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Developing a Sustainable IT Capability: Lessons From Intel's Journey[1]

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Executive Summary

Intel Corporation set itself a goal to reduce its global-warming greenhouse gas footprint by 20% by 2012 from 2007 levels. Through the use of sustainable IT, the Intel IT organization is recognized as a significant contributor to the company's sustainability strategy by transforming its IT operations and overall Intel operations. This article describes how Intel has achieved IT sustainability benefits thus far by developing four key capabilities. These capabilities have been incorporated into the Sustainable ICT Capability Maturity Framework (SICT-CMF), a model developed by an industry consortium in which the authors were key participants. The article ends with lessons learned from Intel's experiences that can be applied by business and IT executives in other enterprises.

SUSTAINABILITY AT INTEL: A CORPORATE STRATEGIC PRIORITY

With emissions of 3,850,000 metric tons of CO_2 in 2007, Intel Corporation knew it faced a long-term challenge to reduce its environmental footprint. Without taking action, overall emissions would increase due to the growth of the company and the increasing complexity of its design and manufacturing processes. Recognizing that addressing these challenges would be a strategic priority for the company in the coming years, Intel chose to develop significant capabilities and a reputation for leadership in the area of sustainability. At the start of 2008, Intel CEO Paul Otellini set out an ambitious five-year goal to reduce environmental impacts in key areas, including energy and water, with a 20% reduction in emissions on 2007 levels by 2012.

Intel already had a track record of taking a proactive approach to sustainability and environmental issues. Since the mid-1990s, it has taken voluntary steps and set aggressive goals to reduce its greenhouse gas emissions. It first started public environmental reporting in 1994, and led a voluntary industry initiative on perfluorocompounds (PFCs) reduction in 1996, which was adopted industry-wide by the World Semiconductor Council in 1998. Intel also focused on the sustainability of its products; in 2003 it established an energy conversation goal of a 4% per year reduction on a per-chip basis. In 2008 it became the largest purchaser of green power in the U.S. and set a target for 85% of its U.S. energy usage coming from renewables by 2011. A timeline of Intel's climate awareness activities is illustrated in Figure 1. This shows that since the mid-1990s, Intel has taken voluntary steps and set aggressive goals to reduce its greenhouse gas emissions.

Intel's CIO, Diane Bryant, saw an opportunity for Intel IT to play a key role in enabling the company to achieve its corporate sustainability goals. She committed Intel IT to helping the business deliver its objectives through the use of sustainable IT to reduce the environmental impacts of IT operations, and help transform the overall Intel organization.

1 Carol Brown is the accepting senior editor for this article.

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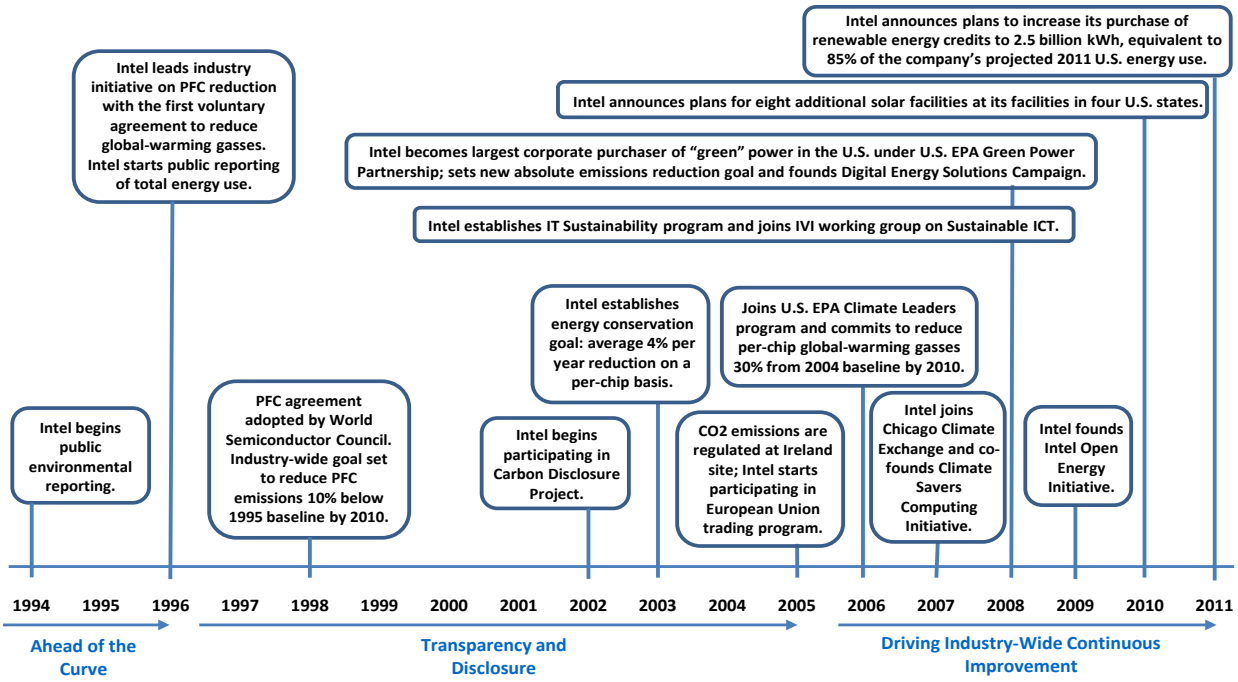
Figure 1: Intel's Climate Awareness Timeline



(Source: Intel Corporate Responsibility Report, 2011)

Researchers have estimated that information and communications technologies (ICT) is responsible for at least 2% of global greenhouse gas emissions,[2] with data centers accounting for about 1.3%.[3] Furthermore, in any individual business, ICT is responsible for a much higher percentage of that business's greenhouse gas emissions footprint. Yet research also estimates that sustainable IT can provide business solutions to reduce an organization's footprint fivefold.[4] If Intel IT was going to deliver on this promise, the organization would need to develop significant sustainable IT capability.

SUSTAINBLE IT AT INTEL

In late 2008, Bryant established the IT Sustainability Program Office to better manage sustainability initiatives and to catalyze change within IT and across Intel and the industry. At that time, Intel IT provided ICT services to Intel's 83,900 employees across 150 sites in 61 countries around the world. Intel IT operations managed more than 200,000 devices (including 90,000+ PCs and 20,000+ handhelds) and 103 data centers with about 100,000 servers. The key sustainable IT challenge for Intel IT was how to manage its IT footprint and enable corporate sustainability practices. The first task of the office was to develop a sustainability strategy to educate and provide leadership to the organization on the principles and importance of sustainable business practices.

As sustainable IT was an emerging field, few guidelines and best practices were available to Intel as it established its sustainable IT capability. Intel IT invested resources in developing practices and frameworks. Intel has long recognized the benefits of industrial collaboration, to both learn from the experiences of other organizations, and to contribute back best-known methods. To derive greater value from sustainable IT, in 2008 Intel joined an industry consortium to develop a framework for systematically assessing and improving sustainable IT capabilities. Other consortium participants included Microsoft, SAP, Chevron, Cisco and Fujitsu, the non-profit sector and academia.

2 For a detailed analysis of the carbon footprint of ICT see Webb, M., *Smart 2020: Enabling the Low Carbon Economy in the Information Age,* The Climate Group, 2008.

3 In 2010 the total electricity used by data centers was estimated at between 1.1% and 1.5% of worldwide electricity consumption. For the U.S., it was between 1.7% and 2.2% of all electricity used. See Koomey, J. G., *Growth in Data Center Electricity Use 2005 to 2010,* Analytics Press, 2011.

4 The case for the avoidance of greenhouse gasses with the use of ICT is discussed in Enkvist, P., Naucler, T. and Rosander, J. "A cost curve for greenhouse gas reduction," *The McKinsey Quarterly,* February 2007, pp. 1-11.

Through the combined expertise and experience of the participants, the consortium identified the four common high-level strategies that were used within their organizations to drive sustainable IT efforts:

1. Align the IT sustainability strategy with core corporate sustainability goals
2. Adjust IT and business processes to reinforce sustainable principles and practices in everyday actions and decision making
3. Encourage a sustainable culture with creative involvement and innovation from all employees
4. Establish consistent policies to support the sustainable IT strategy to meet current and future sustainability objectives.

Below, we describe the sustainable IT program at Intel under each of these four categories.

1. Strategy and Planning: Align IT Sustainability with Core Corporate Sustainability Goals

Aligning IT and Corporate Goals. Intel was already proactively addressing sustainability with an established corporate goal of reducing its carbon footprint by 20% by 2012 from 2007 levels. During 2008, Intel IT worked with the organization to define and agree on specific sustainable IT objectives that were aligned with the company's overall sustainability strategy, objectives and goals. The core of the Intel IT sustainability strategy is to increase sustainable practices and decrease the CO_2 footprint of IT and the wider business. As part of alignment with the overall Intel sustainability strategy, Intel IT has two critical roles:

- An active *contributing role* in reducing Intel's environmental impact by aligning IT processes and practices with the core principles of sustainability, which are to reduce, reuse and recycle
- An innovative *enabling role* by using IT in business processes to deliver sustainability benefits across the enterprise to manage and improve Intel's environmental performance.

A Phased Sustainable IT Roadmap. In order to operationalize Intel's sustainable IT strategy, the IT Sustainability Program Office defined a long-term eco-technology roadmap. The goal of the roadmap was to coordinate sustainability initiatives and drive Intel IT's sustainability project and innovation portfolio.

The roadmap included projects on "enabling Intel sustainability," covering both reduction projects that reduce the overall carbon footprint, and avoidance projects that keep the footprint from escalating, along with projects on policy and compliance. The decision was made to have three phases in the roadmap to help Intel IT maintain its focus and balance between sustainability efforts and ongoing business demands. The roadmap phases were:

- *Phase 1:* Quantify and highlight the (potentially unknown) sustainability impacts of existing IT projects. In most cases these projects had already been undertaken for cost-reduction purposes. The resulting analysis provided a baseline of sustainability projects already in progress with measurable environmental reductions.
- *Phase 2:* Develop innovative proof-of-concepts that can demonstrate new footprint reductions within a 12-month timeframe. Identify opportunities outside of IT where IT solutions can reduce Intel's overall footprint in areas such as office buildings, factories and collaboration technologies.
- *Phase 3:* The widespread proliferation of sustainable IT principles and practices within Intel IT, such as building sustainability into the IT roadmap. Collaborate with other parts of the Intel organization on innovative IT solutions to help reduce Intel's carbon footprint across the organization.[5]

Integrate Sustainable Thinking into Project Planning. Intel IT integrated sustainability thinking into its overall project decision-making process. Sustainability projects within the roadmap have a clear focus on key measurable outcomes, both environmental and financial. The IT finance ROI templates were enhanced by adding relative CO_2 ROI calculations that allow business decision makers to weigh sustainability value as an intangible factor. This empowers the IT Sustainability Program Office to view the forecast and actual CO_2 measurements as the year progresses, to help ensure projects are meeting their goals. It also helps articulate the

5 Within the initial roadmap, Phase 3 included plans for Intel IT to establish a research and development program to explore new concepts within a long-term sustainability research strategy. With the experiences gained from Phases 1 and 2, Phase 3 was revised to focus on collaborations with other divisions within Intel, such as Intel Labs. This allows IT to play to its strengths as a service organization while leveraging expertise from outside the IT organization.

value sustainable IT delivers for both financial and environmental bottom lines.

2. Process Management: Reinforce Sustainable Principles and Practices in Everyday Actions and Decision Making

Redesign Business and IT Processes to Reinforce Sustainability Principles and Practices. An important part in many sustainable IT efforts, within both IT and the business, is a focus on process management. Intel IT examined the processes associated with IT operations and life cycles (including sourcing/purchasing, operating and disposing of IT systems) to identify opportunities to improve their sustainability. In particular, Intel adjusted its IT processes to focus on addressing consumption and waste. For example, the process of requesting a new server now heavily favors virtualization. All new servers should be virtualized where possible; before a new physical server can be installed, justification is needed in terms of both financial and environmental costs.

Intel IT also examined the business processes in the wider business for opportunities to create IT-enabled processes that improved sustainability outcomes across the enterprise.

Data-Driven Sustainable Thinking and Decisions. Intel has a long history of effectively using metrics and data within its decision-making processes, and is continuing this tradition within its sustainable IT efforts. Effective performance reporting is important to demonstrate progress against IT-specific and IT-enabled sustainability objectives.

Understanding the IT Carbon Footprint. Intel IT needed to establish baselines to measure and monitor IT operations to:

- Accurately measure the current IT CO_2 footprint
- Measure the effects of changes made to IT and business processes.

To address these issues, Intel IT developed a measurement model to provide reliable data that can be used to guide both strategic and operational decision making. Two options were investigated to determine current IT CO_2 emissions: electrical power metering and virtual power modeling.

Electrical power meters were installed at several data centers. Although power metering offers the advantages of real-time data and high precision, metering the entire Intel ICT infrastructure would be very expensive and would take a significant amount of time to implement.

Virtual power modeling provided an alternative option. Although not as accurate as power metering, it is far more practical. A detailed equipment inventory already existed, which was originally developed as an asset management and tracking system. This inventory is capable of providing much of the information a power model would need.

After weighing the pros and cons of each measurement option, Intel IT decided on a hybrid approach:

- Model now to quickly establish an overall perspective and "what-if" capabilities
- Complement this with selective power metering, and validate the model as Intel IT learned from the power meters.

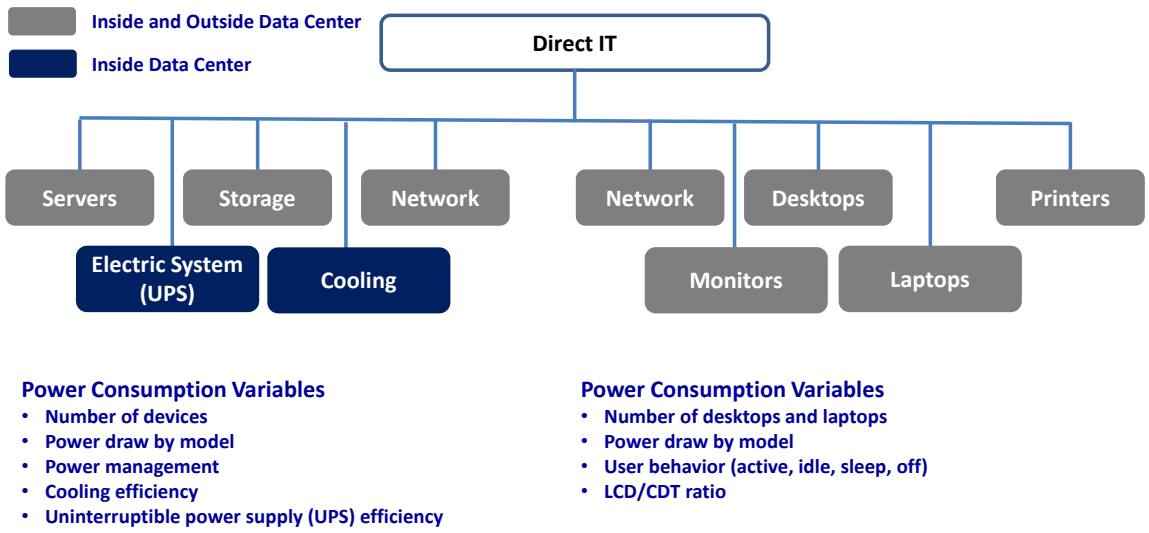
The hybrid model determines the footprint of devices used by Intel IT, as illustrated in Figure 2, and uses several power-metered environments that provided validation points for the model as it was developed. Justification for installing power meters is not strictly based on sustainability ROI, but is usually aligned with other business needs, like improved manageability of environments such as data centers. In the future, Intel IT envisions taking advantage of widespread instrumentation, where the equipment itself provides meter-like data such as power usage and internal temperatures to manage the many environments within IT as well as across the enterprise.

The model enabled Intel IT to analyze the direct IT carbon footprint in more detail and to categorize equipment into segments that could be evaluated for potential savings with targeted improvement initiatives. Two key segments that enabled Intel IT to understand its footprint were: 1) differing equipment types and 2) equipment location.

The equipment-type analysis enabled Intel IT to understand the environmental impacts of its IT equipment. The model showed the carbon footprint contribution from the different equipment types as follows:

- *69% from servers.* Intel had about 100,000 servers to support its main computing solution areas of design, office, manufacturing, enterprise and services.

Figure 2: Overview of Devices that Contribute to Intel IT's Direct Carbon Footprint



- *13% from networks,* both inside and outside of data centers.
- *11% from storage.*
- *7% from client devices,* including desktops and laptops.

The equipment location contribution was as follows:

- *70% from data centers.* Data centers play a key role in supporting new technology development. Equipment (servers, network, storage, UPS, cooling, etc.) located within the data centers was responsible for the majority of emissions.
- *24% from ICT equipment located outside data centers.* Intel is a global company with many sites across the world, and ICT equipment (computing, network, telephony, videoconferencing, etc.) plays a critical role in connecting Intel's workforce.
- *6% from office client computing.* The footprint of office client equipment (monitors, desktops, laptops, printers, etc.) is relatively quite low because of Intel's larger-than-typical data center computing needs and the widespread adoption of laptops across the enterprise. More than 80% of Intel's workforce uses low-energy laptops and monitors.

This information from the model helped Intel IT to identify high-impact opportunities for achieving sustainability benefits.

Identifying High-Impact Opportunities. As part of its sustainable IT planning, Intel IT identified and evaluated the business areas within its organization and across Intel that would provide the highest impact in terms of sustainability benefits, the required cost investment, potential returns and the ability of Intel IT to influence the activity.

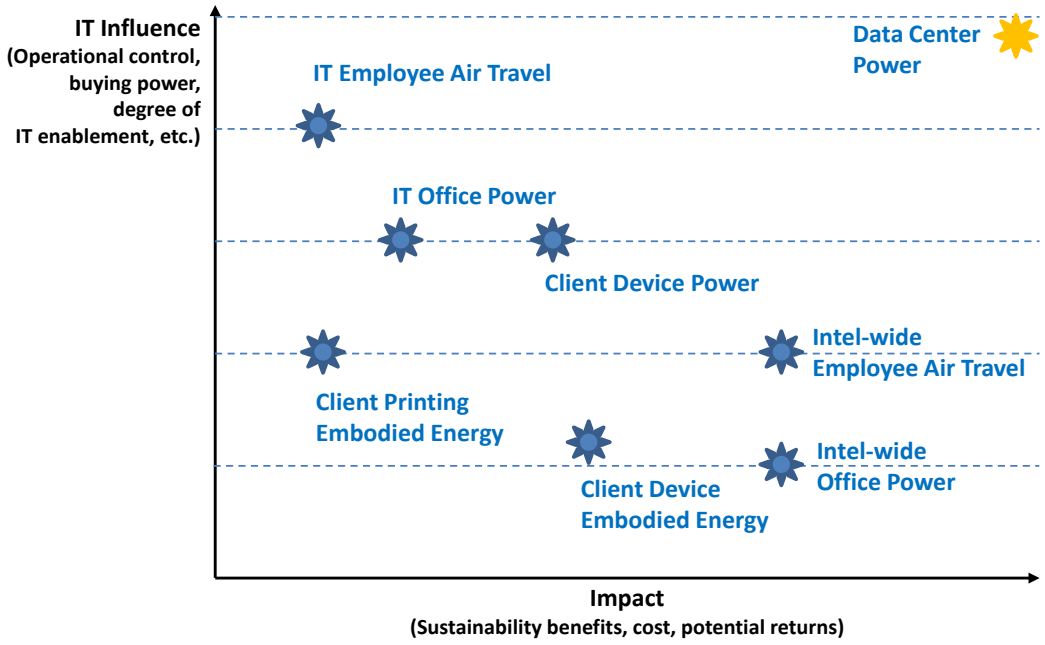
Environmental impact was determined using the "what-if"[6] analysis capabilities of the measurement model to calculate the potential carbon footprint reduction. These calculations were also augmented with rough approximations using publicly available data and average benchmarks scaled to the size of Intel IT.

The influence of IT on the area was determined by considering metrics for operational control, buying power, degree of Intel IT enablement, availability of viable alternatives and other similar factors. The results of this analysis are shown in Figure 3. While it is not feasible to undertake all possible initiatives, the analysis was beneficial within the decision-making process to determine the best places for investment.

The analysis revealed that within Intel IT, the largest impact is electricity usage and the carbon emissions associated with its generation. The main opportunity for reducing power was in data centers, including improving cooling efficiency. Since the majority of IT carbon emissions are accounted for by

6 For example, the model helped Intel calculate the effect of refreshing 1,000 older servers with 300 newer models. In this scenario, the model predicted Intel could double computing capacity as well as reduce its CO_2 footprint by about 1,400 metric tons annually.

Figure 3: Analysis of Sustainability Opportunities with Highest Impacts



servers, regularly refreshing servers, consolidating applications to common platforms and turning off systems when not in use would have the greatest benefits. In the wider business, the main potential was through the use of communications and collaboration technologies to reduce Intel-wide employee travel.

3. People and Culture: Encourage a Sustainable Culture with Creative Involvement and Innovation from All Employees

Building a sustainability mindset strengthens business efficiency, reduces consumption and waste, and enhances the company's brand. Intel knew it would need to influence corporate culture, including decision-making processes and employee involvement, to be more sustainability-focused and adapt to new thinking and methodologies. The goal was to develop a cohesive, integrated strategy that created awareness, along with a sense of urgency within the IT organization and across Intel. The strategy employed by Intel IT to foster a sustainability culture had three key steps focusing on:

1. *Tracking:* Using metrics, aligning incentives and setting stretch goals using "what if" analysis
2. *Decision making:* Using a portfolio approach, getting buy-in and ownership, and maintaining the management structure
3. *Redesigning* work places, value chains, products and processes.

Embed Clear IT Sustainability Principles Across the IT Organization and the Extended Enterprise. To drive adoption, Intel IT developed a clear set of IT sustainability principles for its activities. The principles are a set of aspirational statements to provide guidance on sustainable IT practices. Intel IT's eight sustainability principles are:

1. Consciously manage our capabilities
2. Select sustainable suppliers
3. Enable Intel to meet global sustainability compliance
4. Measure, monitor and optimize consumption
5. Enable sustainable facilities
6. Enable IT sustainability behavior
7. Enable travel avoidance
8. Promote Intel IT's sustainability innovations across Intel and externally.

These principles play an important role in decision making and are included in measurement models, standards and processes. The criteria set out by

the principles may also influence programs toward suppliers with sustainable business practices.

Encourage Creative Involvement and Innovation from all Employees. It is important to drive adoption, create awareness and demonstrate practical relevance of sustainability for all employees, not just specialists in specific projects. In 2009, Intel launched a new environmental employee portal—called "Green Intel"—as well as an interactive online employee community, to facilitate discussion between teams and individuals on sustainability topics such as power management. More than 2,000 employees joined Green Intel in the first six months, making it the fastest growing employee group on Planet Blue, Intel's internal social networking platform.

Create a Common Language for Sustainable IT. Creating a common sustainability language and vocabulary across the IT organization, and other business units, is important to building understanding. Intel IT communicated its message by publishing relevant white papers and participating in key events to further the improvement of education, communication and decision making by following the IT sustainability principles.

Increase Awareness. Creating awareness is an important part of changing the culture to create a consensus on the need for sustainability. Initially, the IT Sustainability Program Office had planned an aggressive communication campaign to raise awareness and drive adoption. To establish a baseline to measure the results of the campaign, an awareness study was conducted to determine how strong the corporate culture was in terms of sustainability. The study showed that Intel employees already had a strong sustainability mindset and their direct "IT touch" was already very efficient. The key findings were:

- Employees mainly used laptops which were turned off when not in use and at night
- Few office devices remained on when not in use, with most devices having sleep-modes enabled to save energy
- Only a few monitors, personal printers and desk lamps were left on at night
- Office space management turned off lights at night.

Based on the survey, the IT Sustainability Program Office focused its efforts on providing incentives for employees.

Use Employee Incentive Programs to Drive Innovation. To help focus all employees on environmental sustainability, in 2008 Intel aligned a portion of the variable compensation of every employee, from entry-level employees to the CEO, to the achievement of environmental sustainability metrics. Each business unit within Intel has specific sustainability goals or targets to achieve that contribute a specific percentage towards employees' bonuses. In 2011, the environmental metrics focused on energy efficiency in operations and on designing energy efficiency into new products; for IT employees, IT energy reduction targets were a component of their bonus schemes.

The alignment of the employee bonus with environmental sustainability has proved to be the prime incentive for engaging employees and facilitating their involvement collectively in focusing on the importance of achieving Intel's environmental objectives. Including sustainability targets in the bonus scheme encourages employees to examine projects they are currently working on to identify tangible contributions toward sustainability goals.

Recognize Achievements: The Intel Environmental Excellence Awards is an annual Intel-wide scheme that recognizes sustainability projects that achieve substantial benefits. Since 2000, Intel has presented these awards to employees across the organization who have helped reduce the company's environmental impact. Contributors to winning projects received monetary awards and/or trophies.

In 2010, 62 individuals and teams from around the world were nominated for the awards for their work on promoting recycling and waste reduction, reducing the environmental impact of products and processes, and educating others on sustainability topics. In addition to environmental benefits, many of these projects save money for Intel, with estimated cost savings from all the winning projects totaling $136 million.

Intel IT employees have been award winners in each of the last three years. The winning sustainable IT projects included:

- Building a design center in Haifa, Israel. This building was Intel's first Leadership in Energy and Environmental Design (LEED)-certified building and the first in Israel to receive LEED Gold certification.

- Achieving LEED certification for a 14-year-old factory and office building in Kulim, Malaysia.
- Using rain water in cooling towers in India to improve data center energy efficiency.
- Conducting research to enable consumer electronic devices to operate in a low-power state.

Drive Adoption. Intel evangelizes sustainability successes outside the organization and contributes to industry best practices. The company has a long history of collaborating with other organizations and agencies. For example, it has worked with the U.S. Environmental Protection Agency (EPA) on a range of initiatives, including Energy Star and Climate Savers, to reduce emissions and increase ICT energy efficiency. Intel has also been a core team member in developing Data Center Codes of Conduct in collaboration with the European Union and the Bureau of Energy Efficiency of the Indian Government.

Intel recognizes the benefits of industry collaboration, to both learn from the experiences of other organizations and to contribute back best-known methods. When appropriate, Intel IT adopts industry best practices within its own operations to help reduce power consumption and resulting CO_2 emissions. For example, the company serves on the board of the Green Grid, a global consortium founded in 2007 comprising organizations dedicated to energy efficiency in business computing ecosystems. The Green Grid provides industry-wide recommendations on best practices, metrics and technologies to improve overall data center energy efficiency. Recent Green Grid activities include creating sustainability data centers metrics for carbon and water usage effectiveness, with Intel representatives serving as key contributors and editors. The resulting metrics are used within Intel's data centers to help manage energy efficiency.

4. Governance: Establish Consistent Policies to Meet Current and Future Sustainability Objectives

Enable and Demonstrate Compliance with IT and Business Sustainability Legislation and Regulation. In recent years, governments around the world have increasingly enacted environmental regulations, which in turn have stimulated sustainability-focused business innovations. As a worldwide organization, Intel recognized the fact that regulatory compliance is their "license to operate" and has ensured it complies with relevant regulation and legislation. It has established clear roles and lines of accountability for sustainability and decision making across the IT organization and the enterprise. Intel IT has responsibility for providing data and information to meet global regulations and standards. It also has risk management in place with regard to regulations focused on imposed processes, data tracking and data storage.

Establish Policies to Support an IT Sustainability Strategy. Intel IT is taking a broad-reaching, long-range approach to identifying the risks and challenges associated with sustainable IT practices and how they impact Intel's business. Intel has established common and consistent corporate policies to meet current and future sustainability objectives. Within Intel IT, the IT Sustainability Program Office maintains a long-term roadmap to coordinate sustainability initiatives and drive sustainable IT within Intel. The office reports into the cross-functional Eco-Management Review Committee (MRC) that reviews Intel's approach to environmental management across the organization. The MRC, led by the Chief Operating Officer and made up of senior leaders from across the company, meets monthly to review environmental sustainability, performance, and strategy.

BENEFITS ACHIEVED

Since the CEO set the 2012 goals, the Intel corporate sustainability program has had encouraging results with significant reduction in greenhouse gas emissions (see Table 1).[7] At the end of 2011, Intel had reduced their absolute emissions more than 60% below 2007 levels. In the same time frame, Intel annual revenue increased by 41%.

The IT sustainability program has allowed Intel IT to increase the performance of its computing environment while reducing the overall IT carbon footprint. This has resulted in energy cost savings of $5.8 million in 2010 (up from $4 million in 2009) and the avoidance of more than 60,000 metric tons of CO_2 emissions.

The program also helped the wider company to reduce its carbon impacts. For example, in 2010 and 2011 new videoconferencing facilities resulted in

7 Intel-wide 2007 figures have been included as a baseline before the corporate goal was set. The Intel IT sustainability program started in late 2008, and the first year of published sustainability metrics for Intel IT is 2009. During the 2008-09 recession, demand for Intel's products remained strong; the recession had little effect on Intel IT's carbon footprint as it continued to invest in refreshing servers and devices, network bandwidth and videoconferencing as part of efficiency efforts.

Table 1: Intel's Overall Corporate Sustainability Performance 2007-2010 and Intel IT's Sustainability Performance 2009-2011

Intel-Wide Performance	2007	2008	2009	2010	2011
Net Revenue ($, billion)	$38.3	$37.6	$35.1	$43.6	$54.0
Workplace employees at year end	86,300	83,900	79,800	82,500	100,100[8]
Greenhouse gas emissions (million metric tons of CO_2 equivalent)[9]	3.85	2.75	2.05	2.12	1.40
Energy use (billion kWh—includes electricity, gas and diesel)	5.8	5.6	5.1	5.2	5.3
Revenue per metric ton of CO_2 equivalent	$9,948	$13,673	$17,122	$20,566	$38,571
Energy use per employee (kWh—includes electricity, gas and diesel)	66,709	67,330	64,073	62,933	52,947
Intel IT Performance					
IT employees			5,660	6,300	6,400
IT spend (as % of net revenue)			3.6%	3.0%	2.6%
IT spending per employee			$16,100	$16,400	$15,500
IT CO_2 footprint (metric tons)			253,000	249,000	246,000
IT spending ($, million)			$1,264	$1,308	$1,404
Saving from travel avoidance due to videoconferencing ($, million)			$14	$27	$73
CO_2 saving from travel avoidance due to videoconferencing (metric tons of CO_2 equivalent)			N/A	22,500	65,000

(Sources: Intel Corporate Responsiblity Reports, 2007-2011, and Intel IT Annual Performance Report 2009-2012)

cost savings of over $114 million and the avoidance of more than 87,500 metric tons of CO_2 emissions. In recognition of Intel IT's sustainability achievements, Intel was included in *Computerworld*'s 2010 and 2011 lists of "Top Green-IT Organizations," and has won InfoWorld Green 15 Awards in 2009, 2010 and 2011.

Improvements in IT Energy Efficiency

In the three years to 2011, Intel IT has increased the performance of its computing environment in areas of processing capacity, storage and networks as detailed in Table 2, and is providing IT services to an additional 11,000 employees, all while reducing the overall carbon emissions of IT operations.

Server Consolidation. One of the primary ways Intel IT is reducing its carbon footprint is through server consolidation in its data centers. Moore's Law results in a doubling of chip performance every 18 months, but the energy consumed by the chip does not double. Moore's Law thus drives continuous chip-level energy efficiency, meaning that newer servers and laptops use less power to do the same work as older machines. In keeping up with Moore's Law, and an ever-increasing computing demand, Intel IT has settled on a four-year server refresh policy. One server with the latest processing technology can replace as many as 10 four-year-old servers. This refresh strategy has allowed Intel IT to double processing capacity and reduce costs. In 2010, server refresh saved an estimated 28,000 metric tons in CO_2, equivalent to the carbon captured by 8,000 acres of pine forest in a year.

Intel IT has also introduced an aggressive server virtualization strategy, which has increased server usage leading to a further 2,500 metric tons of carbon footprint reduction in 2010. Improving the management of workload distribution among servers within data centers has allowed Intel IT to optimize server usage further, allowing it to shut down over 2,300 servers. Overall, Intel IT's efficiency efforts have reduced the number of servers from a high of 100,000 to 75,000. (See the panel below for more information about data center energy efficiency).

8 Total employee count includes wholly owned subsidiaries that Intel IT does not directly support. Intel IT directly supported 91,500 employees in 2011

9 Including renewable energy credit purchases.

Table 2: Intel IT's Operational Performance 2009-2011

Intel IT	2009	2010	2011
IT data centers	95	91	87
Storage capacity (petabytes)	18.6	24.9	38.2
Internet network bandwidth (gigabits per sec)	3.0	4.8	6.2
Processing capacity for silicon design (growth from 2008)	24%	84%	159%
Time to deploy infrastructure services	14 days	3 hours	45 mins
Percentage of applications virtualized (in office and enterprise environments)	12%	42%	64%

(Source: Intel Annual Performance Reports, 2009-2012)

Factors Affecting Data Center Energy Efficiency

The energy efficiency of a data center goes beyond server refresh and virtualization. Data centers generate heat and must be cooled; the required equipment can be a significant consumer of power. Power usage effectiveness—PUE—measures how much power is actually used by IT equipment vs. cooling, and other non-IT equipment. Intel IT actively tracks PUE measurements within its data centers to optimize cooling. Geographic location is also a key factor in cooling; a data center in a cool climate such as Ireland requires less cooling power than a data center in a warm climate such as Mexico. Location is also an important factor for the CO_2 intensity of the power consumed by the data center. A gas or coal fired power utility creates much more CO_2 than a hydro- or wind-power utility. For this reason, many new data centers (e.g., Google's) are located near low-cost and environmentally friendly power sources.

Client Computing Devices. For client devices, Intel has achieved a 70% energy savings per user by deploying low-power laptops instead of desktops; over 80% of its client machines are now laptops. It is also deploying solid state drives (SSDs) that consume less power than conventional hard drives in the laptops. SSDs are also being considered for use in data centers, where they will save energy and reduce heat while enhancing performance. Overall, Intel IT has saved over 100 million kilowatt-hours in energy. The overall trends between increased IT performance and reduced IT carbon emissions are illustrated in Figure 4.

Reducing Travel with Collaboration Technologies

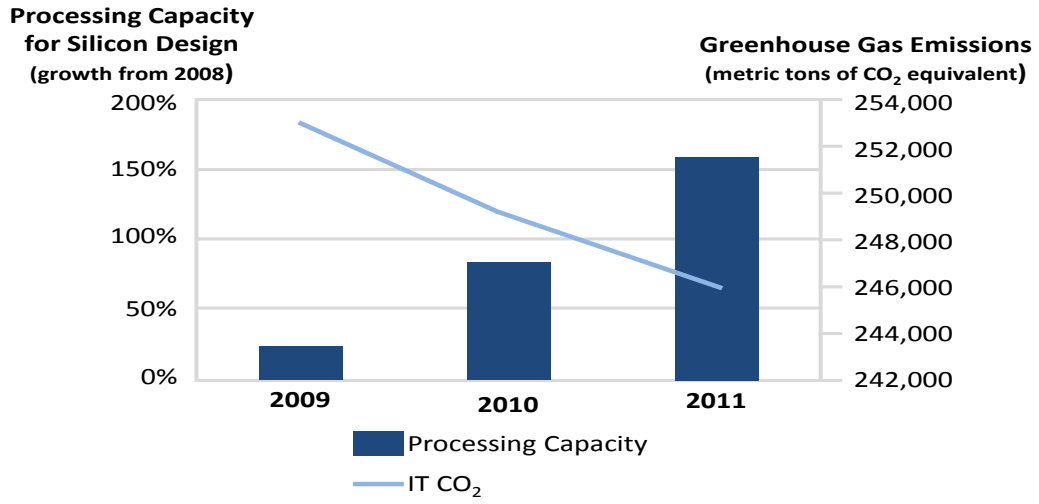
In 2011, Intel had over 91,500 employees across 164 sites in 62 countries around the world. These employees typically work in distributed and virtual teams. The cost of employee travel is expensive in both financial and environmental terms. Intel IT makes extensive use of collaboration technologies, such as videoconferencing, that can reduce the need to travel.

For person-to-person and small group meetings, desktop-based videoconferencing is provided; desktops are refreshed at Intel to ensure they have the capacity to handle full-screen video and application sharing. Meetings of larger teams and groups are accommodated through the use of telepresence rooms. During 2010, Intel more than tripled the number of meeting rooms with videoconferencing capabilities, including the addition of rooms in 11 new countries. The estimate for 2011 was that videoconferencing and telepresence rooms would save 435,000 employee travel hours, avoiding more than $73 million in travel expenses, and over 65,000 metric tons of CO_2 emissions.

A Maturing Sustainability Program

Intel IT wanted to understand the maturity of the sustainable IT program. In 2010, it performed an initial maturity assessment using the Sustainable ICT-Capability Maturity Framework (SICT-CMF), which is described in more detail in the Appendix. Stakeholders from both Intel IT and the business took part in the assessment (including the two Intel authors of this article, along with other senior Intel executives). The results showed Intel IT has a sustainable strategy in place with associated plans and priorities. It has developed capabilities and skills, and has encouraged individuals to contribute to sustainability programs. Overall, the maturity assessment showed that sustainable IT at Intel was on a trajectory towards "Intermediate" maturity level (see the Appendix for a description of the SICT-CMF maturity levels).

Figure 4: Trends in Intel IT's Sustainability



(Source Intel IT Annual Performance Report, 2011-2012)

The assessment allowed Intel IT to compare its current maturity level to the desired level, and thus to identify gaps in capabilities. Based on an analysis of the assessment, Intel IT developed an action plan with recommendations to increase the maturity of its sustainable IT capabilities. In line with its leadership of the sustainable IT program, Intel IT wanted to improve maturity across all areas.

LESSONS LEARNED

Based on our analysis of Intel's journey with sustainable IT, we have identified the following four lessons that can be applied by business and IT executives in other enterprises. We believe these lessons are equally applicable within transaction-intensive IT companies (such as cloud computing companies with massive server farms), general IT industry companies and companies within other industries.

1. Align Business and IT Sustainability Objectives

A key requirement is to align the business vision for sustainability with sustainable IT objectives. Alignment between business and IT goals and milestones, together with senior-level drive, visibility and communication about the need for sustainability are critical for successfully developing a sustainable IT program.

Intel was already proactively addressing sustainability; the CEO had set an ambitious corporate goal of reducing the company's carbon footprint by 20% by 2012 from 2007 levels. Intel IT was able to leverage these goals and worked with the organization to define and agree on specific sustainable IT objectives that are aligned with the organization's overall sustainability strategy, objectives and goals.

2. Build the Business Case for Sustainability

It is important to build a strong business case for sustainable IT projects. Intel IT has discovered that there is a strong business case for sustainable computing, with investment justified by cost savings from sustainable IT projects (e.g., energy savings from data centers, travel cost avoidance from videoconferencing). There is typically a difference between a green IT program (environmental benefits) and a sustainable IT program (environmental and business benefits). It is also harder to build a business case for sustainability by retrofitting a data center, rather than building a new one.

Intel uses Total Cost of Ownership as a guide when building sustainable business cases, together with ROI for specific retrofit projects. The current data

center strategy is to use refresh economics to reduce the need for new data centers, using the existing data center footprint. Where strategic business priorities come into play, such as manufacturing growth, new computing processing capacity is aligned geographically with incremental factory growth. For new service and general business growth, Intel uses a capacity forecasting process; if the forecast demand outpaces projected capacity (including a refresh cycle), new or existing data center expansion can be justified, with sustainable principles incorporated early in the design stage.

3. Use Incentives to Drive Cultural Change Across the Organization

While IT sustainability principles are a useful tool for promoting awareness, driving adoption within the wider organization is a more significant challenge. Engaging the general workforce requires a shift in culture that embeds sustainable IT into the everyday work routine. One of the most effective steps taken by Intel was to encourage employee engagement through bonus schemes that included factors for environmental achievements and leadership. These schemes reward improving sustainable performance, such as energy reduction in Intel operations and products. Incentives vary across different organizational layers, ranging from awards and recognition for new ideas and innovation, to a direct relationship between sustainable performance and compensation for all employees (from entry-level to the CEO). The incentive scheme also enabled goals and targets to be set and reviewed on an annual basis. Goals and targets can be set organization-wide or at business-unit level, allowing the sustainability efforts to be tailored where needed.

4. Establish a Sustainability Office to Coordinate and Promote Sustainable IT Efforts

The formation of Intel's IT Sustainability Program Office played a key role in coordinating sustainability initiatives, promoting the sustainability messages and highlighting successes. The program office was key to establishing a sustainability mindset, priorities and "socializing" sustainability throughout the IT organization. As such programs mature and evolve, sustainability becomes part of "business as usual," and the need for a central sustainability office wanes.

CONCLUDING COMMENTS

This article describes the choices made by Intel IT that helped it establish sustainable IT as a significant contributor to the company's sustainability efforts. While significant challenges still exist, we believe that the actions taken by Intel IT, and the practical lessons learned, can be applied by other organizations seeking to leverage sustainable IT as they look to reduce the environmental impact of IT and to deliver IT-powered sustainability benefits across the enterprise.

APPENDIX: SUSTAINABLE ICT CAPABILITY MATURITY FRAMEWORK

Founded in 2006, the Innovation Value Institute (http://ivi.nuim.ie) is a consortium that includes Intel, Microsoft, SAP, Chevron, Cisco and Fujitsu, non-profit sector organizations and academia. It has used an open-innovation model of collaboration, engaging academia and industry in scholarly work to create the IT-Capability Maturity Framework (IT-CMF)[10] for managing the IT function within an organization. This framework identifies 33 critical IT capabilities and describes each using a maturity model.

The working group on Sustainable ICT was established in 2008 with participation from over 10 organizations, with the group co-chaired by Intel's Charles Sheridan and IVI's Brian Donnellan (co-authors of this article).[11] The collective learnings and experience of the group were captured within a maturity model for Sustainable ICT. This SICT-Capability Maturity Framework (SICT-CMF) is provided on the following page.[12]

The SICT-CMF offers a comprehensive value-based model for organizing, evaluating, planning and managing SICT capabilities. The framework has five maturity levels. Each level comprises a set of

10 For more information on the IT-CMF and how it has been applied within Intel IT, see Curley, M. "The IT Transformation at Intel," *MIS Quarterly Executive* (5:4), 2006, pp. 155-168. A general overview of the IT-CMF is available in Curley, M. "Introducing an IT Capability Maturity Framework," Proceedings of the 9th International Conference on Enterprise Information Systems, Springer, 2007, pp. 21-26, and Curley, M. *Managing Information Technology for Business Value*,"Intel Press, 2004.

11 The other authors of this article have had some involvement with developing the SICT-CMF. Edward Curry was a member of the working group that designed the framework and performed multiple assessments. Bill Guyon was involved in the Intel assessment.

12 The SICT-CMF is described in more detail in Donnellan, B., Sheridan, C. and Curry, E. "A Capability Maturity Framework for Sustainable Information and Communication Technology," *IT Professional* (13:1), 2011, pp. 33-40.

The Sustainable ICT Capability Maturity Framework (SICT-CMF)

Maturity Level	Sustainable IT Capability Categories: *Strategy and Planning*	*Process Management*	*People and Culture*	*Governance*
5. Optimizing	Stakeholders across extended enterprise acknowledge sustainability as a success factor in driving business strategy CEO leverages sustainability as business differentiator	Integration of sustainability for ICT-enabled processes and ICT system management across extended enterprise and tracking scorecard Best practices drive industry and thought leadership on sustainability	Common language adopted across extended enterprise Sustainability is a core value and organization is recognized for thought leadership CEO accountable for branding and image	Driving international standards and legislation Pervasive influence Innovation of policies and adoption across extended enterprise
4. Advanced	Sustainability is a core part of ICT and business planning cycle Senior management led enterprise-wide sustainability metrics	Enterprise prioritizes sourcing, and disposal of ICT assets The IT organization and business drive and track/report enterprise sustainability metrics ICT system design mandated to meet life cycle sustainability	ICT and business role incentives aligned to impact and success for sustainability across the enterprise Staff mentoring/skills focus Best practice recognized	Enterprise compliance with policies is a core business accountability Regulations and policies updated with best practice developed to exceed targets
3. Intermediate (Average rating from the initial 2010 Intel assessment)	ICT sustainability strategy and execution plans in place and integrated across prioritized ICT programs Some business metrics defined and used where local opportunities arise	ICT policies standardized to source and dispose of ICT assets against defined metrics Design of ICT systems prioritizes sustainability targets ICT performance and reporting is tracked on a project-by-project basis	Capability/skills development key asset for staff development Staff encouraged to contribute to sustainability programs and visibility ICT has adopted common language with limited business adoption	Common policies and accountabilities documented and applied to all ICT initiatives Business accountability with limited adoption of best practices
2. Basic	Limited sustainability, strategy planning and execution Where visible, approach and metrics are inconsistent	Basic reactive sourcing; disposal based on local policy Sustainability not integrated into ICT thinking Reactive approach to SICT performance and reporting	Common language defined and limited use within ICT Increasing awareness within ICT of sustainability issues, but little coherence	Common policies may exist with limited documentation and inconsistent adoption within the IT organization Awareness of compliance but limited accountability to meet requirements
1. Initial	No ICT sustainability strategy, execution planning in place Any sustainability metrics are ad hoc and inconsistent	Any attempt at the management of a sustainable life cycle is ad hoc ICT systems are not designed to meet sustainability metrics There is little sustainability tracking or reporting	No awareness of ICT-related sustainability issues or language No communications across the IT organization and the business on sustainability issues	Type and level of compliance unknown Any accountability or policies that exist are ad hoc

behaviors, practices and processes for sustainable IT that can reliably produce required outcomes. The model provides a management system with associated improvement roadmaps that guide senior IT and business management in selecting strategies to continuously improve, develop and manage the sustainable IT capability. In addition to Intel, several IVI consortium members are actively using the SICT-CMF within their sustainable IT efforts to help them understand their current maturity and to set future directions.

The SICT-CMF assessment determines how sustainable IT capabilities are contributing to the organization's overall sustainability goals and objectives. The resulting gap analysis between what the business wants and what sustainable IT is actually

achieving, positions the SICT-CMF as a management tool for aligning sustainable IT capabilities with business sustainability objectives. The framework focuses on the execution of four key actions for increasing the business value of sustainable IT:

- Defining the scope and goal of sustainable IT
- Understanding the current sustainable IT capability maturity level
- Systematically developing and managing the sustainable IT capability building blocks
- Assessing and managing sustainable IT progress over time.

The assessment begins with a survey of IT and business leaders to understand their individual assessments of the maturity and importance of sustainable IT capabilities. A series of interviews with key stakeholders augments the survey with the key business priorities, sustainable IT drivers, successes achieved and initiatives taken or planned. The assessment provides valuable insight into the similarities and differences in how key stakeholders view both the importance and maturity of individual capabilities and the overall vision for success. Understanding the current levels of maturity and strategic importance lets an organization quickly identify gaps in capabilities, and provides the foundation for developing a meaningful action plan.

ABOUT THE AUTHORS

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