2015

IBM and the Environment Report

A message from the Vice President, Corporate Environmental Affairs & Product Safety, Wayne Balta

Over the last couple of years, IBM has been transforming itself for high-value innovation that meets the changing needs of its clients. Transformation is nothing new to IBM. The company has previously transformed itself through multiple eras of technology and through different economic cycles.

We have recently divested commoditizing businesses (including IBM's former x86 server business and semiconductor manufacturing operations) while we have vastly accelerated the growth of strategic imperatives — Data and Analytics, Cloud, Mobile, Social, and Security. All of this has occurred as we not only help clients become digital, but also as we lead the convergence of digital business with digital intelligence. This is epitomized by Watson, and we call it Cognitive Business. Today, our solutions are cognitive and our platform is cloud.

Much about IBM is clearly changing. What is not changing, however, is IBM's commitment to global environmental leadership. This report marks IBM's 26th annual Corporate Environmental Report going back to 1990. That itself is the outcome of a steadfast commitment which has stood the test of time and endured throughout many prior changes, both within our industry and across global societies and economies. Here is a preview of what you'll find in this year's report.

In 2015, IBM's energy conservation projects delivered savings equal to 6.3 percent of our annual energy use, surpassing our goal of 3.5 percent. These projects avoided the consumption of 272,000 megawatt-hours (MWh) of electricity and 172,000 million British thermal units (MMBtu) of fuel oil and natural gas, representing the avoidance of 122,000 metric tons of carbon dioxide (CO_2) emissions. They also saved $28.9 million in energy expense. Between 1990 and 2015, IBM saved 7 million MWh of electricity consumption, avoided 4.3 million metric tons of CO_2 emissions (equal to 63 percent of the company's 1990 global CO_2 emissions), and saved $579 million through its annual energy conservation actions.

We sent 85 percent of the approximately 53,000 metrics tons of nonhazardous waste generated by IBM worldwide to be recycled, and processed 29,800 metric tons of end-of-life product waste while sending only 0.7 percent to landfills or incineration for treatment. However, having achieved these and other significant goals related to our internal operations, we recognize that our greatest opportunities to contribute to the sustainability of our planet lies in our ability to use our products and solutions to address the challenges of our clients and the world.

Today, IBM is the world's foremost cognitive computing and cloud platform company. Through our products and solutions we can help our clients improve their efficiency, conserving energy, water and other resources, and we can help governments address complex environmental problems such as climate change and air and water pollution. Whether using advanced machine learning and Internet of Things technologies to improve prediction of air pollution, or analyzing enormous amounts of data from remote sensors to generate new insights for protecting lakes and other freshwater sources, or using vast amounts of weather data to help forecast power generation at wind farms, IBM technologies are at the forefront of many of the world's sustainability efforts.

This report highlights some of these technologies, along with results from IBM's wide-ranging environmental programs. I hope you enjoy reading it. As you do, please know that following more than a century of accomplishment, innovation, and transformation, IBM endeavors to be one of the world's most essential companies and pursues that journey with a continual commitment to environmental leadership.

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

Commitment to environmental leadership

IBM's corporate environmental programs date from the 1960s. In 1971, IBM CEO Thomas J. Watson Jr. formalized the company's commitment with our Corporate Policy on IBM's Environmental Responsibilities. Updated a number of times over the years, that policy and the breadth of environmental programs supporting it have defined and driven IBM's long-standing commitment to environmental leadership in all of our business activities.

Throughout our operations — whether conserving energy in our data centers; developing environmentally preferable materials for use in our research, development and manufacturing processes; designing products with environmental considerations; or applying our products and solutions to solve environmental problems and advance sustainability — we have seen first-hand what can be achieved with a sustained focus on all aspects of the environment.

- Since 1990, IBM's energy conservation actions have saved 7 million megawatt-hours (MWh) of electricity consumption, avoided 4.3 million metric tons of carbon dioxide (CO_2) emissions and saved the company $579 million.
- In 2015, we established our third-generation CO_2 emissions reduction goal, further building on more than 20 years of sustained results in this area.
- For more than four decades, we have demonstrated leadership by prohibiting or restricting substances of concern from our processes and products before regulatory requirements were imposed.
- From 1995 through the end of 2015, IBM documented the collection and processing of approximately 2.15 billion pounds of end-of-life products and product waste worldwide.
- Our cognitive solutions, delivered on a cloud platform, are helping clients discover how they can operate more efficiently and become more sustainable.

With the new cognitive era upon us — one that combines digital business with digital intelligence — we are discovering and developing cognitive-based technologies to help address our world's environmental and sustainability challenges. We are able to assess air emissions sources and profiles to recommend cost-effective approaches to reduce pollution in real time, forecast and balance energy demand and production to minimize CO_2 emissions associated with electricity generation, and explore better ways to identify less toxic materials to use in products. And this is only the beginning. The combination of cognitive and Internet of Things technologies can be a difference-maker in addressing our world's environmental and sustainability challenges. It is indeed an exciting time, and we are proud to share highlights of our work with you.

Global governance and management system

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

Global environmental management system

Our corporate environmental affairs policy objectives range from workplace safety, conserving natural resources, pollution prevention, and energy conservation and sourcing, to product design for the environment and the application of IBM's technology and expertise to help address some of the world's most pressing environmental problems.

IBM's corporate environmental affairs policy calls for environmental affairs leadership in all of the company's business activities. This leadership is achieved through implementation of a global environmental management system (EMS) that 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 global EMS that IBM ensures operations are executed with the same protective standards for the environment in every country where business is conducted. Highlights of our management system and resulting environmental performance are outlined throughout the sections that follow.

Employee and management responsibility

As noted in IBM's Business Conduct Guidelines, all IBMers have a role to play in protecting the environment. IBM's corporate policy on environmental affairs and its supporting global EMS provide more specific detail on IBM's environmental requirements. 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.

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 impacts of our operations and to drive continual improvement of our environmental performance, including goals on energy and water conservation, renewable electricity sourcing, 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 listing of IBM's environmental key performance indicators.

ISO 14001 standard on environmental management systems

In 1997, IBM became the first major multinational company to earn a single global registration to the International Organization for Standardization (ISO) 14001 environmental management systems 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, first issued in 1971, and the early implementation of our environmental management programs.

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.

IBM is currently working to update its management system to achieve conformity with the recently issued ISO 14001:2015 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. Over the intervening years, we 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 set forth a strategy 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.

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 programs under IBM's single global ISO 50001 certification. As of year-end 2015, 16 entities were registered under IBM's global ISO 50001 accreditation — 12 in the Americas, three in Europe and one in the Asia Pacific region.

Public disclosure

IBM's Corporate Policy on Environmental Affairs also calls for the company to publicly disclose information on our environmental programs and performance. This report marks IBM's 26th consecutive year of annual corporate environmental reporting.

In addition to providing information on our environmental programs and performance in this report, we provide a report based on the Global Reporting Initiative and supply information through a number of other voluntary reporting programs and tools, 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

IBM has a variety of outreach programs to engage various groups and individuals on the subject of the environment. Our community outreach programs range from open houses and emergency preparedness drills with local organizations, to the support of and participation in local environmental projects and environmental education efforts.

IBM also has ongoing dialogues with many stakeholders. Engaged stakeholders include socially responsible investors and other shareholders, environmental nongovernmental organizations (eNGOs), governments, employees, clients, suppliers and others. We consider these relationships to be very valuable, as they allow us to share ideas and obtain various perspectives, input and feedback regarding our programs, activities and performance. They also inform our reporting, enabling us to better meet the information needs of a wide variety of interested people and entities.

IBM Stockholder Relations holds an annual call and webcast for financial analysts, in which executives from a range of IBM organizations are available to discuss all aspects of our corporate responsibility programs and performance, including environment.

Another example of engagement is collaborative innovation. We believe that integrating different expertise and unique perspectives can accelerate new solutions to long-standing problems. You will find examples of IBM's collaborative innovation — in research and solutions, with business partners, clients, universities and other entities — throughout this report and in the section on solutions for environmental sustainability on page 34.

Voluntary partnerships and initiatives

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

Some current governmental examples include the U.S. Environmental Protection Agency's (EPA) ENERGY STAR and SmartWay programs, the European Union (EU) ENERGY STAR program, and the EU Code of Conduct for Energy Efficiency in Data Centres.

Examples of partnerships with eNGOs include our membership in the Center for Climate and Energy Solutions, our participation in Best Workplaces for Commuters, and our collaboration with The Nature Conservancy and the World Resources Institute. We also work with and support organizations such as The Conservation Fund, the Environmental Law Institute and the World Environment Center.

In addition, we partner with other companies and institutions to foster solutions for environmental sustainability.

Two examples of IBM's voluntary partnerships and initiatives are:

- IBM has been a long-standing member of the Wildlife Habitat Council (WHC) and promotes habitat conservation and management. Four IBM sites in the United States have had their land management and wildlife habitat programs certified by the WHC — our corporate headquarters in Armonk, New York; IBM's Research Triangle Park (RTP) site in North Carolina; and two sites in San Jose, California: IBM Research–Almaden and our Silicon Valley Laboratory. Following are highlights of some projects and activities in 2015:
  - At IBM Research–Almaden, IBM partnered with a local beekeeper to bring six beehives to the orchard located on-site. Millions of bees are dying off, with alarming consequences for the world's environment and food supply. We rely on bees to pollinate everything from almonds to strawberries to the hay used to feed dairy cows. By working with the beekeeper, IBM is hoping to help pollinate the native plants in the area and to restore a bee population devastated in the past few years.
  - At our RTP site, IBM partnered with local Eagle Scouts to build a self-guided, interpretive nature trail with guideposts identifying species encountered along the trail. Employees also worked with the local Boy Scouts to sink approximately 20 employee-donated Christmas trees into the site's 3-acre pond to improve the fish habitat. During nesting season, employees help monitor the site network of 40 bluebird houses. The first houses were established in 2001 to provide a habitat as the numbers of bluebirds were sharply declining due to the rise in development activity in the area.
- In 2014, IBM and AECOM, a global engineering company, completed a collaborative effort with the publication of a Disaster Resilience Scorecard for the United Nations based on the U.N.'s "10 Essentials for Making Cities Resilient." Since then, the scorecard has been updated a number of times and deployed by many cities around the world. The scorecard is designed to facilitate iterative assessments of, and drive continual improvements in, an organization's resilience to disasters and other forms of impacts such as climate change. It is available in the public domain and can be used free of charge by any organization, including communities, governments and corporations. The Disaster Resilience Scorecard was awarded a 2015 ND-GAIN Corporate Adaptation Prize by the University of Notre Dame Global Adaptation Index.

Environmental investment and return

Over the past five years, IBM has spent $82.3 million in capital and $456.1 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

($ in millions)

	2011	2012	2013	2014	2015
Capital	$18.4	$9.9	$17.0	$20.3	$16.7
Expense	$96.1	$98.2	$92.3	$86.4	$83.1
Total	**$114.5**	**$108.1**	**$109.3**	**$106.7**	**$99.8**

IBM has tracked environmental expenses related to our facilities, corporate operations and site remediation programs for more than 25 years, and began publicly disclosing this information in our environmental report for 1992. In 2015, the total environmental spending associated with IBM's operations was $99.8 million.

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

In addition, IBM realizes avoidance of costs that likely would occur in the absence of its environmental management system. These savings are not measurable in the same way that expenses are, but avoiding these environmental costs does result in savings for IBM and a reasonable attempt has been made to estimate them. In 2015, IBM's combined, estimated environmental savings and cost avoidance worldwide totaled $114.1 million.

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

2015 environmental expenses worldwide

($ in millions)

Personnel	32.5
Superfund and former IBM site remediation	20.3
Waste treatment and disposal	6.4
Surface water and wastewater management operations	5.6
Waste and materials recycling	5.4
Consultant and legal fees	2.5
Laboratory fees	1.5
Groundwater protection operations	1.0
Permit fees	0.7
Product takeback and recycling costs	0.6
Air emission control operations	0.2
Other environmental operations	6.4
Total	**83.1**

2015 estimated environmental savings and cost avoidance worldwide

($ in millions)

Energy conservation and cost avoidance	54.2
Location pollution prevention operations	24.4
Compliance cost efficiency*	16.6
Corporate operations**	5.6
Spill remediation cost avoidance***	4.9
Packaging improvements	4.3
Potential fines, penalty and litigation avoidance****	2.1
Superfund and site remediation efficiencies	2.0
Total	**114.1**

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

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

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 on the part of IBM's organizations. For 25 years, the Chairman's Environmental Award has promoted the contributions of IBM's business units toward the objectives of IBM's Corporate Policy on Environmental Affairs.

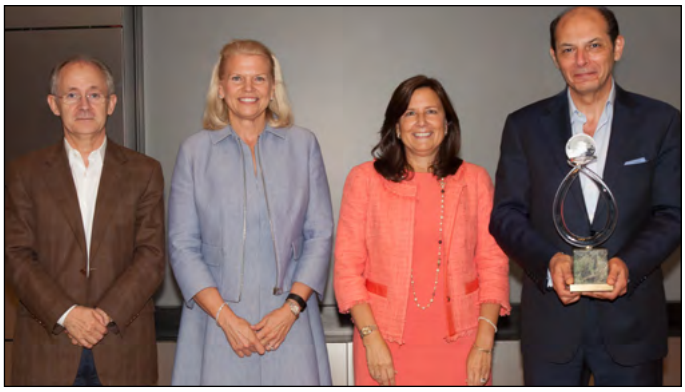
Recipients of the Chairman's Environmental Award are selected based on their degree of leadership, initiative and results in contributing to IBM's environmental affairs policy objectives. Performance against these criteria is evaluated against each nominee's opportunity to contribute given its mission and operations. IBM's chairman presents the award to an executive from the recipient business unit at a gathering of IBM senior executives from all business units.

IBM's Sales and Distribution (S&D) organization received the 2015 Chairman's Environmental Award. This organization delivers value by understanding clients' business needs and bringing together capabilities from across IBM to develop and provide innovative solutions leveraging cloud, analytics, mobile and social, underpinned by security. During the three years covered by the Chairman's Environmental Award nomination, S&D engaged with more than 30 clients across 14 countries on a diverse set of challenges involving the environment, bringing together IBM's expertise in business and technology to implement leading-edge solutions, including:

- The Green Horizons initiative in China, targeting the critical issues of air quality, renewable energy forecasting and energy optimization
- A new information control center in São Paulo, Brazil, built on IBM intelligent transportation technology, to analyze data from 4,000 miles of highways for improved traffic flow and reduced air emissions
- An analytics project in Kenya to better understand the health and sustainability of groundwater resources by identifying illegal bore holes and indiscriminate dumping of poorly treated wastewater
- A Smarter Energy® Solutions project in the city of Setouchi, Japan, supporting that country's largest solar power project
- IBM's Building Management Center solution at a major private engineering university to harness data and analytics delivered via cloud computing for more energy-efficient building management

S&D also leveraged IBM programs such as Smarter Cities Challenge®, People4SmarterCities.com and blogs to promote environmental awareness, education and social collaboration among our clients.

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.



Left to right: Erich Clementi, senior vice president, Sales and Distribution (S&D), Ginni Rometty, IBM chairman, president and CEO, Colleen Arnold, senior vice president, S&D, and Bruno Di Leo, senior vice president, S&D.

Energy conservation and climate protection

IBM recognizes 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 all sectors of society and the economy, as well as governments worldwide, must participate to address 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 low carbon dioxide (CO_2)-emitting and 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, and reduction plans
4. Reducing employee commuting and business travel
5. Increasing the efficiency of IBM's logistics operations

In addition, for our hardware and software products and services, IBM's strategy includes designing and providing clients with energy-efficient solutions that also help reduce their climate impact.

IBM considers energy and materials conservation to be the cornerstone of our climate protection efforts. IBM does not have plans to use emissions offsets to become "carbon neutral" for all or part of 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.

IBM divested its semiconductor manufacturing business on July 1, 2015, eliminating the use and emissions of perfluorinated compounds and other GHGs associated with manufacturing operations.

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 CO_2 by utility companies powering our facilities, or from our use of fuel for heating or cooling, represents the greatest potential climate impact associated with our operations.

In 2015, and including the contribution from our semiconductor manufacturing operations, IBM's energy conservation projects across the company delivered annual savings equal to 6.3 percent of our total energy use, versus the corporate goal of 3.5 percent.

These projects saved and avoided the consumption of 272,000 megawatt-hours (MWh) of electricity and 172,000 million British thermal units (MMBtu) of fuel oil and natural gas, and an associated 122,000 metric tons of CO_2 emissions. The conservation projects also saved $28.9 million in energy expense. These strong results are due to our continued, across-the-board focus on energy demand reduction, efficiency, and the implementation of standard, global energy conservation strategies at our facilities.

Excluding the contribution from our semiconductor manufacturing operations, our 2015 energy conservation savings were 264,000 MWh of electricity, 150,000 MMBtu of fuel and $28.1 million, with an avoidance of 119,000 metric tons in CO_2 emissions. The associated energy conservation projects delivered annual savings equal to 6.9 percent of our adjusted energy use.

IBM's energy conservation goal recognizes only completed projects that actually reduce or avoid the consumption of energy in our operations. Reductions in energy consumption from downsizings, 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 conservation results cited above are conservative in that they include only the first year's savings from the projects. Ongoing conservation savings beyond the first year are not included in the results. Accordingly, the total energy savings and CO_2 emissions avoidance from these conservation actions is actually greater than this simple summation of the annual results.

6.3%

In 2015, and including the contribution from our semiconductor manufacturing operations, IBM's energy conservation projects delivered annual savings equal to 6.3 percent of its total energy use — surpassing our goal of 3.5 percent.

7m MWh

From 1990 through 2015, and including semiconductor manufacturing operations, IBM conserved 7 million MWh of electricity, avoiding 4.3 million metric tons of CO_2 emissions and saving $579 million.

Electricity and fuel use and related CO_2 emissions

Scope 1 and Scope 2 CO_2 emissions

		CO_2 emissions (estimated) metric tons x 1,000	
	Electricity and fuel use (1,000 MMBtu)	Calculated with grid emissions factors	Reduced by the CO_2 avoided by renewable electricity purchases
2015	17,974	1,836	1,584
2014	20,842	2,092	1,842
2013	21,190	2,186	1,962
2012	21,613	2,404	2,195
2011	21,758	2,397	2,182

Notes: (1) The 2015 inventory has not been calculated in accordance with the GHG Protocol Scope 2 Guidance, issued in 2015, to enable consistent year-to-year comparisons. (2) Figures in this table include energy consumption and CO_2 emissions associated with our semiconductor manufacturing operations.

Between 1990 and 2015, and including semiconductor manufacturing operations, IBM saved 7 million MWh of electricity consumption, avoided 4.3 million metric tons of CO_2 emissions (equal to 63 percent of the company's 1990 global CO_2 emissions), and saved $579 million through its energy conservation actions.

Managing IBM's energy program

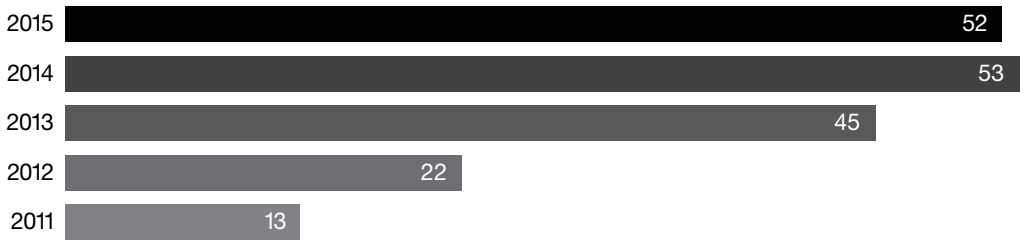
Our global energy management program leverages the expertise of more than 50 IBM energy management professionals deployed around the world. The team has created best-practices checklists that set minimum expectations for building systems and operations, including controls and equipment for lighting, heating/ventilating/air conditioning (HVAC), central utility plants, compressed air, data center and information technology (IT) systems, cafeterias and office systems.

All IBM locations using 2,000 MWh/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 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. These analyses enable monthly metrics reporting to management and the identification of opportunities for improvement. The continuous review of energy use and conservation performance has driven the strong results noted above.

More than 2,100 energy conservation projects involving a range of energy efficiency initiatives delivered savings by 312 IBM locations globally in 2015. Examples include:

- Projects to match building lighting and HVAC with occupancy schedules, or upgrade equipment efficiency through recommissioning equipment or installation of new equipment, were implemented at 223 locations, reducing energy use by 73,100 MWh and saving $5.4 million.
- Central utility plant projects were implemented at 52 locations, reducing energy use by 37,500 MWh and saving $2.3 million.
- Energy benchmarking analyses of office locations were conducted across geographic regions. Comparisons were made among similar IBM locations and with publicly available benchmarks. Locations with energy consumption of more than 100,000 Btu per square foot (100 kBtu/ft^2) are required to establish and execute an action plan beyond any work already done to reduce energy use and cost. Since 2013, the median energy consumption per square foot for all office locations has been reduced by 15.5 percent.
- Data center cooling projects and server and storage virtualization and consolidation projects saved nearly 157,700 MWh of electricity consumption and $16.7 million.

Analytics-enabled energy conservation projects*
(% of projects using analytics)



*Energy conservation projects at IBM's top 10 energy consuming sites

Applying analytics to drive further efficiencies

The IBM energy management and data center teams are expanding their use of analytics to minimize energy use and optimize operating performance. Over 50 percent of 2015 conservation projects executed at IBM's top 10 energy consuming sites utilized analytics to drive energy savings. The lessons learned at these larger sites are being transferred to other IBM locations.

IBM's TRIRIGA® Real Estate Environmental Sustainability (TREES) Impact Manager has been deployed at more than 145 buildings (representing 45 percent of IBM's global energy consumption) realizing savings of 32,300 MWh of energy and $1.7 million in 2015. IBM has sustained an average 10 percent reduction in energy use annually since 2011 for the buildings and systems monitored and managed by the TREES solution. TREES Impact Manager is an IBM-designed software product that integrates existing controls infrastructure across a location, collecting data on an hourly basis and analyzing it for anomalies to minimize the energy consumption required to operate a building.

IBM has installed chiller optimization software (COS) at eight locations. COS balances the operation of all the system components under its rules, maximizing cooling delivery while minimizing energy use. Deployment of COS saved IBM 6,000 MWh of energy and $0.4 million in 2015, and has realized annualized savings of 49,000 MWh and more than $4.4 million at the eight locations, including the semiconductor manufacturing locations, where it has been deployed beginning in 2011.

$2.6m

325 energy conservation projects at more than 100 data center locations reduced cooling energy use by almost 25,800 MWh in 2015, saving over $2.6 million.

Data centers

IBM manages a diverse portfolio of data centers, consisting of both IBM-owned and IBM-managed facilities (for IBM and customers) worldwide. IBM operates additional IT lab raised-floor spaces that support internal hardware and software development and testing operations.

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

In 2015, we completed 325 projects to improve cooling efficiency at more than 100 existing data center locations, reducing energy use by almost 25,800 MWh while saving over $2.6 million. Actions IBM took in 2015 include:

- Installed thousands of blanking panels and cable cutout plugs, reducing the mixing of hot and cold air and increasing cooling efficiency within data centers.
- Increased the average temperature of raised-floor space by 0.5 degrees Celsius. For the period 2011-2015, IBM increased the average raised-floor temperature by 2.5° C with work continuing to further raise temperatures toward an average of 24° C.
- Shut down additional computer room air conditioning (CRAC) units, reducing energy use. IBM shut down more than 33 percent of total installed CRAC units from 2010 to 2015.

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

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IBM data centers in 18 countries are registered under the EU Code of Conduct for Energy Efficiency in Data Centres.

Data center power usage performance

IBM measures or uses estimating protocols to determine the power usage effectiveness (PUE) at many of the data centers we manage. PUE is the ratio of the total energy consumed by the data center, divided by the energy consumed by the IT equipment. The closer the value is to 1, the more efficient the cooling delivery. Using data collected from 63 percent of IBM data center and IT lab raised-floor space, we calculated our average PUE by aggregating the total energy consumption of these spaces during 2015 and dividing it by the aggregated energy consumption of the IT equipment in the same space for the same period.

The average PUE for IBM's raised-floor space is 1.71, the same as 2014, with a range of 1.4 to 3.2. Data centers are highly complex systems that experience changes in equipment layout and type as clients move in and out of the data center and decrease or increase their IT workload, and as existing server, storage and network equipment is replaced or refreshed with new technologies. Depending on how cooling delivery is adjusted in response to these changes, PUE can increase or decrease. In 2015, gains made in increased temperatures were offset by equipment type and layout changes, causing the PUE to remain constant year-to-year.

Because the majority of the data centers in IBM's portfolio consist of spaces that are between 10 and 30 years old and contain IT equipment varying in age from new to 10 years, improving the energy efficiency of these data centers requires thoughtful planning and execution to meet operational objectives and commitments to clients.

The overall performance of IBM data centers is comparable to the average PUE of 1.7 as reported in the Uptime Institute 2014 Data Center Industry Survey of 1,000 data center users predominately located in North America, and compares favorably with the average PUE of 2 as reported by a February 2014 Forrester Consulting Survey commissioned by Digital Realty Trust. 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 three years, we have registered additional data centers, bringing the total number of data centers participating in this program to 39 in 18 countries. Year-to-year, the number of IBM-registered data centers decreased from 46 to 39 because we consolidated some and closed others. IBM's registered data centers represent the largest portfolio from a single company to receive the recognition to date. The registered locations include more than 70 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 in the U.S. Environmental Protection Agency's ENERGY STAR and The Green Grid (industry collaboration) data center energy efficiency initiatives. These programs set operating criteria or 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.

IBM continues to virtualize and consolidate workloads from multiple servers and storage systems with low utilization onto single systems, reducing energy use and expense. In 2015, IBM virtualized more than 30,000 applications and increased the capacity utilization of storage systems in our owned and leased data centers, avoiding almost 132,000 MWh and $14 million in energy expense. Implementation of server and storage virtualization has been a key contributor in reducing the overall electricity consumption of our data centers over the past four years.

IBM is also expanding its cloud computing offerings. At year-end 2015, SoftLayer®, an IBM company, and IBM's Cloud Managed Services operated 46 data centers in 16 countries worldwide. Cloud computing can be an efficient model for providing IT services that optimize hardware utilization and virtualization technologies across the server, storage and network infrastructure.

Renewable energy

In 2015, and including our semiconductor manufacturing operations, IBM contracted with its utility suppliers to purchase over 679,000 MWh of renewable electricity over and above the quantity of renewable energy provided as part of the mix of electricity that we purchased from the grid. This amount represented 16.2 percent of our global electricity purchases and resulted in the avoidance of 252,000 metric tons of CO_2 emissions.

Our contracted renewable electricity purchases as a percent of our global electricity consumption increased by over 2 points, year-over-year. These results move the company toward meeting its goal to procure electricity from renewable sources for 20 percent of IBM's annual electricity consumption by 2020.

16.2%

Contracted renewable energy represented 16.2 percent of IBM's global electricity purchases in 2015, including our semiconductor manufacturing operations, or 679,000 MWh.

Excluding semiconductor manufacturing operations, IBM contracted for 660,000 MWh of renewable electricity over and above the quantity of renewable energy provided as part of the mix of electricity that we purchased from the grid. The 660,000 MWh represented 17.5 percent of IBM's adjusted global electricity consumption.

IBM's contracted renewable electricity purchases occurred in 18 countries: Australia, Austria, Belgium, Brazil, Denmark, Finland, France, Germany, India, Ireland, Italy, Netherlands, Spain, Sweden, Switzerland, Taiwan, United Kingdom and the United States. As a result of these purchases, approximately 30 percent of IBM's locations with data centers or IT labs, and 29 percent of our cloud data centers, currently obtain some or all of their electricity from our contracted renewable-generation sources.

IBM procures 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 — be they from new, "additional" or existing generation sources, and without discriminating against large hydro installations — and their associated CO_2 avoidance. Our rationale is that all purchases signal to our 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.

Our procurement of renewable energy must meet our business needs. Not only should the offerings be cost-competitive with market prices over time, but also, the electricity supply must be reliable in providing uninterrupted power for our critical operations. IBM's strategy of contracting for defined renewable energy has been most successful in Europe, although we substantially increased our contracted purchases in Brazil and India during 2015. We continue to request the inclusion of electricity generated from renewable sources as an option in our contracts in all geographies.

Procuring electricity from renewable sources remains complicated by the relatively low energy density and intermittent nature of wind- and solar-generated electricity; limitations and choke-points in the electricity transmission system; and by international treaties and national, state, and local regulatory and legislative requirements. Continued advances are needed in renewable electricity generation, distribution systems, grid management and storage technologies, as well as in contracting and delivery mechanisms to truly increase the availability of economically viable renewable electricity in the marketplace and supply it directly to consuming locations.

We are pursuing a range of options to further increase our renewable electricity purchases. IBM is working with industry peers, utilities, nongovernmental organizations and other renewable-energy industry participants to identify, develop and capture opportunities to procure electricity generated from renewable sources. The current environment of low natural gas prices in North America, and the associated low electricity prices, make almost all currently available renewable power purchase contracts uneconomical, but we are continuing to work to find opportunities to procure renewable electricity that make business sense.

In addition to our contracted renewable electricity purchases, 16.2 percent of IBM's electricity purchases from the grid were generated from renewable sources (5.6 percent from non-hydro and 10.6 percent from hydro generation sources) — bringing our total renewable electricity purchases to 32.4 percent of our global consumption in 2015. These figures include the semiconductor manufacturing operations. Excluding the semiconductor manufacturing operations, IBM's total renewable electricity purchases equaled 33.7 percent (17.5 percent directly contracted by IBM plus 16.2 percent via grid purchases) of the company's adjusted global energy consumption.

IBM also endeavors to incorporate co-generation, tri-generation and fuel cell systems at individual locations where it makes business sense. Three facilities in Europe have co-generation/tri-generation systems that provide electricity, heating and cooling to support building operations. In addition, one U.S. location has a fuel cell system that provides electricity. In all four cases, the systems provide 10-20 percent of facility energy use. These systems utilize over 60 percent of the energy value of the input fuel, compared to 25-40 percent utilization of the energy inputs for electricity purchased from the grid.

Research and solutions to advance the use of renewable energy

In addition to procuring renewable energy for our own use, IBM is working to further the availability and affordability of renewable energy by investing in IT-related research and development. IBM has used advanced cognitive computing and Internet of Things (IoT) technologies, combined with world-class analytics, to create some of the world's most accurate energy forecasting systems, improve the management of the electric grid and enable the dispatch of higher quantities of renewable electricity to the grid. In 2015, IBM announced the expansion of its Green Horizons initiative with a range of projects and collaborations involving the deployment of intelligent grid and distributed generation management systems around the globe. For additional information, see the solutions for environmental sustainability section on page 34 of this report.

These projects make significant improvements in the availability of renewable electricity on the electric grid. The combination of weather and demand forecasting with the optimization of renewable electricity delivery, coupled with the minimization of conventional reserves necessary for grid reliability, can increase the dispatch of renewable electricity to the grid while reducing the overall grid CO_2 emissions factor. The environmental benefits resulting from IBM's investment in these technologies, which are in use in over 30 projects worldwide, exceed the benefits from isolated large purchases of renewable electricity by fundamentally enhancing the quantity and availability of renewable electricity from existing and planned projects.

Operational CO_2 emissions management

IBM's CO_2 emissions associated with the use of fuel and electricity at its locations were reduced 6 percent from 2014 to 2015 (when the energy use from the divested semiconductor manufacturing business from January through June 2015 is excluded). There were three main factors that drove this reduction:

1. Energy conservation actions and a reduction in our energy consumption drove a 62,000 metric ton (MT) reduction in CO_2 emissions. This represents an approximate 4 percent reduction in our overall CO_2 emissions.
2. The average CO_2 emissions factor associated with our grid-supplied electricity reduced by over 0.005 MT/MWh, reducing CO_2 emissions by 22,000 MT. This represents a 1.5 percent reduction in our overall CO_2 emissions.
3. An increase in renewable energy purchases avoided 8,000 MT of CO_2 emissions — an approximate 0.5 percent year-over-year reduction.

6%

IBM's operational CO_2 emissions associated with the use of fuel and electricity at our locations were reduced by 6 percent from 2014 to 2015, excluding the semiconductor operations.

28.7%

IBM's 2015 CO_2 emissions were reduced by 28.7 percent versus the 2005 baseline, adjusted to exclude the divested semiconductor manufacturing operations, as specified in our third-generation CO_2 reduction goal.

Third-generation CO_2 emissions reduction goal

We continue to make progress toward our third-generation CO_2 emissions reduction goal: to reduce CO_2 emissions associated with our energy consumption 35 percent by year-end 2020, against base year 2005 and adjusted for acquisitions and divestitures. This goal represents an additional 20 percent reduction, from year-end 2012 to year-end 2020, over the reductions achieved from 2005 to 2012 under IBM's second-generation goal.

Adjusting the baseline to remove emissions from our divested semiconductor manufacturing operations, IBM has reduced its CO_2 emissions by 28.7 percent since 2005, and we are on track to achieve the 35 percent reduction by 2020.

Overall CO_2 emissions inventory

IBM tracks and manages Scope 1 and 2 CO_2 emissions across its operations. As discussed in the previous sections, IBM executes a range of programs and processes to reduce GHG emissions. IBM's overall Scope 1 and 2 emissions decreased by 18.8 percent from 2014 to 2015. Over 80 percent of this reduction is the result of the divestiture of IBM's semiconductor operations in July 2015. The remainder resulted from the reductions in our energy consumption and reduced emissions factors for our electricity purchases, which were discussed above. To enable consistent year-to-year comparison, the 2015 inventory has not been calculated in accordance with the GHG Protocol Scope 2 Guidance (issued in 2015). A summary of our total 2014 and 2015 emissions inventory is provided in the following table:

IBM 2014 and 2015 Scope 1 and 2 emissions inventory

(Metric tons [MT] of CO_2 equivalent, including semiconductor manufacturing operations)

Scope 1 emissions	Emissions type	2014	2015
Fuel use	Operational	226,187	187,553
Perfluorinated compounds	PFC	215,893	108,867
Nitrous oxide	Other	23,724	14,086
Heat transfer fluids	Other	83,566	30,556
HFCs	Other	7,283	12,984
Total Scope 1 emissions		556,653	354,046
Scope 2 emissions			
Electricity: Using grid and location MT CO_2/MWh emissions factors	Operational	1,847,141	1,638,067
Purchased energy commodities	Operational	34,871	36,266
Total Scope 2 emissions		1,882,012	1,674,333
Total Scope 1 and 2 emissions		**2,438,665**	**2,028,379**
CO_2 avoidance: Renewable electricity purchases	Operational	(250,345)	(252,231)
Total Scope 1 and 2 emissions adjusted for renewable electricity		**2,188,320**	**1,776,148**

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. Key contributors to this effort are IBM's two flexible work programs that are available to many employees:

- Work-at-home — Enables employees to work from a home office
- Mobile employees — Enables employees to work from home for a designated number of days each week

In 2015, 97,000 of our approximately 380,000 global employees participated in one of these programs. In the United States alone, IBM's work-at-home and mobile programs are estimated to have conserved 7.2 million gallons of fuel and avoided 56,500 MT of CO_2 emissions in 2015.

IBM is a member of the Best Workplaces for Commuters (BWC) program. Currently, 20 IBM locations in the United States, where approximately 43 percent of the company's U.S. employees report to work, are registered as BWC sites. Many locations actively work with their local or regional transit commissions to integrate IBM's programs with regional programs, increasing commuting options for our employees. Globally, many of our locations provide support for the use of public transit systems, including shuttles from locations to mass transit stations and alternate transportation or "loaner" cars for business trips during the workday.

In some countries, IBM provides leased vehicles for employees that they may use for both business and personal purposes. For these vehicles, we continue our effort to move to more fuel-efficient models by setting standard guidelines for 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 or offer more fuel-efficient vehicles.

Reducing business travel

Through the rapid adoption of the IBM Connections social business platform, collaboration via social technologies grew significantly in 2015. This included 494,000 communities, 245,000 Wikis housing 3.8 million pages with 351 million views, and 3.9 million shared files that were downloaded 163 million times. Blogs, activities and forums saw similar levels of social interaction. As a business platform, we have over 100 internal integration partners leveraging IBM Connections via their applications in a socially collaborative fashion. We also conducted 750 million minutes of online meetings during the year.

These knowledge-sharing technologies bring employees together without travel to collaborate on topics of business interest.

Efficiency of logistics

IBM is optimizing logistics operations and increasing packaging density and strength to reduce the CO_2 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.

Since 2009, 100 percent of IBM's spending on shipments of goods within the United States and from the United States to Canada and Mexico went through a SmartWay logistics provider. 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 CO_2 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. One of the areas we focus on is our suppliers' energy efficiency and climate protection programs.

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 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 establish voluntary goals in these areas, measure their performance and publicly disclose their performance against those goals. We manage this requirement through two processes: IBM's own supplier environmental management system requirements, and our membership in the Electronic Industry Citizenship Coalition (EICC).

IBM has continued to work with first-tier suppliers to further our requirement that all IBM suppliers have a social and environmental management system in place and disclose information on goals and performance. More information may be found in the environmental requirements in the supply chain section. 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 EICC Environmental Reporting Initiative, which asks EICC members and suppliers in the global electronics supply chain to measure and report key indicators on energy consumption, GHG emissions, water and waste. We believe, as do the other EICC 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. EICC and its member companies have developed education modules to assist suppliers in tracking their energy use and GHG emissions. Companies in the electronics industry share many suppliers, and the EICC GHG emissions disclosure process enables efficiency associated with information disclosure. We use the EICC reports completed by our component and parts suppliers to augment and validate our internal supplier assessment work.

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 occur during the lifecycle of a typical process or 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 are ripe for improved energy efficiency and innovation. However, IBM does not assert the specific amount of Scope 3 GHG emissions associated with our value chain. The necessary estimating assumptions and corresponding variability simply do not allow for adequate credibility, let alone calculations that could be perceived as deterministic.

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 2 emissions. Since the ultimate goal for climate protection is for global societies to achieve demonstrable reductions in actual 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 and reused to extend product life, that incorporate recycled content and environmentally preferable materials and finishes, and that can be 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 must be documented in IBM's Product Environmental Profile (PEP) tool and reviewed at various checkpoints during the development process.

Compliance management tools like the Product Content Declaration 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, Product Content Declarations (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 process

Regulatory and legislative requirements affecting electrical and electronic equipment continue to proliferate globally. Integrated within IBM's global EMS, IBM has programs — underpinned by robust processes and state-of-the-art tools — that ensure our continued compliance with worldwide environmental laws and regulations without impacting business. In 2015, we identified 127 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). In 2015, IBM automated key elements of its PCD process. For example, the PCD refresh process was automated to help ensure that PCDs are current. Additional enhancements included a help function that provides IBM's suppliers with real-time assistance should they have questions regarding IBM requirements for submission of a PCD.

IBM conducts quality audits of PCDs to drive improvements in the content of the declarations and the supporting administrative processes. The improvements in product material content data management 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 also deployed analytical tools for managing environmental compliance of products. As an example, one such tool identifies, in real time, which IBM part numbers (among thousands) are impacted by expiring exemptions for the European Union RoHS Directive. This information, coupled with supply chain information, assists engineers and procurement staff with part-number transition management to ensure compliance while avoiding a negative impact on IBM's business. Prior to the tool's deployment, engineers spent extensive amounts of time analyzing complex bills-of-materials to identify which IBM parts were impacted by changing RoHS requirements.

2015 product stewardship goals and performance

Recycled plastics

In 2015, 5.05 percent of the plastic resins procured by IBM and its suppliers for use in IBM's products contained some recycled content. Comparing only the weight of the recycled fraction of these resins to the total weight of plastics (virgin and recycled) purchased, 2.75 percent of IBM's total plastic purchases in 2015 were recycled plastic versus the corporate goal of 5 percent. The significant decline in the use of recycled plastics in 2015 is largely attributable to the divestiture of IBM's x86 server business in 2014. Given the diminishing amount of plastics contained in IBM's current product portfolio, we are re-evaluating the goal to determine how it should be modified to better align with IBM's current business.

Use of landfills

IBM's product end-of-life management operations worldwide processed 29,800 metric tons (65.7 million pounds) of end-of-life products and product waste, and sent only 0.7 percent of the total to landfills or incineration facilities for treatment, versus IBM's corporate goal of sending no more than 3 percent 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 continually improve the computing power delivered for each kilowatt-hour (kWh) of electricity used with every new generation of server. In 2015, the IBM Power Systems™ S812LC, S822LC and E850 — the three servers for which typical watts consumed per relative performance are available from the comparable, previous-generation systems — achieved improvements ranging from 23 to 73 percent on this metric.

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 2015, the IBM Power Systems S812LC, S822L, S822LC and E850 were certified to the ENERGY STAR server requirements (Version 2). The IBM FlashSystem® 900, IBM XIV® Gen3 storage system, and IBM Storwize® V3700 storage products had some of their available configurations certified against Version 1 of the ENERGY STAR data center storage requirements.

As of May 2016, IBM had six Power® server and three storage machine types certified to the ENERGY STAR requirements. The Power servers meet the EPA's requirements for power-supply efficiency, idle power limits or power management capability, and Standard Performance Evaluation Corporation (SPEC) Server Efficiency Rating Tool (SERT) metric data reporting. The storage products meet requirements for power-supply efficiency and reporting of Storage Network Industry Association (SNIA) Emerald Power Efficiency Measurement Specification results.

For links to the data sheets for ENERGY STAR certified IBM servers and storage products, see our ENERGY STAR certified products webpage.

Product energy efficiency

Product energy efficiency was formalized as one of the company's corporate objectives when IBM's product stewardship program was established in 1991. Through 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 data centers.

Following are some 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's Power Systems provide enterprise-class server capabilities for traditional and cloud applications, with an emphasis on data-centric and highly virtualized operations that require high reliability and availability. IBM POWER8® servers offer a broad range of specialized functional capabilities that may not be available in other servers. From an energy efficiency standpoint, Power Systems servers can deliver the most workload for unit of energy consumed of any server when the system is configured to achieve maximum utilizations of up to 85 percent and EnergyScale™ power management capabilities are employed. EnergyScale matches energy use of the server to its workload levels.

IBM released five models of IBM Power Systems servers in 2015: the one-socket S812LC; the two-socket S822L, S822LC and S824L; and the four-socket E850. These Power Systems servers continue to use 80 PLUS Platinum certified power supplies, one grade above ENERGY STAR requirements and two grades above requirements established pursuant to European Union Directive 2009/125/EC, which provides ecodesign requirements for computer servers. Of these systems, the S812LC, S822L, S822LC and E850 have been certified to ENERGY STAR server requirements (Version 2), bringing the total number of ENERGY STAR servers offered by IBM to six. Depending on the products and their configurations, the two-socket servers reduce idle power 25 to 67 percent below maximum power, and the four-socket servers reduce idle power 32 to 41 percent.

IBM Power Systems servers can make material improvements in the efficiency of data center operations. One client consolidated the workload of 300 x86 servers onto one IBM Flex System® chassis populated with six S822L servers and three IBM Storwize V3700 storage systems, reducing the space requirements from six racks to one and annual energy use by 480 megawatt-hours (MWh) while avoiding 275 metric tons of CO_2 emissions. Another client installed IBM POWER8 servers to deliver 30 percent more transactions per hour with server utilization improvements of 20 to 80 percent. The improved operation over the previous system reduced energy consumption by 24 MWh, avoiding 10 metric tons of CO_2 emissions annually. Similar productivity and energy efficiency improvements can be achieved across the thousands of IBM Power Systems that IBM sells each year.

In 2015, IBM introduced a water-cooling option for the IBM Power System S822 and 822L two-socket servers. The water is channeled directly to a heat exchanger on the processors, offering increased cooling efficiency and server performance.

z Systems mainframes

IBM z Systems™ mainframe servers provide a unified, secure infrastructure for cloud, enterprise mobility, and analytics operations and applications. The IBM z13™, announced in January 2015, has the ability to support hundreds of images and operate at utilizations of 90 percent or better to enable the consolidation of multiple workloads onto a single, highly efficient server platform. With its high utilization rates, the z13 offers one of the most efficient computing platforms when measured by the workload delivered per unit of energy consumed.

IBM offers a water-cooled version of the z13, which provides 8 percent more computing capacity per kilowatt consumed when compared to the air-cooled model.

High-performance computers

IBM offers a full range of purpose-built and "off the shelf" technical computing (supercomputer) solutions. IBM's supercomputers are found in both the TOP500 and Green Graph 500 supercomputer lists. As of November 2015, IBM had four Blue Gene®/Q supercomputers that appeared among the top 25 in the TOP500 list as well as the top 50 of the Green Graph 500. The TOP500 list ranks computers based on their ability to solve a linear set of equations, while the Green Graph 500 compares high-performance computing (HPC) systems based on a "performance per watt" metric. Technologies developed through IBM's HPC development efforts are leveraged across the entire IBM product line to improve performance and energy efficiency.

The speed and expandability of IBM's HPC products and solutions have enabled users — in the business and scientific community as well as governments — to carry out complex simulations and address a wide range of problems on topics such as life sciences, astronomy, climate and many other applications. IBM is partnering with NVIDIA Corp. and the U.S. Department of Energy to construct two OpenPOWER supercomputers based on IBM's Data Centric computing architecture. The "Sierra" supercomputer at Lawrence Livermore and "Summit" at Oak Ridge will become operational in 2018. Access time will be available to researchers to execute scientific and research projects in the areas of energy, national defense, healthcare, genomics, economics, financial systems, social behavior, and visualization of large and complex data sets.

Storage systems

IBM continues to enhance its portfolio of storage systems, utilizing and improving various 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 number of terabytes required to accomplish a given storage task.

In 2015, IBM expanded its range of flash-based storage systems, announcing the IBM FlashSystem V9000. Flash storage reduces energy use by 60 percent or more compared to disk drives, and significantly improves server and storage performance by minimizing the latency associated with data transfer within the data center.

Utilizing a combination of IBM XIV Gen3 and IBM FlashSystem 900 storage systems, IBM System Storage SAN volume controllers and various optimization software offerings, two clients were able to eliminate three and four racks of storage, reduce power consumption by 30 and 40 percent, respectively, improve the capacity utilization of their storage hardware and absorb future business growth in their existing infrastructure.

The IBM XIV high-end, grid-scale disk storage system offers excellent economic benefits, achieving an 80 percent reduction in space footprint and power consumption over previous-generation technologies configured to handle and store comparable amounts of data. Its grid-scale architecture automatically enables 95 percent utilization of storage capacity with no performance degradation. One client implemented an IBM XIV Gen3 storage system to upgrade its storage infrastructure, reducing power consumption by 65 percent and hardware footprint by 45 percent while improving overall workload performance and storage capacity utilization.

The IBM Storwize family disk storage systems include built-in functions such as Real-time Compression™ and Easy Tier technology, combining flash and hard-disk drives to deliver extraordinary levels of efficiency and high performance. These capabilities enable the Storwize hardware to manage more data than previous-generation systems, decreasing the hardware and energy consumption footprint required to manage a given amount of data by 20 to 80 percent, depending on the application.

IBM has continued to expand its software-defined IBM Spectrum Scale™ storage offerings, which enable storage automation and virtualization in both traditional 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 ultimate outcome is to maximize the amount of data stored on a minimum number of storage products, in turn minimizing energy use.

Development of energy efficiency standards

IBM actively assists in the development of external product energy efficiency standards. In 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. Since then, we have continued our support for the ENERGY STAR program, assisting in the development of new criteria and certifying products that comply with the criteria. Today, IBM engineers are actively participating in the development of updates to the ENERGY STAR requirements for server and storage products.

We are providing technical assistance regarding the assessment of the Standard Performance Evaluation Committee (SPEC) Server Efficiency Rating Tool (SERT) and the Storage Network Industry Association (SNIA) Emerald Power Efficiency Measurement Specification. In addition, 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 in terms of minimizing the deployed server power required to deliver a given workload.
- Working in collaboration with The Green Grid, the Information Technology Industry Council, and Digital Europe to evaluate the SERT and Emerald results and to advocate for SERT and Emerald as the harmonized energy efficiency test metrics for server and storage products.
- Assisting the EPA and regulatory bodies in the European Union and China with the development of server energy efficiency criteria based on the SERT metric.

0.7%

In 2015, IBM's PELM operations sent 0.7 percent of product waste directly to landfills or incineration as a disposal treatment — performing better than our goal of 3 percent maximum.

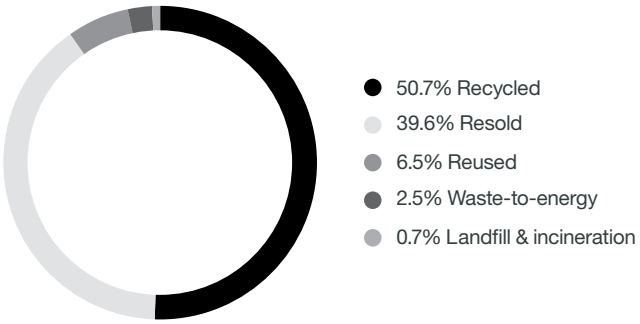
Product recycling and reuse

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. In addition, IBM's Global Asset Recovery Services organization offers Asset Recovery Solutions to commercial customers 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. While IBM has not offered products to

2015 product end-of-life management operations
(% by weight of 29,800 metric tons processed)



household consumers in more than a decade, many countries and states require IBM to maintain these programs to address the diminishing amounts of returned personal computing products and monitors once sold by IBM.

IBM's voluntary environmental 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 incineration facilities for treatment does not exceed a combined 3 percent of the total amount processed. In 2015, 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 29,800 metric tons (65.7 million pounds). Of the 29,800 metric tons processed by IBM PELM operations worldwide, 50.7 percent was recycled as materials, 39.6 percent was resold as products, 6.5 percent was product reused by IBM and 2.5 percent was incinerated for energy recovery.

IBM's corporate-wide requirement for the environmental evaluations of the company's PELM suppliers was established in 1991, expanding 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 those 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 2015, IBM has documented the collection and processing of approximately 975,000 metric tons (about 2.15 billion pounds) of product and product waste worldwide.

Product packaging

IBM's corporate environmental requirements for product packaging are included in our environmental packaging guidelines, which were first published in 1990 and have been updated as needed over the years.

IBM has had a program focused on the environmental attributes of its product packaging since the late 1980s. Under the program, IBM packaging engineers design solutions that minimize toxic substances by specifying nontoxic materials and inks. We keep packaging to a minimum while achieving protection to the product being shipped. We also collaborate with suppliers to use recycled and recyclable materials and promote reuse. The design of rugged products, the efficient use of protective packaging, and the environmental benefits resulting from improvements in transportation efficiency are addressed and tracked though this program. Key elements of IBM's packaging guidelines have also been embedded in various engineering specifications and procurement documents, which can be found on IBM's information for suppliers webpage. This helps to extend the reach of IBM's packaging program to include our supply chain and business partners.

IBM's environmental packaging requirements incorporate a list of the most commonly used packaging materials. Each is evaluated 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 listed are based on practical and regulatory experience and customer feedback. Other environmental areas addressed in the 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, through web-enabled tools. Any suppliers with a non-conformance must submit and implement improvement plans to close out the identified issues within an agreed timeframe. Applying this process to packaging suppliers worldwide ensures ongoing compliance with IBM's product packaging requirements.

Packaging reduction and improvements

In 2015, our global packaging engineering team saved an estimated 790 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 $4.3 million.

The following are highlights of two projects implemented:

Supplier packaging redesign for IBM Storwize V7000 hybrid storage systems — The IBM Storwize V7000 hybrid storage system was originally sent from the supplier in individually packaged units on a pallet. IBM's packaging team worked with the supplier to design and validate a bulk package that could hold 10 units per single package on a pallet, which resulted in a 60 percent reduction in packaging materials (eliminating corrugated and plastic cushioning) and a 55 percent reduction in pallet size, which significantly reduced shipping costs. In total, the project will save an estimated 520 metric tons of packaging materials and $3.8 million in cost.

IBM z13 shipping and packaging improvements — The industry standard for shipping large high-end products such as mainframes normally requires the product to be palletized in a wooden crate to protect the product during transit. Although a successful method, this results in a very large and heavy (280 kilograms) solution that uses large amounts of wood, metal, neoprene rubber, and plastic (cushions). In order to reduce environmental impact and cost, the packaging team designed a process to ship the product on its casters (no pallet or crate) using a "white glove" shipping process (i.e., dedicated padded van) for U.S. domestic shipments. The shipping process utilizes less material — only a plastic bag to keep off moisture and dust during shipping, and a cushioned endcap made using a new compostable mushroom-based material called Restore Mushroom Packaging. Overall, the shipping and packaging design improvements saved an estimated 150 metric tons of packaging materials and $690,000 in cost per year compared to traditional palletized rack crate packaging methods. This package design also received a 2016 AmeriStar Award in the electronics category from the Institute of Packaging Professionals.

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 stated that the paper and paper/wood-based packaging directly acquired by IBM should be procured from suppliers that source from sustainably managed forests, where such sources exist.

When this goal was first established, sufficient quantities of sustainably sourced paper and packaging materials were not available to meet our needs. In 2015, after a continued focus on this objective by IBM and our suppliers over the years, 97 percent of the paper and paper/wood-based packaging IBM procured worldwide came from suppliers that warranted that the source was derived from forests managed in an ecologically sound and sustainable manner. This figure includes a portion of supply from recycled content. This requirement is now incorporated into our standard supplier specification for paper/wood-based packaging.

Materials research and process stewardship

As an integral part of its global Environmental Management System, IBM routinely and consistently monitors and manages the substances used in its development and manufacturing processes, and in its products.

Environmentally preferable substances and materials

Our precautionary approach includes the careful scientific review and assessment of substances prior to their use in processes and products. When the weight of scientific evidence determines a potential adverse effect on human health or the environment, we have proactively prohibited the use of certain substances, restricted their use or found alternative substances to use in our processes and products – even when current laws permit such use.

When IBM develops new processes or significantly modifies existing processes, we conduct a scientific assessment of all substances in the process, including those that have been approved previously. Through these scientific assessments, we seek to identify potential substitutes that may be environmentally preferable. We believe that the same scientific rigor is required to investigate the human health and environmental effects of potential substitutes as was applied to investigate the substances in use.

IBM has a long history of taking proactive steps to evaluate the chemicals used in our processes and products – first by identifying potential substitutes that may have less impact on the environment, health and safety, and then by eliminating, restricting and/or prohibiting the use of substances for which a more preferable alternative is available that is capable of meeting quality and safety requirements of our processes and products.

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 prohibited the use of TBBPA as an additive flame retardant in IT system enclosures for newly released products in 2007.

- 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 and in new manufacturing applications in 2007, and eliminated their use in existing manufacturing, development and research processes as of Jan. 31, 2010.

We communicate IBM's restrictions on specific substances and other environmental requirements for our products through our Engineering Specification: Baseline Environmental Requirements for Supplier Deliverables to IBM.

Nanotechnology and horizon materials

By definition, nanotechnology is the application of scientific and engineering principles to make and utilize very small things (dimensions of roughly 1 to 100 nanometers), creating materials with unique properties and enabling novel and useful applications. It involves an ever-advancing set of tools, techniques and unique applications involving the structure and composition of materials on a nanoscale.

Nanotechnology is already part of a wide variety of products – from cosmetics and sunscreens to paints, clothing and golf equipment. It can make products lighter, stronger, cleaner, less expensive, more precise and more energy-efficient. Nanotechnologies have been critical to advancements in the IT industry.

IBM Research became involved in the world of nanoscience in 1981 when Gerd Binnig and Heinrich Rohrer invented the scanning tunneling microscope, revolutionizing our ability to manipulate solid surfaces the size of atoms. Since then, IBM has achieved numerous developments in the field – from moving and controlling individual atoms for the first time, to developing logic circuits using carbon nanotubes, to incorporating sub-nanometer material layers into commercially mass-produced hard disk drive recording heads and magnetic disk coatings.

We were also one of the first companies to create safe work practices and health and safety training for our employees working with nanoparticles. Further development of nanomaterials presents the potential to reduce the overall materials use footprint of microelectronics manufacturing as well as produce advanced materials that reduce impact on both human health and the environment.

While IBM does not directly manufacture most components used in our current products, we continue to make significant new investments in research and development for “7 nanometer and beyond” silicon technology that will address physical challenges that are threatening current semiconductor scaling. In addition, we are focused on developing alternative technologies for post-silicon-era chips using entirely different approaches that are required because of the physical limitations of silicon-based semiconductors.

In 2015, IBM scientists demonstrated a new way to shrink transistor contacts without reducing performance in carbon nanotube devices, opening a pathway to dramatically faster, smaller and more powerful computer chips beyond the capabilities of traditional semiconductors. IBM’s breakthrough overcomes a major hurdle that silicon and any semiconductor transistor technologies face when scaling down. In any transistor, two things scale: the channel and its two contacts. IBM had previously shown that carbon nanotube transistors can operate as excellent switches at channel dimensions of less than 10 nanometers — the equivalent to 10,000 times thinner than a strand of human hair and less than half the size of today’s leading silicon technology. IBM’s new contact approach overcomes the other major hurdle in incorporating carbon nanotubes into semiconductor devices, which could result in smaller chips with greater performance and lower power consumption. Carbon nanotube chips could greatly improve the capabilities of high-performance computers, enabling big data to be analyzed faster, increasing the power and battery life of mobile devices and the Internet of Things, and allowing cloud data centers to deliver services more efficiently and economically. By advancing research of carbon nanotubes to replace traditional silicon devices, IBM is paving the way for a post-silicon future and delivering on its $3 billion chip R&D investment announced in July 2014.

In developing nanomaterials and other horizon materials and technologies, IBM takes care to ensure that we minimize the risks that new materials may pose to employees and the environment. As a part of our upstream chemical review process, materials intended for core technology development are reviewed prior to their use in IBM processes and products. This rigorous review not only prevents specific chemicals from being used in IBM-developed manufacturing processes, but also sets the conditions and settings in which other materials can be used, including engineering, administrative and personal protective controls. In addition, we continue to assess the environmental, health or safety impacts of our manufacturing processes, even after they are put into production, versus newly developed scientific information to determine if process and material changes are necessary.

Pollution prevention

Pollution prevention is an important aspect of IBM's long-standing environmental efforts and it includes, among other things, the management of hazardous and nonhazardous 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 or to replace chemicals with more environmentally preferable substitutes. We maintain programs for proper management of the chemicals used in our operations, from selection and purchase to storage, use and final disposal.

The total hazardous waste generated by IBM worldwide in 2015 decreased by 32 percent from 2014, to 2,740 metric tons. This reduction was primarily associated with the divestiture of IBM's semiconductor manufacturing operations in July 2015. Excluding hazardous waste from those operations, IBM would have seen a 0.2 percent reduction in the generation of hazardous waste in 2015.

58%

Of the total 2,740 metric tons of hazardous waste IBM generated worldwide in 2015, 58 percent was recycled.

For the hazardous waste that is generated, we focus on preventing pollution through a comprehensive, proactive waste management program. Of the total 2,740 metric tons of hazardous waste IBM generated worldwide in 2015, 58 percent was recycled, 25 percent was sent off-site for treatment, 10 percent was sent by IBM directly to regulated landfills and 7 percent was sent for incineration.

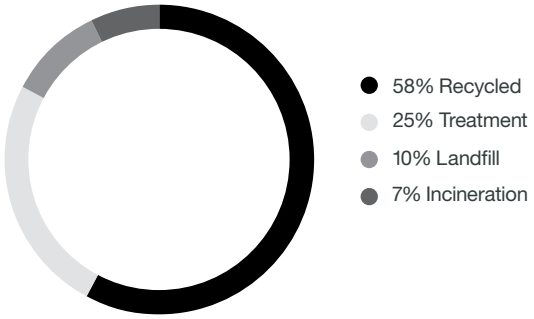
Nonhazardous waste

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 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 customers at the end of a lease. The second expansion was made to include nonhazardous waste generated by IBM at leased locations meeting designated criteria.

2015 total generated hazardous waste worldwide by treatment method

(2,740 metric tons)



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 2015, we sent 85 percent of the nonhazardous waste generated by IBM worldwide to be recycled.

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

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

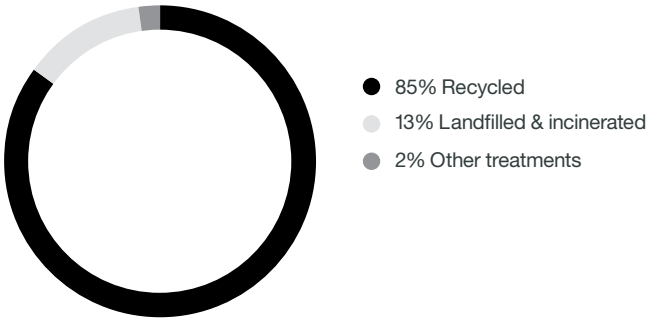
	2011	2012	2013	2014	2015
Total sent for recycling	55	60	56	92	46
Total generated	70	69	65	107	53
Percent recycled by weight	78%	87%	86%	86%	85%

In 2015, our worldwide operations generated approximately 53,000 metric tons of nonhazardous waste, a decrease of 54,000 metric tons from 2014. This significant reduction was largely due to a decrease in the generation of construction debris from construction projects as compared to 2014. In addition, the divestiture of IBM's semiconductor manufacturing operations in July 2015 resulted in further decreases in nonhazardous waste generation. Excluding construction debris and wastes associated with divested semiconductor manufacturing operations, IBM would have seen a reduction of 5,000 metric tons of nonhazardous waste generation in 2015.

Source reduction and waste prevention initiatives implemented by IBM worldwide were estimated to have prevented the generation of over 5,800 metric tons of nonhazardous waste in 2015, with estimated annual handling, treatment and disposal cost savings and revenue returns totaling $3 million.

2015 total nonhazardous waste worldwide by treatment method

(53,000 metric tons)



Water conservation

The preservation of water resources and protection of watersheds are important areas of focus for IBM.

IBM established its first water conservation goal in 2000, focusing on the significant use of water in our microelectronics manufacturing operations. Since then, IBM's water conservation efforts avoided the accumulated use of 21.3 million cubic meters of water in those operations.

With the divestiture of IBM's semiconductor manufacturing operations, our direct water use has reduced substantially. IBM's remaining water use is primarily associated with cooling at our large facilities and data centers, and with irrigation and domestic water uses at facilities occupied by IBM.

In 2015, IBM set out to better quantify and understand the environmental impacts of our water use after the divestiture of our semiconductor manufacturing operations. In particular, we identified those data centers and other IBM locations in water-stressed regions with the highest potential water consumption. Many of these locations have already undertaken significant projects to reduce their water use. For example, IBM's Watson Research Center in Yorktown Heights, New York, has implemented a rooftop rainwater harvesting system that captures more than 1 million gallons of water for reuse in the site's cooling towers annually.

In early 2016, IBM established a new goal to achieve ongoing year-to-year reductions in water withdrawals at these locations in water-stressed regions. We are currently collecting baseline water withdrawal information for these facilities, and will begin reporting on our progress against this goal in the next report.

Solutions for environmental sustainability

At IBM, we believe that our greatest opportunity to contribute to the sustainability of our planet comes from the application of our knowledge, technologies and solutions to address the sustainability challenges of our clients and the world. IBM's products and solutions have enabled our clients to improve their efficiency and reduce their environmental impact. But now, through a combination of new cognitive technologies and an ever-more-instrumented planet — what some call the Internet of Things (IoT) — we are unlocking never-before-seen insights into, and solutions for, the relationships among business, society and our natural environment.

Jefferson Project Director Rick Relyea (left) and IBM Research Distinguished Engineer Harry Kolar examine a visualization of a computer-generated model of Lake George.

Water

More than ever, saving and protecting bodies of freshwater around the world is critical. Freshwater comprises only 3 percent of all water on earth, and two-thirds of it is frozen. The profound impact of freshwater — underscored by severe drought or devastating floods — vividly demonstrates how closely water is linked to the world economy and the welfare of people and all living things.

The Jefferson Project at Lake George

Rensselaer Polytechnic Institute, IBM and The FUND for Lake George launched The Jefferson Project in June 2013, in an ambitious effort to model Lake George in New York — its depths and shoreline — to get a holistic and accurate view of everything happening in and around one of the United States' pristine lakes. The goals of the project are multifold and include understanding and managing the complex factors impacting the lake from invasive species, pollution and other factors, as well as developing a template to use in other freshwater bodies around the globe.

The three partners initially developed preliminary models of key natural processes within the watershed. As part of the first phase of the project, a network of 12 sensor platforms, including vertical profilers and tributary monitoring stations, were deployed around Lake George and its tributaries in late 2014.

Now, the Jefferson Project is entering a new phase in which enormous amounts of data will be captured from the sensors and analyzed. The computing infrastructure powering the Jefferson Project involves multiple computing platforms, ranging from an IBM Blue Gene/Q supercomputer to intelligent-computing elements and IoT technology situated on various sensor platforms in and around the lake.

The potential impact of the project extends well beyond the shores of Lake George. By capturing and pooling data from all sorts of sensors and swiftly analyzing it, scientists and policy makers around the globe could soon accurately predict how weather, contaminants, invasive species and other threats might affect a lake's natural environment. Armed with these new insights and a growing body of best practices, corrective actions could be taken in advance to protect freshwater sources anywhere in the world.

Waterfund Insight Service for better water management

EnerTech, a wholly owned subsidiary of the National Technology Enterprises Company — itself a subsidiary of the Kuwait Investment Authority — selected the Waterfund Insight Service to model and prioritize its strategic water technology investments. IBM developed the Waterfund Insight Service, an IBM Cloud Business solution, to provide national and local governments the ability to better understand and forecast the actual costs of water under different hydrological and financial scenarios, creating the financial transparency required to stimulate capital investment in freshwater.

Waterfund Insight Service provides a data visualization decision support service, enabling water utilities, corporations and government agencies around the world to make informed, data-driven decisions for effective water management. The service provides a better understanding of the impact on local water costs from changing climate conditions, capital spending and business factors, with "what-if" scenario analysis and data visualization.

Waterfund Insight Service is based on the Water Cost Index (WCI), an innovative financial benchmark developed by Waterfund. It partnered with IBM Research to calculate the true cost of water production in cities that represent over one-quarter of global combined gross domestic product (GDP). EnerTech will use the Waterfund Insight Service to analyze, forecast and measure the financial performance of competing new technologies that can benefit Kuwait and the broader Middle East.

IBM's World Community Grid: clean water

World Community Grid®, launched in 2004 as a philanthropic initiative of IBM Corporate Citizenship, is the biggest volunteer computing initiative devoted to humanitarian science and is as powerful as some of the world's fastest supercomputers. World Community Grid enables anyone with a computer or Android device to donate their unused computing power to advance cutting-edge scientific research on topics related to health, poverty and sustainability.

In one research study (Computing for Clean Water), a global team of researchers led by Tsinghua University in Beijing used World Community Grid to simulate water flow through carbon nanotubes at an unprecedented level of detail. Their study revealed a phenomenon, known as diffusion, that can increase a type of water transport through nanotubes by 300 percent. This breakthrough discovery has many possible applications — including the potential to improve water filtration technology, make seawater desalinization more efficient and affordable — and it may even shed light on how drugs pass through tiny channels in human cell walls. The team published its findings in the prestigious journal *Nature Nanotechnology*. The nearly 100 million calculations performed on IBM's virtual, crowdsourced supercomputer would have taken more than 37,000 years to perform on a single-processor PC, and would have cost millions of dollars. Instead, the work was completed in a fraction of the time, thanks to the massive computational power donated by 150,000 World Community Grid volunteers around the world, at no cost to the scientists.

Learn more about World Community Grid and how you can contribute to scientific research at worldcommunitygrid.org.

New potential for access to clean water

Cities

Consider the rate at which cities are changing and growing today. Rapid urbanization, strained infrastructure and enormous amounts of data are placing new demands upon — and creating opportunities for — cities. IBM is working with cities around the world to use advanced technologies to help identify ways to tackle urbanization challenges, improve sustainability and deliver better services to their citizens.

Green Horizons initiative and air pollution

In 2014, IBM Research launched a 10-year initiative with the city of Beijing called Green Horizons. It uses advanced machine learning and IoT technologies to improve prediction of pollution events, enabling officials and businesses to take preventive action. As part of this initiative, IBM's China Research lab is working with the Beijing Environmental Protection Bureau (EPB) to provide one of the world's most advanced air-quality forecasting and decision support systems, able to generate high-resolution 1 kilometer (km)-by-1km pollution forecasts 72 hours in advance, and pollution trend predictions up to 10 days into the future. It models and predicts the effects of weather on the flow and dispersal of pollutants as well as the airborne chemical reactions between weather and pollutant particles. In the first three quarters of 2015, the Beijing government was able to achieve a 20 percent reduction in ultra-fine particulate matter (known as PM 2.5), bringing it closer to its goal of a 25 percent reduction by 2017.

In December 2015, we announced the expansion of Green Horizons. That included:

- An agreement with the Delhi Dialogue Commission to understand the correlation between traffic patterns and air pollution in India's capital, and provide the government with "what-if" scenario modeling to support more informed decision making for cleaner air.
- A pilot program with the city of Johannesburg and South Africa's Council for Scientific and Industrial Research to model air pollution trends and quantify the effectiveness of the city's intervention programs in support of Johannesburg's air quality targets and long-term sustainable development.
- Additional clean air projects in China, with the EPB in Baoding to support that city's environmental transformation; the city of Zhangjiakou (host to the 2022 Winter Olympics) to improve air quality for the outdoor sporting event; and Xinjiang Province in northwest China.

Intelligent transportation

Cities around the world face common transport challenges — from increasing congestion, safety concerns and aging infrastructure, to a lack of funding and increasing environmental impacts. Avoiding vehicular idle time and delays, such as those caused by weather conditions, road obstructions or accidents, reduces fuel consumption and associated greenhouse gas (GHG) emissions.

Helping to fight air pollution with cognitive computing and IoT

IBM's Intelligent Transportation solutions provide traffic analysis and prediction capabilities, and a comprehensive, scalable platform for traffic management. Data from sensors, cameras and status reports are used to monitor traffic and road conditions. The captured data is analyzed to identify traffic bottlenecks and unsafe conditions. Based on the analysis, these solutions propose recommendations to reroute traffic and generate orders to address specific unsafe conditions or maintenance problems.

The state of São Paulo, Brazil, implemented an IBM traffic management solution to monitor and manage 6,000 kilometers of roads. The solution facilitated a reduction of 99 percent — from hours to minutes — in the time required to identify and address traffic problems. It also identified and prioritized needed repairs and maintenance to reduce unsafe conditions.

Energy

Addressing climate change will require actions from all sectors of society and governments to conserve energy and increase the use of renewable energy sources. IBM solutions and technologies are enabling our clients to improve their efficiency and reduce the environmental impacts associated with their energy use.

Green Horizons increasing renewable energy sources into the grid

In addition to the work noted above regarding air pollution, the Green Horizons initiative is also expanding its offerings of analytic and cognitive tools to improve the management of the electric grid and enable the dispatch of higher quantities of renewable electricity into it. New customer engagements include:

- U.K. energy company SSE is piloting IBM technology to help forecast power generation at its wind farms in Great Britain. The system is able to forecast energy for individual turbines and includes visualization tools to show expected performance several days ahead.
- In Japan, IBM is working with the Toyo Engineering Corporation and renewable energy company Setouchi Future Creations LLC on the Setouchi solar project — one of the largest in the country. IBM's monitoring systems will help Setouchi manage and control energy from the plant's 890,000 solar panels.
- IBM is working with China's largest wind power solution provider — Xinjiang Goldwind Science & Technology Co., Ltd. — to use IoT, cloud computing, big data analytics and other advanced technologies to drive innovation and transform Goldwind's business and technological models. Also in China, Shenyang Keywind Renewable Company is using cognitive forecasting technologies to help integrate more energy into the grid.
- The Zhangbei Demonstration Project, managed by China's State Grid Jibei Electricity Power Company, is tapping the power of Green Horizons renewable energy forecasting technology to integrate 10 percent more alternative energy into the national grid, enough to power more than 14,000 homes.

U.S. Department of Energy's SunShot Initiative

IBM researchers are working with academic, government and industry collaborators to develop a self-learning weather model and renewable forecasting technology, known as SMT, through a program supported by the U.S. Department of Energy's SunShot Initiative. The SMT system uses machine learning, big data and analytics to continuously analyze, learn from and improve solar forecasts derived from a large number of weather models. These refined forecasts, when combined with a grid management system that balances supply and demand, can be used to increase and optimize the output of solar and other renewable resources. By using state-of-the-art machine learning and other cognitive computing technologies, IBM scientists are generating solar and wind output and demand forecasts that are up to 30 percent more accurate than ones created using conventional approaches, whether minutes or days in advance.

Using IBM Watson IoT to drive transformation in the electricity industry

Fingrid, Finland's main electricity transmission grid operator, has selected IBM Watson™ IoT technology to help drive transformation in the electricity industry and ensure uninterrupted service for customers. Using networks of sensors and IBM's advanced analytics, Fingrid has pioneered a new solution called ELVIS, which provides system operators with a consolidated view of the entire electricity transmission grid.

Keeping the power flowing through Fingrid's 14,000-kilometer electricity grid is a daunting task that requires a holistic understanding of grid operations, maintenance and safety issues. In the past, Fingrid had to collect data from disparate systems and databases manually — which could take days, if not weeks, to get all the information required for root cause analysis. IBM's IoT-based solution increases the automation of the system, helping Fingrid to quickly identify issues and optimize maintenance scheduling and management. In addition, by connecting asset information with geographic location and financial data, the company can use sophisticated graphical visualizations to better understand maintenance and operating costs.

Help power affordable solar energy research on World Community Grid

World Community Grid: clean energy

Another project supported by IBM's World Community Grid is The Clean Energy Project, led by a team of scientists from Harvard University. Its goal is to develop efficient and inexpensive solar cells using organic-based molecular materials that may serve as viable solutions for future energy needs. Taking a big data approach and harnessing World Community Grid's distributed computing power, Harvard researchers are screening millions of organic compounds to assess their effectiveness for solar cell use. In the largest quantum chemistry experiment ever conducted, the team screened over 2.3 million compounds, identifying over 35,000 compounds predicted to perform at double the rate of efficiency of most organic solar cells in production today.

In 2013, the team released a free database that catalogs the ratings of the compounds screened on World Community Grid, and their work has been praised by the White House Office of Science and Technology Policy for its contribution to the field of materials science. Organic solar cells have the potential to be cheaply manufactured. They can be flexible enough to be painted or sprayed on roofs, windows and walls, and thin and light enough to be applied to portable devices and materials — making them useful to remote and impoverished populations. During 2015, Harvard researchers demonstrated that techniques from the field of machine learning can enable them to screen candidate molecules with less computational time while achieving a high level of accuracy. This, in turn, allows for the exploration of an increasingly large and diverse number of molecules. The research project is ongoing, and new compounds will be added to the database as they are analyzed.

Buildings

Buildings use about 40 percent of global energy and emit approximately one-third of GHG emissions. Building intelligence is evolving through emerging technologies in cloud computing, data analytics and intelligent field devices — effectively merging the virtual and real worlds within the built environment to optimize energy consumption and minimize environmental impact.

IBM Building Management Center solution for facilities management

The IBM Building Management Center solution mines and aggregates data from multiple sources across an enterprise, enabling operators to capitalize on new insights to manage operational, energy and space efficiencies within and across facilities while reducing cost and associated GHG emissions. Cloud-based analytics software helps identify anomalies and likely solutions, and issues prioritized work orders to assess and correct the problem. The solution enables maintenance teams to avoid time-consuming manual diagnostics, improve equipment longevity, optimize building energy consumption and minimize cost.

IBM is collaborating with a major university on a nine-building pilot of the IBM Building Management Center solution. The solution is delivered on the IBM SoftLayer cloud and monitors thousands of data points from building automation and control systems offered by several different manufacturers. After only four months of work, focused on 60-plus air handling units, annualized energy savings of over $135,000 and 16,000 megawatt-hours of electricity, steam and chilled water have been identified. Subsequent work will focus on air handling systems across the campus and later will extend to lighting, water and other utilities.

IBM completed a similar collaboration with a large government entity, applying the solution to 81 buildings, which identified approximately $14 million in energy savings in less than three years.

Environmental requirements in the supply chain

IBM does business with suppliers that are environmentally and socially responsible and requires their awareness of these responsibilities. 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 IBM's 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
- Preventing the transfer of responsibility for environmentally sensitive operations to any company lacking the commitment or capability to manage them properly
- Reducing environmental and workplace health and safety risks of our suppliers
- 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 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, IBM suppliers are required to:

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

More information on these requirements may be found on IBM's supply chain environmental responsibility website.

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

IBM has additional requirements for those suppliers where IBM:

- Specifies and/or furnishes chemicals or process equipment
- Procures hazardous waste and nonhazardous special waste treatment and/or disposal services
- Purchases product end-of-life management services
- Uses extended producer responsibility systems

Specific 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, and reporting.

For hazardous waste and product end-of-life management suppliers, IBM conducts a supplier environmental evaluation, which may include an on-site review of the supplier facility. 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.

Key milestones

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

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

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

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

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

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
- Corporate environmental and social responsibility
- Compliance with IBM's social and environmental management requirements and 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 and nonhazardous special wastes are treated, recycled or disposed at IBM-approved facilities within the country where they are generated, whenever possible. IBM does not export hazardous and nonhazardous special 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 hazardous and special 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.

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 2,408 monitoring wells and 111 extraction wells in place at its current and former locations.

In 2015, IBM's remediation wells extracted approximately 13,500 pounds of solvents from past contamination at four currently operating IBM locations and 14 former IBM locations in three countries. At six of these locations, an additional 2,414 pounds of solvents were removed by soil vapor extraction or other methods. 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 the parties that may have sent waste or otherwise contributed to contamination at third-party-owned sites, regardless of whether those sites were complying with environmental laws at the time. As of year-end 2015, IBM had received notification (through federal, state or private parties) of its potential liability at 114 such sites since the beginning of the Superfund program in 1980. Of these, 63 are on the U.S. National Priority List. At most of the 114 sites, IBM has either resolved its liability or has proven it has no outstanding liability. Currently, IBM is actively participating in a cleanup or otherwise managing its potential liability at only 17 Superfund sites.

When environmental investigation and/or remediation at a current or former IBM location or a non-IBM facility is probable, and the costs for future activities can be reasonably estimated, IBM establishes financial accruals for loss contingency. IBM 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 Dec. 31, 2015, the total accrual amount for all such environmental liabilities and associated activities was $283 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 self-assessment. IBM's Corporate Internal Audit organization may also conduct environmental, health and safety audits. Audit and self-assessment results are communicated to top management. Follow-up, accountability and closure of actions are clearly delineated.

In addition, independent audits are conducted as part of IBM's single, global registration to the ISO 14001 standard. Approximately 25 IBM locations and relevant business organizations (known as registered entities) are audited annually by an external ISO 14001 registrar. Our manufacturing, hardware development, chemical-using research locations and other registered entities are audited by the ISO 14001 registrar on a 12- to 30-month cycle.

As an integral part of IBM's global Environmental Management System, the ISO 14001 registrar also audits IBM's energy management program and the enterprise-wide database for recording and managing energy information (e.g., consumption, conservation, renewable energy purchases) against the ISO 50001 standard on energy management systems. Annually, between six and eight of our ISO 14001 registered entities are audited for conformance to the ISO 50001 standard.

On an annual basis, using a sampling approach, the registrar audits IBM's ISO 14001 registered entities covering 15 to 30 percent of IBM's global annual energy consumption. During these audits, the auditor tests energy consumption records in the enterprise-wide database, comparing the consumption values on the energy bill to the database entries, determining the accuracy of reported savings from energy conservation projects, and verifying that IBM's energy management program requirements are being implemented consistently. The results of this testing 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 audits can be found on the IBM environmental reporting, disclosure and verification webpage.

Accidental releases

IBM sites 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 exceed applicable legal reporting requirements, and every event meeting IBM's reporting criteria must be reported through EIRS. Each IBM location must have a documented incident prevention program (including provisions for preventing environmental incidents or their recurrence) and reporting procedure. In 2015, nine accidental releases of substances to the environment related to IBM operations were reported through EIRS — two releases to air, five to land and two to water.

Emissions to air were two releases of refrigerants due to minor leaks in refrigeration systems. Releases to land were two releases of cooling-tower water, one release of contaminated untreated groundwater, one release of wastewater, and one release of fuel where the soil was subsequently excavated. Releases to water were one release of chilled water and one release of untreated sewage due to a pipe defect. 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 2015, IBM received 80 agency inspections at facilities worldwide with no resulting fines or penalties. Over the past five years, IBM has paid seven fines totaling $81,939.

Fines and penalties worldwide
($ in thousands)

	2011	2012	2013	2014	2015
Number	0	3	0	4	0
Fines	$0.0	$74.8	$0.0	$7.1	$0.0

Awards and recognition

United States

2016 Climate Leadership Award

IBM received a 2016 Climate Leadership Award from the U.S. Environmental Protection Agency (EPA), the Center for Climate and Energy Solutions, and The Climate Registry. The award was in the category of Excellence in Greenhouse Gas (GHG) Management (Goal Setting), which recognized IBM for setting a third-generation GHG emissions reduction goal. IBM has received four Climate Leadership Awards since the award program's launch in 2012, and is the first recipient to win an award in each of the four award categories recognizing individual organizations.

2016 AmeriStar Award

IBM received a 2016 AmeriStar Award from the Institute of Packaging Professionals for its IBM System z® rack packaging for domestic U.S. shipments, which utilizes on-caster deliveries and a compostable mushroom-based material. IBM's entry won in the electronics category. The AmeriStar Award honors outstanding contributions to the packaging community.

2015 Chairman's Award

IBM received the 2015 Chairman's Award from the Alliance to Save Energy. The Chairman's Award is presented to an individual or organization that has shown exemplary service to the cause of energy efficiency. IBM was recognized for its long-standing and comprehensive global energy management program, as well as the impressive results that we achieved.

Green Power Partners

Three IBM SoftLayer® cloud data centers in Texas were recognized by the U.S. Environmental Protection Agency as Green Power Partners. At these locations, 100 percent of the electricity consumed is generated by wind.

Ethics in Business and Community Award

IBM Austin, Texas, received an Ethics in Business and Community Award in the large business category from RecognizeGood, a nonprofit working locally to promote the good work of individuals, businesses and other nonprofits in the community. The award recognized IBM Austin's overall business practices, including a significant commitment to environmental leadership and performance.

Colorado Environmental Leadership Program — Gold Leader

IBM Boulder, Colorado, was recognized as a Gold Leader in the Colorado Environmental Leadership Program by the Colorado Department of Public Health and Environment. The award recognized IBM Boulder's environmental management system, environmental goals and record of compliance. The Colorado Environmental Leadership Program is a voluntary program recognizing Colorado entities that go beyond compliance with environmental regulations and reach toward the goal of sustainability.

Business Recycling Achievement Award — Excellence in Recycling

IBM Gaithersburg, Maryland, received a Business Recycling Achievement Award — Excellence in Recycling from the Montgomery County Department of Environmental Protection. The award recognized the site for recycling a high percentage of its waste stream.

Bike Friendly Business Award

IBM Rochester, Minnesota, received a Bike Friendly Business Award — Bronze Level from the League of American Bicyclists. The award recognized IBM Rochester's investment in construction and maintenance of 3.7 miles of on-site bike trails. IBM also partnered with the city of Rochester by providing an easement in 2013 to allow for the interconnection of the site's bike trails with the city of Rochester bicycle trails and Douglas State Trail. The site provides bike rack parking close to buildings and locker and shower facilities to accommodate employees who ride to work.

Ecuador

General Rumiñahui Award for Social Responsibility Best Practices

IBM Ecuador received a General Rumiñahui Award for Social Responsibility Best Practices from the Pichincha provincial government. The award recognizes companies for their good practices in areas such as human rights, social responsibility, community investment and environmental practices.

Mexico

Environmental Excellence Award

IBM Mexico received an Environmental Excellence Award from the Mexican Federal Environmental Protection and Enforcement Agency (PROFEPA) for its outstanding commitment to environmental protection, preservation and social responsibility, and for continuous improvements in environmental performance. IBM's implementation of EPA's SmartWay program for all our shipments of goods in Mexico, and the development and execution of two Smarter Cities® projects, were among the programs and projects recognized by the award. IBM Mexico has been certified under PROFEPA's Clean Industry Program since 2005.

Philippines

Outstanding Energy Award

IBM Philippines received an Outstanding Energy Award from the Philippine Department of Energy in the 2015 Don Emilio Abello Energy Efficiency Awards for energy savings and carbon dioxide (CO_2) emissions avoidance.

Performance summary

Environment

IBM maintains goals covering the range of its environmental programs, including climate protection, energy and water conservation, waste management and product stewardship. These goals and our performance against them are discussed in this report. The goals identified here as KPIs are based on stakeholder interest and materiality. IBM considers all of its goals to be important metrics of the company's performance against its commitment to environmental protection.

Energy conservation KPI

IBM's goal is to achieve annual energy conservation savings equal to 3.5 percent of IBM's total energy use. In 2015, IBM again achieved this goal, attaining a 6.3 percent savings from its energy conservation projects.

Energy conservation	2011	2012	2013	2014	2015
As % of total electricity use	7.4	6.5	6.7	6.7	6.3

Product energy efficiency KPI

IBM's product energy goal is to improve the computing power delivered for each kilowatt-hour of electricity used with each new generation or model of a product. Please see the product stewardship goals and performance table on page 22.

Recycled plastics

In 2015, 5.05 percent of the plastic resins procured by IBM and its suppliers through IBM's corporate contracts for use in IBM's products contained some recycled content. Comparing only the weight of the recycled fraction of these resins to the total weight of plastics purchased (virgin and recycled), 2.8 percent of IBM's total plastic purchases in 2015 were recycled plastic versus the corporate goal of 5 percent. The significant decline in the use of recycled plastics in 2015 is largely attributable to the divestiture of IBM's x86 server business to Lenovo in 2014. Given the diminishing amount of plastics contained in IBM's current product portfolio, we are re-evaluating the goal to determine how it should be modified to better align with IBM's current business.

Recycled plastics	2011	2012	2013	2014	2015
% of total plastics procured through IBM contracts for use in its products that have been recycled	12.4	12.6	10.8	12.1	2.8

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 of the total amount processed.

In 2015, IBM's PELM operations sent only 0.7 percent of the total processed to landfill or incineration facilities for treatment.

PELM management	2011	2012	2013	2014	2015
% of total processed sent by IBM's PELM operations to landfill or incineration for treatment	0.4	0.3	0.3	0.5	0.7

Nonhazardous waste recycling

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 2015, we recovered and recycled 85 percent of our nonhazardous waste.

Nonhazardous waste recycling	2011	2012	2013	2014	2015
% sent for recycling of total generated	78	87	86	86	85

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 nonrenewable 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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