one facility. As a result, IBM operates a large number of data centers that are geographically dispersed and that have relatively low electricity demands (0.5 to 5 megawatts [MW]). The diversity of size and location of these IBM data centers and the relatively low demand make it economically difficult to match renewable generation sources to our consumption.

In addition, a great majority of IBM's facilities with electricity demand greater than 1 MW are leased locations across 30 countries. Over one-third of these locations have limited or no opportunity to procure economically priced, commercial quantities of renewable electricity in today's markets. These realities further challenge our ability to negotiate appropriate contract terms with providers and/or to procure renewable electricity to power our operations.

Currently, "green tariff" offerings of one- to three-year terms from utilities and energy service companies offer the best match to our needs, but come with high premiums in many markets. Contract offerings with four- to eight-year terms for our desired quantity of electricity have emerged in the last year, and we are hopeful they will present us more economical procurement options in the future. Despite these challenges, we remain steadfastly committed to and will continue to aggressively pursue renewables procurement to power our operations.

Research and solutions to advance the use of renewable energy

While increasing the renewable generating capacity in the global electricity supply is an important step to decarbonizing the electricity supply, the quantity of renewable electricity in the grid will ultimately be limited without advances in demand and generation forecasting; grid management systems; and electricity storage and transmission technologies. Recognizing the importance of expanding the availability of renewables, IBM has made major investments in the use of powerful weather models and analytic and cognitive capabilities and solutions to develop highly accurate forecasting tools for electricity demand and solar- and wind-power generation. We also invest in tools to match electric vehicle, refrigeration and other assets to excess renewables generation that cannot easily be accommodated by demand in the grid. These tools will enable better utilization of available renewable generation, more effectively integrate new capacity into the grid, and minimize or prevent curtailments. The environmental benefits resulting from IBM's investment in and deployment of these technologies exceed the benefits from IBM's purchases of renewable electricity for its own consumption by increasing the quantity and availability of renewable electricity from existing and planned projects.

Operational CO₂ emissions management

From 2000 to 2016, IBM set and achieved three successive CO₂ emissions reduction goals. We set our first such goal in 2000 and our second in 2007. In 2015, we established our current, third-generation CO₂ emissions reduction goal, which called for IBM to reduce CO₂ emissions 35 percent by 2020 against a base year of 2005.

We achieved that goal in 2016, and in 2017, we demonstrated additional emissions reduction progress by implementing energy conservation and efficiency projects and moving IT workloads onto more efficient infrastructure. As of year-end 2017, CO₂ emissions attributable to IBM at its managed locations have been reduced by 42.9 percent versus a baseline of 2005.

IBM increased its net operational CO₂ emissions reduction to 42.9 percent in 2017 versus a 2005 baseline, continuing the achievement of our 2020 CO₂ emissions reduction goal.

IBM received a Climate Leadership Award from the Center for Climate and Energy Solutions, The Climate Registry and Bloomberg Philanthropies in the category of Excellence in Greenhouse Gas Management Goal Achievement in March 2018. This award recognized IBM's achieving our third-generation CO₂ emissions reduction goal in 2016, and made IBM the first and only company to win a Climate Leadership Award six times in the program's seven-year history.

The CO₂ emissions attributable to IBM operations in co-location spaces (where electricity supply is controlled by a landlord) during 2017 were 257,000 metric tons of CO₂. IBM does not exercise direct operational control over these facilities or their operations. However, IBM does manage the IT operations and recognizes the importance of addressing co-location energy use and associated CO₂ emissions. The combined CO₂ emissions from IBM-

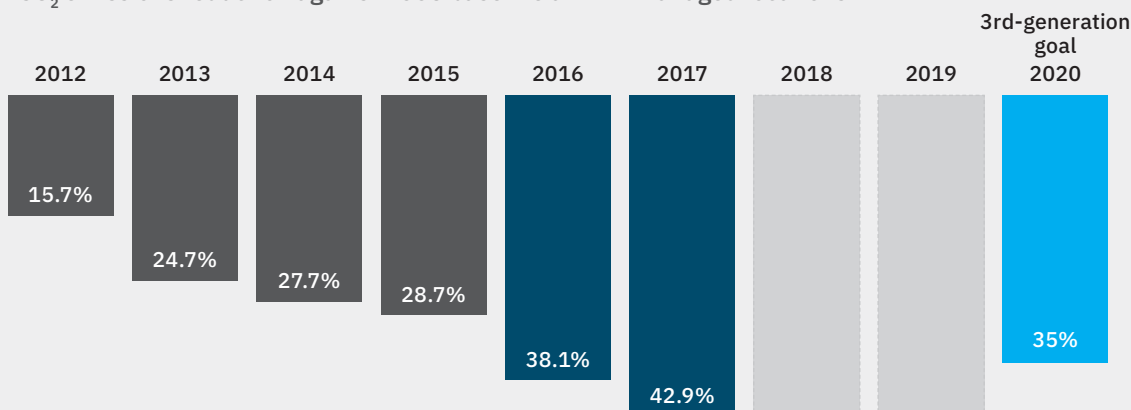
managed spaces and those attributable to co-location spaces decreased by 2 percent from 2016 to 2017.

Overall CO₂ emissions inventory

IBM tracks and manages Scope 1 and Scope 2 emissions across its operations. This includes operational CO₂ emissions related to IBM's energy consumption as discussed in the previous section, as well as other Scope 1 emissions such as those resulting from the use of leased vehicles for IBM's service technicians, use of refrigerants in cooling systems and use of chemicals supporting research and manufacturing activities. IBM's Scope 2 emissions are calculated in accordance with the "market-based method" in the GHG Protocol Scope 2 Guidance (issued in 2015). With these additional Scope 1 emissions, the year-to-year reduction of IBM's total Scope 1 and Scope 2 emissions in IBM-managed space and operations was 6.8 percent.

We calculated our 2016 and 2017 emissions in accordance with the "market-based method" in the GHG Protocol Scope 2 Guidance, as well as in accordance with IBM's own calculation method, which preceded the newest guidance and was used to assess IBM's progress in attaining its CO₂ emissions reduction goal. The IBM method calculates the operational CO₂ emissions based on emissions

Operational CO₂ emissions reduction against 2005 baseline at IBM-managed locations



factors specific to a location, country and grid region, and then subtracts the avoided CO₂ emissions associated with IBM's renewable electricity purchases to get the net operational CO₂ emissions for the year. The market-based method recognizes the actual environmental attributes of energy consumed (e.g., assigns zero emissions to the consumption of contracted renewable electricity), allows the use of utility-specific emissions factors in the calculation at locations where they are available, and requires the use of "residual" emissions factors (currently available for the European Union) for grid consumption at locations where only a portion of the consumption is satisfied through contracted renewables purchases. Our comparison of the operational CO₂ emissions calculated by the IBM and market-based methods indicates that the results from the two calculation methods differ by only 0.3 percent.

A summary of our total 2016 and 2017 Scope 1 and Scope 2 emissions inventory is provided in the table below.

Transportation and logistics initiatives

Employee commuting and leased/rental vehicles

IBM has been active for decades in promoting programs that reduce employees' work-related commutes or that reduce commute-related CO₂ emissions. For example, many locations promote biking to work by having bicycle lockers, racks and showers available on-site. At several larger locations, IBM sponsors shuttle services to transport employees to mass transit stations and also between IBM campuses and buildings. In Europe and Japan, many IBM locations are within reach of the public transportation system, giving employees the choice to use more energy-efficient mass transit to commute to work.

Globally, many of our locations partner with local public transit authorities to develop ride-sharing programs and negotiate subsidized transit passes for IBM employees. IBM is a member of the Best Workplaces for Commuters (BWC) program. Currently, seven IBM locations in the United States, where approximately 25 percent of the company's U.S. employees report to work, are registered

IBM 2016 and 2017 Scope 1 and Scope 2 emissions inventory

(Metric tons [MT] of CO₂ equivalent)

		2016*		2017	
Summary		IBM method	Market-based method	IBM method	Market-based method
Operational Scope 1 Emissions		91,000	91,000	84,000	84,000
Scope 2 emissions: Electricity		1,425,000	1,118,000	1,310,000	1,038,000
Scope 2 emissions: Purchased commodities		38,000	38,000	39,000	39,000
CO ₂ avoidance from renewable electricity purchases		(300,000)	Captured above	(275,000)	Captured above
Net Operational Scope 1 and Scope 2 emissions		1,254,000	1,247,000	1,158,000	1,161,000
Non-operational Scope 1 emissions	Emissions type				
Fuel use	Transportation	27,000	27,000	28,000	28,000
Semiconductor research and manufacturing chemicals	PFC	1,300	1,300	1,700	1,343
Refrigeration chemicals	HTF, HFC	14,000	14,000	11,000	11,000
Total other Scope 1 emissions		42,300	42,300	40,700	40,700
IBM's total Scope 1 and Scope 2 emissions		1,296,300	1,289,300	1,198,700	1,201,700

* Differences between the data in the 2016 and 2017 IBM and the Environment reports are a result of rounding in this year's report.

as BWC sites. Our BWC-registered locations actively work with their local transit commissions and offer other commuter benefits on-site to integrate IBM's programs with regional programs, increasing commuting options for our employees.

IBM employees in the United States can also take advantage of IBM's Commuter Benefits Program. Launched in 2016, the program allows employees to pay for eligible mass transit and qualified parking expenses related to commuting to work with pre-tax money. Use of the benefit to procure mass transit passes translates into monetary savings on commuting costs and encourages employees to opt for more efficient commuting options where available.

In some countries, IBM provides leased vehicles for employees that they may use for both business and personal purposes. For these vehicles, we have set standard guidelines that require leasing of vehicles with lower emissions profiles. These guidelines enable reductions in average car emission levels as the car fleets are renewed. For the cars our employees rent while traveling for business, we have worked with rental car companies to require that they offer more fuel-efficient vehicles.

Managing business travel

Business travel is a necessary and important part of ensuring that IBM understands our clients' needs and delivers the best client experience possible. IBMers can reduce the need for travel by taking advantage of strategic collaboration and meeting tools that allow them to easily engage with clients and their colleagues to have productive meetings, without the need for travel.

Efficiency of logistics

IBM is optimizing logistics operations, and increasing packaging density and strength, to reduce the CO₂ emissions generated by the transport of IBM products and their components.

IBM has been an active participant of the U.S. Environmental Protection Agency's SmartWay Transport Partnership since 2006. SmartWay is a voluntary initiative to improve fuel efficiency and reduce GHG emissions associated with logistics operations.

In 2017, 96 percent of IBM's spending on shipments of goods within the United States and from the U.S. to Canada and Mexico went through a SmartWay logistics provider. The remaining 4 percent are largely carriers hired for local or one-off deliveries or support at an operating facility. IBM voluntarily applies specific SmartWay requirements to our distribution operations globally.

IBM also develops product packaging that minimizes material use and package volume while optimizing package strength. This helps reduce transport-associated CO₂ emissions. Accomplishments in this area are discussed in the [product stewardship](#) section of this report.

Energy and climate protection in the supply chain

IBM is committed to doing business with environmentally responsible suppliers. We require that all of our "first-tier" suppliers (those with which we hold a direct commercial relationship) establish and sustain a management system to address their corporate and environmental responsibilities—including their use of energy and Scope 1 and Scope 2 GHG emissions—and to cascade IBM's requirements to their suppliers who perform work that is material to the goods or services being supplied to IBM. Our suppliers are also required to measure their performance, establish voluntary goals in these areas and publicly disclose their performance against those goals. We manage this through two processes: IBM's own supplier environmental management system requirements, and our membership in the Responsible Business Alliance (RBA)—formerly the Electronic Industry Citizenship Coalition. The IBM Global Procurement organization assesses suppliers (existing and new) regarding their compliance with the IBM Social and Environmental Management System requirements as a component of its overall supplier management and assessment process.

IBM's requirements for our suppliers rest on the foundational belief that real results in GHG emissions reduction are made possible by actionable information about a company's energy use and GHG emissions, and that each company is best positioned to assess and implement actions to address its own emissions in a way that is meaningful and sustainable. In short, each enterprise must take responsibility to reduce its own energy use and GHG emissions.

IBM has been an active participant in the [RBA Environmental Reporting Initiative](#), which asks RBA members and suppliers in their respective global supply chains to measure and report key indicators on energy consumption, carbon emissions, water and waste. We believe, as do the other RBA members, that as companies gain an understanding of their energy use and GHG emissions, they are more likely to take actions to improve their performance. RBA and its member companies have developed education modules to assist suppliers in establishing programs to track their energy use and GHG emissions. Since RBA members in the electronics and other industries share many suppliers, the RBA GHG emissions disclosure process is efficient. We use the RBA reports completed by our component and parts suppliers to augment and validate our internal supplier assessment work.

More information on IBM's supplier programs may be found in the [environmental requirements in the supply chain](#) section.

IBM's position on the determination of Scope 3 GHG emissions

Approximations of Scope 3 GHG emissions can help entities recognize where the greatest amounts of GHGs may be generated during the lifecycle of a typical process, general product or service on a macro level. This can be helpful when assessing, for example, what phases of a general product's design, production, use and disposal provide the best opportunities for improved energy efficiency and innovation. However, IBM does not estimate Scope 3 GHG emissions associated with our value chain because the assumptions associated with such estimates simply do not lead to credible results.

Like many companies, IBM has thousands of suppliers around the world. They are in all types of businesses and very few, if any, work solely for IBM. Furthermore, the sources of energy used by these suppliers vary, and IBM does not believe we could generate a credible estimate or apportionment of the energy used by these suppliers that would be associated with the products or services provided to IBM alone, versus those emissions associated with products or services provided to their other customers. In addition, IBM's specific scope of business with any given supplier remains dynamic, as it is driven by business need.

Moreover, one company's asserted Scope 3 emissions are another company's Scope 1 and Scope 2 emissions. Since the ultimate goal for climate protection is for global societies to achieve demonstrable reductions in actual Scope 1 GHG emissions, IBM believes real results in GHG emissions reduction are directly achieved when each enterprise takes responsibility to address its own emissions and improve its energy efficiency. This is reinforced by IBM's announcement in 2010 that all of our first-tier suppliers are expected to develop a management system, identify their significant environmental impacts—including GHG emissions—and develop reduction plans for those impacts.

Product stewardship

IBM established its product stewardship program in 1991 as a proactive and strategic approach to the environmental design and management of our products. The program's mission is to develop, manufacture and market products that are increasingly energy efficient; that can be upgraded, refurbished, remanufactured and reused to extend product life; that incorporate recycled content and environmentally preferable materials and finishes; and that can be dismantled, recycled and disposed of safely.

Framework

IBM's product stewardship objectives and requirements are implemented through our global environmental management system (EMS), internal standards, product specifications and applicable IBM offering management processes. 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 (PCD) for IBM Suppliers support the assessments required for a complete PEP prior to product release. IBM's design and compliance controls—including a specification for Baseline Environmental Requirements for Supplier Deliverables to IBM, PCDs and compliance assessment protocols—are managed by an interdisciplinary team with representatives from IBM organizations that design, manufacture, procure, deliver and service our product offerings. The team's activities are coordinated by IBM's Center of Excellence for Product Environmental Compliance.

Product environmental compliance processes

Regulatory and legislative requirements affecting electrical and electronic equipment continue to proliferate globally. Integrated within IBM's global EMS, we have programs—underpinned by robust processes and state-of-the-art tools—that ensure our continued compliance with worldwide environmental laws and regulations while supporting business objectives. In 2017, we identified 160 new or modified product-related regulations and acted upon them to meet the milestones defined by the regulations.

Frequent verification of product data is required to maintain compliance of parts and products relative to both IBM's product environmental requirements and the latest regulatory requirements, such as the expiration schedule for exemptions in the European Union Directive on the Restriction of Hazardous Substances (RoHS, 2011/65/EU). IBM conducts quality audits of PCDs to drive improvements in the content of the declarations and the supporting administrative processes. Improvements in data management regarding the materials contained in IBM's products ensure that IBM's technical documentation for product hardware meets the quality requirements described within European Norm 50581: "Technical documentation for the assessment of electrical and electronic products with respect to the restriction of hazardous substances."

IBM has deployed dedicated analytical tools for managing environmental compliance of products. For example, one tool identifies which IBM part numbers (among thousands) are impacted by expiring exemptions for the European Union RoHS Directive. This information, coupled with other supply chain information, assists engineers and procurement staff with part-number transition management and ensures compliance while supporting business objectives. These tools save IBM engineers extensive amounts of time analyzing complex bills-of-materials to identify the IBM parts impacted by changing requirements.

Product energy efficiency

Product energy efficiency was formalized as one of the company's corporate objectives when IBM established its product stewardship program in 1991. Through the collaboration of IBM Research and our product development teams, we have combined hardware and software technologies to improve the energy efficiency of IT equipment and in turn, data centers.

What follows are examples of new products IBM has developed with increased performance and improved

energy efficiency. Additional information about these products, and how they are being used by clients to improve their operations, reduce energy use and costs, and lower the greenhouse gas emissions associated with their operations, can be found on IBM's [energy efficient products, services and solutions](#) webpage.

IBM Power Systems

IBM announced its first server product featuring the POWER9 processor family, the IBM Power Systems Accelerated Compute Server AC922, in December 2017.

2017 product stewardship goals and performance

Product end-of-life management

IBM's product end-of-life management operations worldwide processed 26,500 metric tons (58.5 million pounds) of end-of-life products and product waste, and sent approximately 0.7 percent (by weight) of the total to landfills or incineration facilities for treatment — performing better than IBM's corporate goal of sending 3 percent or less of the total amount processed to landfill or incineration facilities for treatment.

Product energy efficiency

One of IBM's product energy efficiency goals is to improve the computing power delivered for each kilowatt-hour (kWh) of electricity used by each new generation of server. In 2017, IBM released its POWER9-based Power Systems Accelerated Compute (AC922) server for high-performance computing analytics and artificial intelligence. When compared to comparable IBM POWER8 products, IBM POWER9-based servers have Server Efficiency Rating Tool (SERT) weighted geometric mean active efficiency scores up to three times higher — which represents three times the performance or work delivered without any increase in power use. The SERT was created by the Standard Performance Evaluation Corporation (SPEC).

IBM also introduced its next-generation mainframe, the IBM z14 server, in 2017. On average, the IBM z14 server

delivers 23 percent or more work per kilowatt depending on the choice of components and cooling method.

IBM also has a goal to qualify its new server and storage products to the U.S. Environmental Protection Agency's (EPA) ENERGY STAR program criteria where practical, and where criteria have been developed for the specific server or storage product type. In 2017, IBM certified select configurations of the IBM Storwize® V7000 storage product to Version 1 of the ENERGY STAR data center storage requirements. None of the server products IBM released during 2017 was subject to ENERGY STAR criteria.

As of May 2018, IBM had [five Power Systems servers](#) and [seven storage products](#) certified to the ENERGY STAR requirements. The Power Systems servers meet the EPA's requirements for power-supply efficiency, idle power limits or power management capability, and SPEC SERT metric data reporting. The storage products meet requirements for power-supply efficiency and reporting of the Storage Networking Industry Association Emerald Power Efficiency Measurement Specification results.

All ENERGY STAR certified IBM FlashSystem® storage products and certified IBM server products have 80 PLUS Platinum certified power supplies.

The AC922 has two POWER9 processors with up to two terabytes of memory and support for up to six graphics processing units. The POWER9 servers are designed for high-performance computing, analytics, and artificial intelligence (AI) workloads. Initial SERT test data from servers with POWER9 processors indicate that the servers' performance-to-power efficiency increased by a factor of up to three over comparable POWER8-based products. The increased performance-to-power capabilities of the POWER9 servers enable them to deliver more workload than previous-generation servers, offering clients an opportunity to consolidate and reduce the number of servers required to perform a given workload and to decrease the energy demand and consumption of their data center operations.

IBM Power Systems client efficiency examples

IBM Power Systems servers can make material improvements in the efficiency of data center operations. Since the POWER9 servers were not released until the end of 2017, the examples below detail improved efficiencies of client operations achieved using POWER8 products:

- One client deployed two S824 servers and one E870 server to replace its legacy IT infrastructure and Enterprise Resource Planning system. The Power Systems servers reduced the number of physical servers required compared to competitors' offerings, resulting in less space, maintenance, power and cooling requirements and more energy efficient operation. The system upgrade also delivered 73 to 83 percent increased performance thereby improving customer service and internal administrative processing times.
- Another client upgraded their server systems to a POWER8 platform, reducing the number of servers needed to support their workload by 50 percent with a commensurate reduction in energy consumption.

IBM Z® servers

The IBM z14 server, announced in 2017, is designed for the cloud and is the only server that can deliver 100 percent encryption of application, cloud service and database data without changes to applications. It is capable of managing blockchain, AI and high-volume transactional workloads securely and efficiently. On average, the z14 delivers 23 percent or more work per kilowatt (kW) than the IBM z13® through increased processor capacity and performance, a 3.2x increase in memory capacity and the ability to store twice as much data on the same storage disk space. The z14 server also offers several energy-saving options:

- Capability to operate using high-voltage direct current power, which reduces conversion losses and increases energy efficiency
- A water-cooled model, which delivers 6 percent more computing capacity per kW compared to the air-cooled model
- Capability to operate at temperatures of up to 40 degrees Celsius for defined periods of time, enabling use of direct air cooling to reduce cooling costs

With its high utilization rates, the z14 offers one of the most efficient computing platforms when measured by the workload delivered per unit of energy consumed.

Storage systems

IBM continues to improve its range of storage products — including the IBM FlashSystem 900, the IBM XIV®, the Storwize family, the DS8880 enterprise storage family, and tape systems — offering clients solutions across all their data storage needs. IBM storage products are supported by software-defined storage and capacity optimization methods (COMs) 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 de-duplication, 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.

IBM has also continued to expand its software-defined **Spectrum Scale™** storage offerings, which enable storage automation and virtualization in both on-premise and cloud environments. Spectrum Scale storage enables the reduction of storage energy consumption and costs through data consolidation and the use of data placement technologies to optimize the use of available storage devices, including tape storage. The desired outcome is to maximize the amount of data stored on a minimum number of storage products, in turn minimizing energy use.

Storage systems client solution examples

- One client, a provider of marketing as a service solutions, implemented IBM Spectrum Accelerate™ on IBM Cloud to deliver a high-availability, easily expandable, enterprise storage solution for its clients. Application performance was increased by 15 to 20 percent while hardware requirements and operating expenses, including energy cost, were reduced by up to 60 percent.
- A client in the medical services field upgraded a portion of their legacy data storage equipment to IBM FlashSystem 900 products, reducing the hardware footprint and energy consumption by over 80 percent. The FlashSystem storage was integrated with IBM XIV and Storwize products using IBM Spectrum Virtualize™ to enable significant data compression and optimization of data storage across the hardware products, significantly increasing the quantity of data stored on the system. In addition, the upgrades enabled the client team to achieve sub-millisecond response times, improving the productivity of their medical staff.

These are just two examples of the improvements in storage utilization and reduction in energy use that can be

achieved through the deployment of new storage technologies utilizing COMs capabilities and software-defined storage capabilities such as the IBM Spectrum Accelerate and Virtualize software. Similar productivity and energy efficiency improvements are being achieved across the thousands of IBM storage systems that IBM sells each year.

Development of energy efficiency standards

IBM actively assists regulatory and standards bodies in the development of product energy efficiency standards. In 1992, IBM became a charter member of the EPA ENERGY STAR computer program and helped to develop the first criteria for personal computers. Since then, we have continued to support the ENERGY STAR program and other regulatory programs to assist in the development of new criteria for certifying server and storage products.

IBM engineers are working with industry peers and technical associations to support the development of harmonized worldwide energy efficiency standards for server and storage products. We are:

- Performing extensive evaluations of SERT test data and other industry metrics in support of creating a single metric that can be used to effectively assess the energy efficiency of server products, with the goal of driving a reduction in server power required to deliver a given workload.
- Working in collaboration with The Green Grid, the Information Technology Industry Council and its China affiliate, USITO, and DIGITALEUROPE to evaluate SERT and Storage Networking Industry Association Emerald Power Efficiency Measurement Specification results, and to advocate for SERT and Emerald as the harmonized energy efficiency test metrics for server and storage products.
- Assisting the ENERGY STAR program and regulatory bodies in China, the European Union and Japan with the development of server energy efficiency criteria based on the SERT metric.

Product recycling and reuse

As part of our product end-of-life management (PELM) activities, IBM began offering product takeback programs in Europe in 1989, and has extended and enhanced them over the years. IBM's Global Asset Recovery Services organization offers Asset Recovery Solutions to commercial clients in countries where we do business. These solutions include:

- Management of data security and disk overwrite services
- Worldwide remarketing network for product resale
- State-of-the-art refurbishing and recycling capability for IT equipment
- Optional logistic services such as packing and transportation

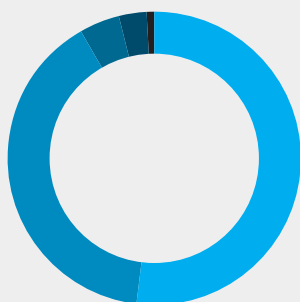
In many countries and U.S. states, we offer solutions to household consumers for the end-of-life management of computer equipment, either through voluntary IBM initiatives or programs in which we participate.

IBM's goal is to reuse or recycle end-of-life products such that the amount of product waste sent by our PELM operations to landfills or to incineration facilities for treatment does not exceed a combined 3 percent (by weight) of the total amount processed. In 2017, IBM's global PELM operations sent approximately 0.7 percent by weight of end-of-life products and product waste directly to landfill

or incineration as a disposal treatment. The total weight of end-of-life products and product waste processed by these operations was 26,500 metric tons (58.5 million pounds). Of the 26,500 metric tons processed by IBM PELM operations worldwide, 52.2 percent was sent for recycling as materials, 39.6 percent was resold as products, 4.4 percent was product reused by IBM, 3.1 percent was incinerated for energy recovery, and an estimated 0.7 percent was sent to landfills or incinerated for final disposal.

IBM established its corporate-wide requirement for the environmental evaluations of the company's PELM suppliers in 1991, an expansion of our supplier environmental evaluation program introduced in 1972. We evaluate these suppliers prior to doing business with them and every three years thereafter. Our objective is to use only suppliers that have a strong focus on environmental management, including complying with laws and regulations as well as sound management practices. More about IBM's requirements for our PELM suppliers may be found in the [environmental requirements in the supply chain](#) section of this report.

From 1995, when we first began including product recovery in our annual corporate environmental report, through the end of 2017, IBM has documented the collection and processing of approximately 1 million metric tons (about 2.3 billion pounds) of product and product waste worldwide.



2017 product end-of-life management operations

(% by weight of 26,500 metric tons processed)

- | | |
|------------------|----------------------------------|
| ■ 52.2% Recycled | ■ 3.1% Waste-to-energy |
| ■ 39.6% Resold | ■ 0.7% Landfill and incineration |
| ■ 4.4% Reused | |

Product packaging

IBM has had a program focused on the environmental attributes of its product packaging since the late 1980s. 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.

The engineering specifications establish requirements on packaging materials used in protecting, handling or marketing of IBM products, parts and assemblies, including those supplied by Original Equipment Manufacturer or Contract Manufacturer suppliers. They address requirements for restricted heavy metals and other substances of very high concern, packaging material data collection and reporting. IBM packaging engineers design solutions that are intended to minimize packaging waste and specify non-toxic materials and inks for use in packaging. We keep packaging to a minimum while continuing to provide protection to the product being shipped to clients, and we collaborate with suppliers to use recycled and recyclable materials and promote reuse. The design of rugged products and other optimization measures for the efficient use of protective product packaging, and less tangible environmental benefits associated with improvements in transportation efficiency, are addressed and tracked.

IBM's supplier environmental packaging requirements are accessible from the [information for suppliers](#) webpage.

IBM has evaluated the most commonly used packaging components and subcomponents on a variety of environmental criteria. When options are available, suppliers are required to choose the material that has the least adverse effect on the environment. The materials are evaluated based on our experience and client feedback. Other environmental areas addressed in IBM's packaging requirements include:

- Ozone-depleting substances
- Restricted heavy metals and other materials of concern

- Source reduction
- Reusable packaging systems
- Recyclable packaging
- Conserving natural resources

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. Applying this process to packaging suppliers ensures ongoing compliance with IBM's product packaging requirements.

Packaging reduction and improvements

In 2017, IBM's corporate distribution packaging technology team saved an estimated 141 metric tons of packaging materials through the implementation of packaging redesign projects for parts and assemblies shipped to manufacturing locations, and for packaged finished products supplied to clients worldwide. These projects delivered an estimated annual materials and transportation cost savings of \$983,000. Highlights of three packaging reduction projects implemented in 2017:

- Server packaging redesign for IBM interplant shipment

IBM redesigned packaging for internal shipment of IBM Power® servers and storage systems from individual packaging of systems to a bulk packaging system. The packaging redesign reduced corrugated cardboard, polyethylene foam and wood used in packing individual machines on a pallet by devising a bulk packaging system of several machines on a single wood pallet. This initiative saved an estimated 18.3 metric tons of packaging materials and \$91,000 in materials and transport costs per year.

- Server packaging redesign for supercomputer deliveries

IBM redesigned a single server package to bulk packaging to support a series of two large supercomputer deliveries. The packaging redesign resulted in a reduction of corrugated cardboard, polyethylene foam and wood used in packing individual machines on a pallet by devising a bulk packaging system of 10 machines per single wood pallet. This initiative saved an estimated 74 metric tons of packaging materials and \$216,000 in materials and transport costs per year.

- Storage system packaging redesign

IBM redesigned the packaging for the IBM TS2900 Tape Autoloader. The redesign maintains a high level of protection for the product while reducing the amount of expanded polypropylene foam cushion and corrugated cardboard needed to protect individual machines, and avoiding the use of a wood pallet for single shipments. Further, two or more machines can now be transported on a single pallet. Expanded polypropylene foam cushions and plastic sheeting, used for protection of the product during shipment from the supplier's facility to IBM's manufacturing plant, is reused for fulfillment to customers. This initiative saved an estimated 48.7 metric tons of packaging materials and \$676,000 in materials and transport costs per year.

for paper/wood to IBM, or to provide evidence that sources have been certified to be from sustainably managed forests by an accredited third-party certification scheme. Requirements in support of this goal are incorporated into our standard supplier specifications for paper and paper/wood-based packaging.

In 2017, 98 percent of the paper and paper/wood-based packaging IBM directly procured worldwide came from suppliers that warranted that the source was derived from forests managed in an ecologically sound and sustainable manner.

Sourcing of paper and paper/wood-based packaging materials

IBM established its voluntary environmental goal for the responsible sourcing of paper and paper/wood-based packaging in 2002. It required that the paper and paper/wood-based packaging directly acquired by IBM be procured from suppliers that source from sustainably managed forests, where such sources exist. Continued focus on this objective by IBM and our suppliers over the years has allowed IBM to attain this goal consistently for more than 95 percent of paper and paper/wood-based packaging that we directly acquired. In 2016, the goal was enhanced to require suppliers either to disclose sources

Materials and process stewardship

As an integral part of its global environmental management system, IBM monitors and manages the substances used in its research, development and manufacturing processes, and in its products.

Environmentally preferable substances and materials

IBM endeavors to use substances and materials in its internal development and manufacturing activities that are protective of both employees and the environment. When research activities involving chemicals or new materials demonstrate the potential for use in commercial products, processes or technologies, or when IBM modifies existing internal chemical or material processes, IBM requires those chemicals or materials to undergo an extensive evaluation of regulatory, health and safety, and environmental impacts. We call this formal chemical evaluation and approval process an upstream chemical review. This review helps to ensure that IBM is using the least hazardous chemicals where possible, and is a key element of IBM's precautionary approach to chemical management.

IBM's focus on environmentally preferable substances and materials considers the weight of scientific evidence for potential adverse effects on human health or the environment. To that end, IBM maintains corporate programs and strategic skill sets in chemical management and toxicology to evaluate materials used in our products and processes. As a result of our initiatives in both product and process stewardship, we have proactively prohibited or restricted the use of certain hazardous substances in our products and processes, and found more environmentally preferable alternatives—even where current laws permit such use.

The following is a sampling of IBM's 40-plus years of leadership in voluntarily prohibiting or restricting substances of concern from our processes and products, even before regulations required that we do so. For a more complete list, see our [materials use](#) webpage.

Polychlorinated biphenyls (PCBs)

IBM initiated a multi-year effort to eliminate PCBs from use in our products in 1974 and achieved elimination in 1978.

Chlorofluorocarbons (CFCs)

In 1989, IBM became the first major IT manufacturer to announce a phase-out of CFCs, a Class I ozone-depleting substance, from our products and manufacturing and development processes.

Class I and II ozone-depleting substances

IBM completed the phase-out of Class I ozone-depleting substances in 1993. Subsequently, IBM eliminated Class II ozone-depleting substances from our products and processes in 1995.

Trichloroethylene (TCE), ethylene-based glycol ethers and dichloromethane

Examples of other chemicals that IBM voluntarily prohibited from our manufacturing processes include TCE in the late 1980s, ethylene-based glycol ethers in the mid-1990s and dichloromethane in 2003.

Polybrominated biphenyls (PBBs) and polybrominated diphenyl ethers (PBDEs)

IBM prohibited PBBs and PBDEs from its product designs in the early 1990s and then extended the prohibition to purchased commodities through our procurement specifications in 1993.

Cadmium

IBM prohibited the use of cadmium in inks, dyes, pigments and paints in 1993, in plastics and plating in 1994, and in CRT monitors along with nickel cadmium batteries in the mid-1990s.

Polyvinyl chloride (PVC) and tetrabromobisphenol A (TBBPA)

IBM ceased the specification of PVC in our IT system enclosures in 2000, and in 2007, we prohibited the use of TBBPA as an additive flame retardant in IT system enclosures for newly released products.

Specific perfluorinated compounds (perfluorooctane sulfonate [PFOS] and perfluorooctanoic acid [PFOA])

IBM prohibited the use of PFOS and PFOA in the development of new materials in 2005, in new manufacturing applications in 2007, and eliminated their use in existing manufacturing, development and research processes as of January 31, 2010.

Informing the broader industry

IBM's regular internal assessments of process chemicals include review of the latest scientific studies and literature regarding the environmental and health effects of the materials that we use. The routine surveillance and review of the latest chemical literature by our toxicology staff has, in several cases, indicated that certain substances used in IBM's manufacturing processes require greater controls in specific applications than previously understood by industry and/or regulators. In these instances, IBM participates in efforts to share our expertise and knowledge in chemical management and chemical safety with the industry at large.

One example of these efforts pertains to the evaluation of indium and indium compounds used in semiconductor manufacturing applications. A team of IBM toxicologists, industrial hygienists and occupational physicians carefully investigated the scientific and clinical literature regarding indium and indium compounds, and found that few documented Occupational Exposure Limits (OELs) were available for the materials. The team further concluded that the available scientific evidence suggested that the current recommended OELs for indium should be lowered as an added precaution. Using quantitative toxicology risk assessment methods and techniques, IBM developed,

peer-reviewed and adopted a new internal OEL that was appreciably less than the current OEL for these materials. In setting a new IBM internal OEL for respirable indium, IBM continues a long record of precautionary assessment and reduction of risks associated with the chemicals and materials it brings into its operations.

In 2017, we presented our efforts to develop an internal health-based OEL for indium at a Semiconductor Research Corporation webinar and at American Industrial Hygiene Association conferences to disseminate the information to a broader audience. IBM's work was also presented at the annual meeting of the Society of Toxicology in March 2018.

In another example of IBM leadership in sharing our expertise, the Semiconductor Environmental, Safety and Health Association (SESHA) requested that our toxicologists, along with fellow environmental, health and safety colleagues from GlobalFoundries and the State University of New York Polytechnic Institute, present an update on their and others' research on tetramethylammonium hydroxide (TMAH). TMAH has applications in photolithography processes such as etching, cleaning, polishing and stripping. This collaborative update was presented in November 2017 and in April 2018 at the annual SESA/ Semiconductor Industry Association International High Technology Environmental Safety and Health Symposium and Exhibition, focusing on the current state of the science regarding the use of TMAH. We participated in these joint working sessions and presentations to provide our expertise and increase industry awareness of the unique hazards of TMAH.

Pollution prevention

Pollution prevention is an important aspect of IBM's long-standing environmental efforts and it includes, among other things, the management of waste.

Hazardous waste

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. Where possible, we redesign processes to eliminate or reduce chemical use and to substitute more environmentally preferable chemicals. We maintain programs for proper management of the chemicals used in our operations, from selection and purchase to storage, use and final disposal.

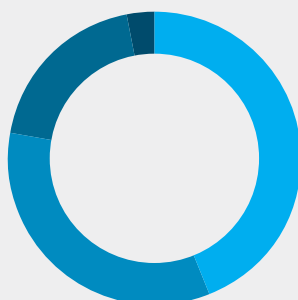
IBM's total hazardous waste generation in 2017 increased by 7 percent (by weight) from 2016, to 1,460 metric tons. This increase was caused by the disposal of hazardous waste generated by a water leak from a fire suppression system at one of our facilities. The water was contaminated with diesel fuel from an emergency generator located within the area where the water leaked. The contaminated water was contained, avoiding any release to the environment. If hazardous waste generated as a result of this incident were removed, IBM would have seen a 16 percent reduction of hazardous waste generation in 2017.

For the hazardous waste that is generated, we focus on preventing pollution through a comprehensive, proactive waste management program. Of the total 1,460 metric tons of hazardous waste IBM generated worldwide in 2017, 44.2 percent (by weight) was recycled, 33.6 percent was sent by IBM directly for incineration, 18.8 percent to regulated landfills, and 3.4 percent for treatment.

Nonhazardous waste

IBM has also focused for decades on preventing the generation of nonhazardous waste, and where this is not practical, recovering and recycling the materials that are generated. Nonhazardous waste includes paper, wood, metals, glass, plastics and other nonhazardous chemical substances.

We established our first voluntary environmental goal to recycle nonhazardous waste streams in 1988. The goal has since evolved on two fronts. The first expanded on the traditional dry waste streams to include nonhazardous chemical waste and end-of-life IT equipment from our own operations, as well as IBM-owned equipment that is returned by external clients at the end of a lease. The second expansion was made to include nonhazardous waste generated by IBM at leased locations meeting designated criteria.



2017 total generated hazardous waste worldwide by treatment method
(% by weight of 1,460 metric tons processed)

- 44.2% Recycle
- 33.6% Incineration
- 18.8% Landfill
- 3.4% Treatment

Our voluntary environmental goal is to send an average of 75 percent (by weight) of the nonhazardous waste generated at locations managed by IBM to be recycled. In 2017, we recovered and sent 87.8 percent of the nonhazardous waste generated by IBM worldwide to be recycled, a 1.5 percent increase over 2016.

Treatment methods that were credited toward the waste recycling target included material recycling, reuse, energy recovery, composting, reclamation, and land farming. Treatment methods that result in a non-beneficial use and that were not credited toward the recycling target included incineration, landfilling, and treatments such as aqueous treatment, biodegradation of organics, filtration, neutralization and stabilization.

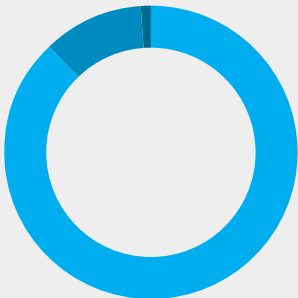
In 2017, our worldwide operations generated approximately 36,900 metric tons of nonhazardous waste, a decrease of about 7,600 metric tons from 2016.

Source reduction and waste prevention initiatives implemented by IBM worldwide were estimated to have prevented the generation of about 185 metric tons of non-hazardous waste in 2017, with estimated annual handling, treatment and disposal cost savings and revenue returns totaling \$2.2 million.

Total annual nonhazardous waste quantity and recycling performance

(Metric tons x 1,000)	2013	2014	2015	2016	2017
Total sent for recycling	55.9	91.7	45.6	38.4	32.4
Total generated*	65.0	106.7	53.5	44.5	36.9
Percent recycled (by weight)	86.0%	85.9%	85.2%	86.3%	87.8%

** Total generated nonhazardous waste excludes sanitary wastewater sent to publicly owned treatment systems*



2017 total generated nonhazardous waste worldwide by treatment method
(% by weight of 36,900 metric tons processed)

- 87.8% Recycle
- 10.8% Landfill and incineration
- 1.4% Other treatments

Note: Total generated nonhazardous waste excludes sanitary wastewater sent to publicly owned treatment systems.

Water conservation

Through IBM’s global environmental management system, IBM continues to improve water-use efficiency and to minimize our operational impact on water resources.

IBM’s current water use is primarily associated with cooling at our large facilities and data centers, and for irrigation and domestic purposes. Following the divestiture of our semiconductor manufacturing operations in 2015, IBM reassessed the environmental impacts of our water use. We did this by using the World Business Council for Sustainable Development’s Global Water Tool, which highlights regions around the globe where water resources are stressed to meet human and ecological demand for fresh water. We identified 45 data centers and other large IBM locations in regions worldwide that were considered highly or extremely highly water-stressed. IBM established a new goal in 2016 to achieve ongoing year-to-year reductions in water withdrawals at these locations.

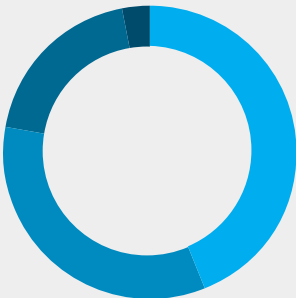
In 2017, IBM reduced water withdrawals at these data centers and other large IBM locations in water-stressed regions by 2.9 percent versus 2016. This reduction was primarily associated with enhanced water systems maintenance and efficiency improvements in deionized water purification systems. Water withdrawals equivalent to 5.4 percent of total withdrawals were avoided by on-site water reuse for manufacturing processes (reuse of rejected water from deionized water purification systems) and wastewater recycling activities (mainly used in buildings’ cooling tower systems and landscape irrigation).

Annual reduction in water withdrawals at data centers and other large IBM locations in water-stressed regions

	2016	2017
Annual water reduction	6.6%	2.9%
Water reuse and recycling (percent of total withdrawals)	5.4%	5.4%

Water sources for these locations consisted primarily of municipal water supplies (67 percent), fresh surface waters (24 percent) and groundwater (4 percent), accounting for 95 percent of total water use. The remaining 5 percent came from bottled water, on-site process water and treated wastewater. The main uses of water at these locations are for domestic purposes (45 percent), heating, ventilation and air conditioning (HVAC) systems (31 percent), landscape irrigation (19.5 percent), and manufacturing processes (4.5 percent).

IBM also continues to implement water conservation projects at locations that are not in water-stressed regions. For example, IBM’s Bromont, Canada, location operates a deionized water purification system for manufacturing use that generates some rejected water that is reused in the same system. This activity avoided the withdrawal of 24,500 cubic meters of water in 2017. The site also further optimized the deionized water purification system to minimize the amount of water rejected, among other measures, reducing water withdrawals by 799 cubic meters per year. The combined 25,299 cubic meters represented 13 percent of the total water withdrawals at the Bromont location in 2017.



2017 water use at IBM locations in water-stressed regions

- 45% Domestic water use
- 31% Heating, ventilation and air conditioning (HVAC) systems
- 19.5% Landscape irrigation
- 4.5% Manufacturing processes

Solutions for environmental sustainability

At IBM, we thrive on challenges. Striving to solve environmental challenges is a job we take very seriously. We apply our vast technology, expertise, and insight across industries, addressing the necessities of life itself—from the air we breathe, to the water we drink, and the food we eat. The challenges we face today have never been more complex, demanding or seemingly impossible to solve. However, IBMers are working to develop and implement solutions—creating innovation that truly matters for our company and the world. Following are examples of some innovative solutions we are developing and implementing that contribute toward environmental sustainability.

Protecting and managing our water resources

Water affects every aspect of human life. It plays a role in everything from health and nourishment, to business and commerce, to energy and transportation. IBM solutions provide the technical foundation to facilitate the flow of information across organizations and establish a shared, comprehensive view of our water resources. Our solutions also help the farming industry to improve crop yield while using less water.

Tackling ocean plastic with IBM

A 2015 research paper published in *Science* magazine estimated that between 5.5 and 14.6 million metric tons of plastic made their way into our oceans that year, and that the yearly amount could double by 2025.

Working with IBM and IBM Business Partner Cognition Foundry, the Plastic Bank is mobilizing entrepreneurs from the world's poorest communities to recycle plastic waste in return for life-changing goods. The team developed a blockchain-powered token reward to underpin the

recycling of plastic waste. The tokens can be exchanged for valuable commodities. IBM's blockchain technology tracks the plastic recycling process, from waste collection, credit and compensation through delivery to companies for reuse.

The Plastic Bank's token rewards and exchange platform incentivizes the collection of plastic, preventing it from entering the oceans. To date, the Plastic Bank has collected over 8 million pounds of plastic waste from its first recycling centers in Haiti, the equivalent of 144 million plastic bottles. This was accomplished by more than 1,850 full-time collectors working across 40 collection locations. ([Watch a video](#) about this project.)

Using sensors with IBM's cognitive IoT technologies to improve water management

In 2017, IBM teamed with Dublin City University (DCU) Water Institute to launch a pilot program that uses the Internet of Things (IoT) combined with advanced analytics to monitor and manage ecological systems. The deployment of DCU sensors with IBM's machine learning and cognitive IoT technologies will help protect and conserve natural resources and address environmental management issues such as water quality for both freshwater and marine environments.

In the past, water systems have been primarily monitored by technicians manually gathering water samples and sending them to labs for analysis. Yet with sensors



IBM researcher Harry Kolar deploys a Dublin City University Water Institute sensor at Lake George in New York.

becoming cheaper, more durable, and more capable, it is now possible to place them directly into water systems and continually gather data. These sensor advancements combined with improved geospatial coverage, have allowed scientist to develop full computer models of ecosystems that can be used to identify problems and intervene before they become major environmental issues. The sensors can measure physical, chemical and biological parameters to better understand changes in the environment. Additional applications may include improved management of pollution from sources such as agricultural or stormwater runoff that can affect lakes, rivers, estuaries and marine ecosystems.

IBM and DCU Water Institute are piloting these technologies in Ireland and the United States. ([Watch a video](#) about this project.)

The Jefferson Project at Lake George

Since 2013, The Jefferson Project at Lake George, a collaboration between IBM, Rensselaer Polytechnic Institute and The FUND for Lake George, has built the world's most advanced environmental monitoring system. The system incorporates a sensor network that gathers more than nine terabytes of physical and chemical data annually; computer models that depict the weather and flow of water, nutrients and contaminants through the watershed and lake; and data from surveys of aquatic animals that inhabit the lake and streams. A new, low cost DCU water quality sensor has been deployed in one of the most important tributaries that feed the lake, and it is being evaluated with the goal of further improving the monitoring system to better understand the impacts of human activities on the Lake George ecosystem.

With a nearly completed sensor network, and increasingly sophisticated computer models, IBM cognitive computing technologies are being used to analyze and make sense of incoming data. The project will not only help to manage and protect this particular natural resource, but it also provides a blueprint to preserve important lakes, rivers and other bodies of freshwater around the globe.

IBM Watson IoT™ enables water conservation through precision irrigation

Having farmed in California for more than 80 years, E. & J. Gallo Winery believes that no resource is more important than water, making water management a top priority of the company for decades. The winery worked with IBM Watson IoT, which developed technologies to use weather reports and remote sensor data to deliver precise amounts of water to each grapevine, optimizing growth and reducing the amount of water required for irrigation. The secret is located above the clouds, in a satellite looking down on the vineyard.

A 30-by-30-meter grid, aligned with National Aeronautics and Space Administration satellite imagery, is mapped over the vineyard block. Each block of vines in the grid gets its own personal irrigation plan based on weather data and soil moisture levels. This allows the exact amount of water needed—based on highly targeted irrigation requirements—to be dispensed to each grapevine. As the weather changes, the irrigation rates change to ensure vines only receive water when needed. The result? For E. & J. Gallo Winery, the world's largest family-owned winery, the Watson IoT solution resulted in a 26 percent improvement in yield quantity, a 50 percent improvement in uniformity, and a 25 percent reduction in water use required.



E. & J. Gallo Winery worked with IBM Watson IoT to develop a precision irrigation system that saves water and improves yields.

Improving the air we breathe

According to the World Health Organization (WHO), exposure to outdoor air pollution accounts for approximately 3 million deaths annually. WHO [has concluded](#) that this more than doubles previous estimates, and confirms that air pollution is now the world's largest single environmental health risk. IBM is working with cities around the globe to tackle air pollution challenges and provide solutions to help improve the air we breathe.

Providing community air quality data

One way to increase public awareness of the impacts of air pollution is by making air quality data more broadly available. In 2017, The Weather Company® (an IBM Business) collaborated with air quality sensor manufacturer PurpleAir to expand the availability of local air quality and pollution data for the public. As a result of this collaborative effort, owners of PurpleAir devices can now contribute data from their units to The Weather Underground®, a consumer division of The Weather Company. This data is displayed on maps on its website to provide one of the most granular pictures available of air pollution within the United States.

Green Horizons initiative and air pollution forecasting

Green Horizons is a 10-year initiative launched by IBM in 2014 with the city of Beijing. It uses advanced machine learning and IoT technologies to improve the understanding and forecasting of pollution events. The IBM China Research Laboratory is working with the Beijing Environmental Protection Bureau to provide one of the world's most advanced air quality management systems. It can help identify sources of pollution, and provides forecasts at least 72 hours in advance. It also models and predicts the effects of weather on the flow of pollutants in the air and the reactions between weather and pollutant particles. Utilizing IBM's data assimilation and cognitive modeling, the city of Beijing has seen a significant reduction in fine particulate matter concentration (known as $PM_{2.5}$). During the first seven months of 2017, the $PM_{2.5}$

concentration was recorded to be [34.7 percent lower](#) than during the same period in 2013, prior to the launch of Green Horizons.

IBM has also entered into research collaborations with governments in Delhi, India, and Johannesburg, South Africa, to leverage Green Horizons technology and address air pollution issues in those cities as well.

For future applications, Green Horizons will move toward personalized pollution exposure measurements and health services. Because environmental pollution, health and safety are highly connected, IBM is moving swiftly to apply a targeted yet integrated approach to enable governments and individuals in their efforts to battle pollution and associated diseases.

Conserving energy and addressing climate change

Climate change is one of the most critical environmental challenges facing the planet. Since the early 1990s, IBM has been collaborating with clients and others on innovations to help protect the world's climate through energy conservation and the use of renewable energy. Today, we continue that effort and reinforce our long-standing commitment to addressing these environmental challenges.



Dr. Jin Dong of IBM Research – China leads IBM's Green Horizons initiative.

Smarter Buildings

The IBM Smarter Buildings solution started as an internal pilot initiated by IBM's real estate and software development organizations and the research division. The objective was to apply IBM analytics to existing building system operational data, generating insights to improve energy efficiency. What began as a pilot at one IBM location in 2009 is now deployed at 24 major IBM campuses, encompassing 155 buildings and over 24.5 million square feet of space around the globe. This solution captures 40 percent of IBM's energy usage and 34 percent of our energy spending.

The IBM Smarter Buildings solution combines IBM's real estate management, software and services expertise with analytics to reveal a building's hidden failings and to identify opportunities for improvement in building performance and efficiency. The solution implemented at IBM compiles real-time operating data from approximately 27,000 field data sources (e.g., air conditioning systems, boilers, chilled water systems) every 15 minutes. The Smarter Buildings solution sends out automatic alerts when systems are operating outside of optimal conditions, with a specific focus on energy efficiency, so that personnel can take corrective action and implement operational modifications.

From 2013 to 2017, IBM's global energy management team utilized IBM's Smarter Buildings solution to reduce energy consumption by 35,000 MWh per year, with associated annualized savings of \$1.7 million. The implementation has demonstrated on average a positive return on investment after one to two years, while energy savings have increased in each year of operation. Due to the outstanding results of IBM's internal Smarter Buildings solution implementation, IBM offers the service to its clients as Building Optimization with IoT.

IBM's Smarter Buildings solution has helped reduce energy consumption by 35,000 MWh per year.

Developing smart sensors to detect greenhouse gas emissions

Most pollutants are invisible to the human eye, until their effects make them impossible to ignore. Methane, for example, is the primary component of natural gas. If methane leaks into the air before being used, it can warm the earth's atmosphere. Methane is estimated to be the [second-largest contributor](#) to global warming after CO₂.

In the United States, emissions from oil and gas systems are the largest industrial source of methane gas in the atmosphere. The U.S. Environmental Protection Agency estimates that 9.3 million metric tons of methane leaked from natural gas systems in 2016. Scientists at IBM are working with natural gas producers, such as Southwestern Energy, to develop intelligent methane monitoring systems.

At the heart of IBM's research is silicon nano-photonics that are tuned to detect minuscule amounts of methane. This evolving technology transfers data by light, enabling computing literally at the speed of light. These chips can be embedded in a network of sensors on the ground near natural gas infrastructure, or even fly on autonomous drones — generating insights that, when combined with real-time wind data, satellite data and other historical sources, can be used to build complex environmental models to detect the origin and quantity of pollutants as they occur.

Protecting wildlife

The protection of wildlife and endangered species from extinction is important to the health of the planet. Extinction is being hastened due to a number of factors, poaching being one of them. IBM technology is being used on the front line to help save African rhinos from the threat of poachers and extinction.

Today, South Africa is home to more than 70 percent of the world's remaining rhino population. Conservationists are battling to protect these iconic animals that are being killed. Over the past decade, more than 7,000 rhinos were killed across the African continent, and in 2016, 1,054 were reported killed in South Africa alone.

In 2017, IBM joined forces with Wageningen University in the Netherlands, India IT provider Prodapt, and MTN, a leading African telecommunications provider, to protect endangered rhinos at South Africa's Welgevonden Game Reserve. A solution was needed that would help the wildlife managers to understand and predict possible threats of poaching, and act ahead of time to prevent harm to the animals.

According to research conducted on Welgevonden Game Reserve, prey animals in the wild react in different ways, depending on the type of threat they encounter and the perceived danger from predators, such as lions and leopards, or the presence of people in the vicinity. IBM's IoT

technology was selected by MTN as part of their Connected Wildlife Solution. Protecting the rhinos begins with fitting collars containing custom sensors onto prey animals including zebra, wildebeest, eland and impala. Information is collected on animal location, movement, direction and average speed of travel. Using the data, patterns are developed based on the animals' response to threats. As a result, animals such as zebras will act as sentinels with their response patterns becoming an early warning system to indicate the presence of poachers and protect the rhinos.

The predictive nature of this solution takes away the reliance on game reserve teams to be in the right place at the right time, or to respond to events such as the distant sound of gunfire. The aim is for the technology to be made available for deployment at game reserves across Africa and abroad.



IBM IoT technology is helping to protect endangered rhinos at South Africa's Welgevonden Game Reserve.

Environmental requirements in the supply chain

IBM does business with suppliers that are environmentally and socially responsible, and encourages environmental leadership among them. IBM also routinely responds to requests from our clients and governments for information about the environmental attributes of our products. In many cases, the source for this information is our suppliers.

The objectives of our requirements for suppliers and our supplier evaluation program include:

- Ensuring that IBM does business with environmentally responsible suppliers that are actively managing and reporting on their environmental impacts
- Helping our suppliers build capabilities and expertise in the environmental area
- Avoiding the transfer of responsibility for environmentally sensitive operations to any company lacking the commitment or capability to manage them properly
- Reducing our suppliers' environmental and workplace health and safety risks
- Protecting IBM, to the greatest extent possible, from potential environmental liabilities or adverse publicity

Supplier social and environmental management system requirements

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. With this in mind, the baseline environmental requirements for IBM suppliers are summarized below:

- 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 may be found on IBM's [social and environmental management system supplier requirements](#) webpage.

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

In certain situations, IBM has established additional environmental requirements for suppliers. Those situations include when IBM:

- Specifies and/or furnishes chemicals or process equipment
- Procures hazardous waste treatment and/or disposal services

- Procures product end-of-life management services
- Uses extended producer responsibility solutions

Environmental requirements are documented in our contracts with suppliers conducting these types of activities anywhere in the world. These may include requirements related to chemical content, chemical management, waste management, spill prevention, health and safety, downstream supplier management, and reporting.

For suppliers providing hazardous waste management services or product end-of-life management services, IBM conducts a three-stage supplier environmental evaluation, with increasing levels of detail, depending on the risks associated with and the potential environmental impacts from the supplier's operations.

We evaluate these suppliers prior to entering into a contract with them, and then approximately every three years thereafter, to ensure their operations and commitment to workplace safety and sound environmental practices continue to meet our requirements. The evaluations are conducted by IBM's Corporate Environmental Affairs staff, or internal or third-party environmental professionals under the direction of this staff.

IBM's hazardous waste and product end-of-life management supplier evaluations are comprehensive in the scope of the environmental aspects covered, including:

- Facility operational activities, capabilities, capacities and services
- Compliance with IBM's social and environmental management requirements and the supplier's own social and environmental management system
- Applicable legal requirements and compliance
- Permits, licenses and other applicable regulatory requirements
- Environmental liability insurance and financial assurance

IBM also requires its hazardous waste and product end-of-life management suppliers to track the shipment and processing of any hazardous materials they handle for IBM—down to the final treatment, recycling or disposal location—and to report that information to us.

As with all of our environmental programs, IBM manages its hazardous waste and product end-of-life management programs to the same high standards worldwide. Doing so can be particularly challenging in some countries where processing infrastructure that meets IBM's requirements (for treatment, recycling and/or disposal) is limited or nonexistent.

Under IBM's waste management program, hazardous wastes are treated, recycled or disposed of at IBM-approved facilities within the country where they are generated, whenever possible. IBM does not export hazardous wastes from the U.S. or any other country where suitable processing facilities are available within the country.

If there are no suppliers in a country that meet IBM's environmental and safety requirements for hazardous waste or product processing, the waste generated by IBM's operations is shipped to facilities in other countries where those requirements can be met. This shipping is done in compliance with country laws and regulations, and in accordance with international treaties such as the Basel Convention on the Control of Transboundary Movements of Hazardous Wastes and their Disposal.

Though rare, there are sometimes situations in which local processing of waste is not possible and shipping to IBM-approved suppliers in other countries is not allowed due to legal requirements. In these situations, IBM will store wastes and product end-of-life materials in properly contained and managed storage facilities, as allowed by law, until suitable processing facilities are available.

IBM's supplier evaluation program was extended in 2014 to cover suppliers providing collective solutions (e.g., consortia) for the management of IBM's end-of-life product wastes. These suppliers have become more important as new extended producer responsibility regulatory schemes have been implemented in many countries. IBM evaluates the collective solutions we use to fulfill our responsibilities as a manufacturer of products covered by such schemes, as well as collective solutions that we use for the disposal of products purchased for our internal use.

In 2016, IBM established a goal to have its first-tier suppliers providing product end-of-life management, recycling and disposal services in the U.S., Canada and the European Union (EU) attain third-party certification to a responsible recycling standard such as R2, e-Stewards, WEEELABEX, EN 50625, or other IBM-acceptable equivalent standards. The goal has a phased implementation for each region with the following target dates: year-end 2016 for the U.S., year-end 2017 for Canada, and year-end 2018 for the EU. As of year-end 2017, our first-tier suppliers in the U.S. and Canada achieved the goal, and first-tier suppliers in the EU are on track to achieve the goal by year-end 2018.

Key IBM milestones for responsibility in the supply chain

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 Organisation for Economic Co-operation and Development (OECD)

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 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

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 supplier evaluation program to include suppliers providing collective solutions for the management of IBM's end-of-life product wastes

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 or the EU achieve third-party certification to an acceptable electronic product recycling standard

Remediation

When groundwater contamination was first discovered at one of IBM's sites in 1977, the company voluntarily initiated groundwater monitoring at all of its manufacturing and development locations worldwide. Today, IBM has 2,494 monitoring wells and 95 extraction wells in place at its current and former locations.

In 2017, IBM's remediation operations extracted over 12,500 pounds of solvents from groundwater at three currently operating IBM locations and 12 former IBM locations in three countries. Additionally, over 7,400 pounds of solvents were removed by soil vapor extraction or other methods at seven of these locations. IBM also has financial responsibility for remediation at two additional former locations.

Under the U.S. Superfund law, IBM is involved in cleanup operations 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 and the shipments of waste to that site were legal, or even best practices, at the time. As of year-end 2017, IBM had received notification (through federal, state or private parties) of its potential liability at 115 such sites since the beginning of the U.S. Superfund program in 1980. Of these, 61 are on the U.S. National Priority List. At most of the 115 sites, IBM has either resolved its liability or has demonstrated that it has none. Currently, IBM is cleaning up, or otherwise participating in remediation management, at 18 Superfund sites.

When an environmental investigation and/or remediation at a current or former IBM location or at a non-IBM facility is probable, and the costs for future activities can be reasonably estimated, IBM establishes financial accruals for loss contingency. IBM also accrues for estimated costs associated with closure activities (such as removing and restoring chemical storage facilities) when IBM decides to close a facility. As of December 31, 2017, the total amount accrued for all such environmental liabilities and associated activities was \$267 million.

Audits and compliance

IBM reviews its environmental performance against both external and internal requirements, and takes prompt and decisive action when any issues are identified.

Every year, IBM’s manufacturing, hardware development and chemical-using research locations and organizations—such as product groups, Real Estate Strategy and Operations, Global Services, Global Logistics, Global Asset Recovery Services, and Global Procurement—complete a comprehensive environmental self-assessment. IBM’s Corporate Internal Audit organization may also conduct environmental audits of these functions. Audit and self-assessment results are communicated to top management. Accountability, follow-up actions and their closure are clearly delineated.

In addition, independent audits are conducted by an external third party as part of IBM’s single, global registration to the ISO 14001 and 50001 standards. Approximately 20 IBM locations and relevant business organizations (known as registered entities) are audited annually against the ISO 14001 environmental management systems standard by an external ISO 14001 registrar. Registered entities are audited on a 12- to 30-month cycle.

Five to eight registered entities, representing 10 to 30 percent of IBM’s global annual energy consumption, are also audited annually to the ISO 50001 energy management systems standard. These audits include management and tracking of consumption data, identification of significant energy uses, and demonstrating progress against the IBM energy conservation goal.

The results of the ISO 14001 and 50001 audits are used as inputs for a separate, third-party validation audit of IBM’s corporate greenhouse gas emissions management and reporting process. The results of the latest greenhouse gas verification audit can be found on our [auditing and verification](#) webpage.

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 reporting criteria must be reported through the EIRS. Each IBM location must have a documented incident prevention program and reporting procedure. In 2017, eight accidental releases of substances to the environment related to IBM operations were reported through the EIRS—five releases to air, two releases to land and one release to water. The five releases to air were all refrigerants used in cooling systems. The two releases to land were one of chilled water and one of antifreeze. The release to water was steam condensate. The root causes were investigated for all releases and corrective actions were taken as appropriate. None of the releases was of a duration or concentration to cause long-term environmental impact.

Fines and penalties

One significant measure of a company’s proactive approach to pollution prevention and environmental performance is its record of fines and penalties. In 2017, IBM received 73 agency inspections at its locations worldwide with no resulting fines or penalties. Over the past five years, IBM has paid four fines totaling \$7,125.

Fines and penalties					
worldwide (\$ in thousands)					
	2013	2014	2015	2016	2017
Number	0	4	0	0	0
Fines	\$0.0	\$7.1	\$0.0	\$0.0	\$0.0

Awards and recognition

2018 Climate Leadership Award

IBM received a 2018 Climate Leadership Award for Excellence in Greenhouse Gas Management Goal Achievement from the Center for Climate and Energy Solutions and The Climate Registry, in partnership with Bloomberg Philanthropies. The 2018 award recognized IBM for attaining its third-generation greenhouse gas emissions reduction goal—a goal it exceeded four years early. This is the sixth time IBM has been recognized in the award program’s seven-year history.

Smart Energy Decisions Innovation Award

IBM received a Smart Energy Decisions Innovation Award in the Customer Project awards category for Energy Data Management. This award, in the inaugural year of the program, recognized our internal deployment of IBM’s Smarter Buildings solution, which combines IBM’s real estate management, software and services expertise with analytics to detect faults in building mechanical systems in nearly real time, identifying optimization opportunities and yielding enhanced building performance and efficiency.

2017 Energy Management Insight Award

IBM received a 2017 Energy Management Insight Award from the Clean Energy Ministerial, a global forum sponsored by 24 national governments and the European Commission that promotes policies and programs to advance clean energy. IBM earned the award for producing a case study to share insights on the process and benefits of setting up an energy management system certified to the global ISO 50001 standard.

Austin Green Business Leaders Program — Platinum Level

IBM Austin, Texas, was recognized in the Austin Green Business Leaders Program at the highest level, Platinum. The city of Austin created the program to support Austin businesses and their pursuit of sustainability. Businesses that excel in the program are recognized as Silver, Gold or Platinum based upon scores in these seven categories: communication and outreach, resource management, water, energy, healthy work environment, transportation, and community stewardship.

Colorado Environmental Leadership Program — Gold Leader

IBM Boulder, Colorado, was recognized as a Gold Leader in the Environmental Leadership Program by the Colorado Department of Public Health and Environment. The award recognizes IBM Boulder’s environmental management system, environmental goals and record of compliance. There are Gold, Silver and Bronze award tiers, each with unique requirements and expectations. The Environmental Leadership Program is a voluntary initiative recognizing Colorado entities that go beyond compliance with environmental regulations and reach toward the goal of sustainability.

Sustainable Manufacturing Award

IBM received the Sustainable Manufacturing Award in the Manufacturing Leaders Awards 2017. The award recognizes a company’s commitment to sustainable practices: impacting change, transforming processes and introducing policies that ensure the ongoing practice of sustainable manufacturing.

IBM has received six Climate Leadership Awards in seven years.

Class of Excellence Wastewi\$e Label — Hong Kong

IBM Hong Kong received the Class of Excellence Wastewi\$e label for our commitment to environmental protection and waste reduction in the Hong Kong Awards for Environmental Excellence.

Clean Industry Recertification — Mexico

IBM Mexico earned the PROFEPA (Mexico's Federal Environmental Protection Agency) "Industria Limpia" ("Clean Industry") recertification. PROFEPA grants this certification to companies that demonstrate full compliance with Mexican environmental regulations. IBM Mexico has been certified under PROFEPA's Clean Industry Program since 2005.

2017 Outstanding Energy Efficiency Award — Philippines

IBM Philippines received its third consecutive Outstanding Award from the Philippines' Department of Energy in the 2017 Don Emilio Abello Energy Efficiency Awards for energy savings and CO₂ emissions avoidance.

Performance summary

IBM maintains goals covering the range of its environmental programs including climate protection, energy and water conservation, pollution prevention, waste management and product stewardship. These goals, identified below as key performance indicators (KPIs), and our performance against them are discussed in this report.

Energy conservation KPI

IBM’s goal is to achieve annual savings equal to 3.5 percent of IBM’s total energy use in IBM-managed space. In 2017, IBM again surpassed its goal by attaining a 4.2 percent savings from energy conservation projects.

Energy conservation	2013	2014	2015	2016	2017
As % of total energy use	6.7	6.7	6.3	5.3	4.2

Renewable electricity procurement KPI

IBM’s renewable electricity procurement goal is to purchase 20 percent of our electricity consumption at IBM-managed space from renewable sources by 2020, over and above the quantity of renewable energy provided as part of the mix of electricity that we purchase from the grid. In 2017, IBM contracted with its utility suppliers to purchase approximately 779,000 megawatt-hours of renewable electricity, representing 22.9 percent of our global electricity consumption and once again exceeding our goal.

Renewable electricity procurement	2013	2014	2015	2016	2017
As % of total electricity purchases	11.8	14.2	16.2	21.5	22.9

CO₂ emissions reduction KPI

Our third-generation CO₂ emissions reduction goal is to reduce CO₂ emissions associated with energy consumption at IBM-managed locations 35 percent by year-end 2020, against base year 2005 and adjusted for acquisitions and divestitures. In 2017, IBM once again exceeded this goal having reduced its operational CO₂ emissions by 42.9 percent against the 2005 baseline.

CO ₂ emissions reduction	2013	2014	2015	2016	2017
As % of 2005 baseline CO ₂ emissions	24.7	27.7	28.7	38.1	42.9

Water conservation KPI

IBM established a new water conservation goal to achieve year-to-year reductions in water withdrawals at 45 data centers and other large IBM locations in water-stressed regions in 2016. In 2017, IBM reduced water withdrawals at these locations by 2.9 percent from 2016.

Water conservation	2016	2017
% annual reduction in water withdrawals at data centers and other large IBM locations in water-stressed regions	6.6	2.9

Nonhazardous waste recycling KPI

Our goal is to send an average of 75 percent (by weight) of the nonhazardous waste generated at locations managed by IBM to be recycled. In 2017, we recovered and sent 87.8 percent of our nonhazardous waste to be recycled.

Nonhazardous waste recycling	2013	2014	2015	2016	2017
% by weight sent for recycling of total generated*	86.0	85.9	85.2	86.3	87.8

* Excludes sanitary wastewater transported to publicly owned treatment systems

Product energy efficiency KPI

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. In 2017, IBM released its POWER9-based Power Systems Accelerated Compute (AC922) server for high-performance computing analytics and artificial intelligence. When compared to comparable IBM POWER8 products, IBM POWER9-based servers have Server Efficiency Rating Tool (SERT) weighted geomean active efficiency scores up to three times higher—which represents three times the performance or work delivered without any increase in power use. The SERT was created by the Standard Performance Evaluation Corporation (SPEC). IBM also introduced its next-generation mainframe, the IBM z14 server, in 2017. On average, the IBM z14 server delivers 23 percent or more work per kilowatt depending on the choice of components and cooling method.

ENERGY STAR certified products KPI

IBM has a goal to qualify its new server and storage products to the U.S. Environmental Protection Agency’s (EPA) ENERGY STAR program criteria where practical, and where criteria have been developed for the specific server or storage product type. In 2017, IBM certified select configurations of the IBM Storwize V7000 storage product to Version 1 of the ENERGY STAR data center storage requirements. None of the server products IBM released during 2017 was subject to ENERGY STAR criteria.

As of May 2018, IBM had five Power Systems servers and seven storage products certified to the ENERGY STAR requirements. The Power Systems servers meet the EPA’s requirements for power-supply efficiency, idle power limits or power management capability, and SPEC SERT metric data reporting. The storage products meet requirements for power-supply efficiency and reporting of the Storage Networking Industry Association Emerald Power Efficiency Measurement Specification results.

Product end-of-life management KPI

IBM’s goal is to reuse or recycle end-of-life IT products such that the amount of product waste sent by IBM’s product end-of-life management (PELM) operations to landfills or incineration for treatment does not exceed a combined 3 percent (by weight) of the total amount processed. In 2017, IBM’s PELM operations sent only 0.7 percent of the total processed to landfill or incineration facilities for treatment.

Product end-of-life management	2013	2014	2015	2016	2017
% by weight of total processed sent by IBM’s PELM operations to landfill or incineration for treatment	0.3	0.5	0.7	0.6	0.7

IBM environmental affairs policy

IBM is committed to environmental affairs 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.

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IBM Corporate Environmental Affairs and Product Safety
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Produced in the United States of America
June 2018
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