



## Green IT

Green Information Technologies (Green IT) reduce the environmental impacts associated with conventional Information Technologies (IT). Examples of Green IT include energy efficient hardware and data centers, server virtualization, and monitoring systems. Green IT focuses on mitigating the material and energy burdens associated with conventional IT while meeting our information and communication demands.<sup>1</sup>

### Patterns of Use

- The number of personal computers in use worldwide surpassed 1 billion units in 2008.<sup>4</sup>
- Globally, more people have mobile phones than access to working toilets.<sup>5</sup>
- 174 million smartphones were sold globally in 2009. 1.4 billion were sold in 2015.<sup>6,7</sup>
- In 2011, 76% of U.S. households had a computer or a tablet, compared to 51% in 2000.<sup>8</sup>
- In 2005, laptops comprised 31% of primary household computers. In 2009, that rose to 44%.<sup>9,10</sup> More than 14% of households used their primary computer for 10 or more hours per day in 2009.<sup>10</sup>
- In 2013, U.S. data centers consumed 91 billion kWh of electricity—2.4% of total electricity consumption—at a cost of \$13 billion.<sup>2,3</sup>
- The peak power associated with servers and data centers in 2007 was 7 GW. Existing technologies and efficient design strategies can reduce server energy use by 25% or more, while best management practices and consolidating servers can reduce energy use by 20%.<sup>11</sup>
- Computers and office equipment consumed 253 billion kWh of electricity in 2012, 24% of the total electricity consumption of office buildings that year.<sup>13</sup>

### Energy and Environmental Impact

- Electricity used for U.S. servers & data centers creates 104 billion lbs CO<sub>2</sub>e annually.<sup>2,14</sup>
- Computer electricity consumption varies greatly with age, hardware, and user habits. An average desktop computer requires 48 W when idle and 2.3 W in sleep mode (285 kWh annually). Laptops require less power on average - 15 W when idle and 1.2 W in sleep mode (89 kWh annually).<sup>15</sup>
- A 17" light emitting diode (LED) LCD monitor uses about 13 W while on, 0.4 W in standby, and about 0.3 W when off.<sup>16</sup>
- Every kWh used by office equipment requires an additional 0.2-0.5 kWh of air conditioning.<sup>17</sup>
- The life cycle energy burden of a typical computer used for 3 years is 4,222 kWh. Only 34% of a computer's life cycle energy consumption occurs in the 3-year use phase. Production dominates life cycle energy use due to the high energy costs of semiconductors and short use phase.<sup>18</sup>
- Manufacturing represents 60-85% of life cycle energy demand for a personal computer and 50-60% for mobile phones. Remanufacturing energy is a fraction of manufacturing energy: 5-30% for personal computers and 5% for mobile phones.<sup>19</sup>
- Some emerging technologies can reduce manufacturing burdens. Globally, 3D printing has the potential to reduce total primary energy use by 2.5-9.3 EJ and CO<sub>2</sub> emissions by 131-526 Mt by 2025.<sup>20</sup>

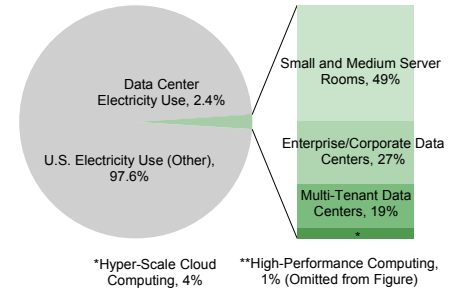
### Electronic Waste

- In 2014, approximately 42 million metric tons of e-waste were generated worldwide.<sup>22</sup>
- U.S. federal hazardous waste regulations allow the export of e-waste, posing a global threat to human health.<sup>23,24</sup> An estimated 5-30% of the 40 million computers used in the U.S. were exported to developing countries in 2010.<sup>25</sup> The International Trade Commission found that the U.S. exported 17% of its used electronics in 2011.<sup>26</sup>
- In 2010, the U.S. disposed of 52 million computers and 152 million mobile devices. 40% of computers and 11% of mobile devices are recycled.<sup>27</sup>
- The main constituents of printed circuit boards used in mobile electronics are polymers and copper, with trace amounts of precious metals Ag, Au, and Pd, and toxic metals As, Be, Cr and Pb.<sup>28</sup>
- One ton of printed circuit boards has a higher concentration of precious metals than one ton of mined ore.<sup>29</sup>

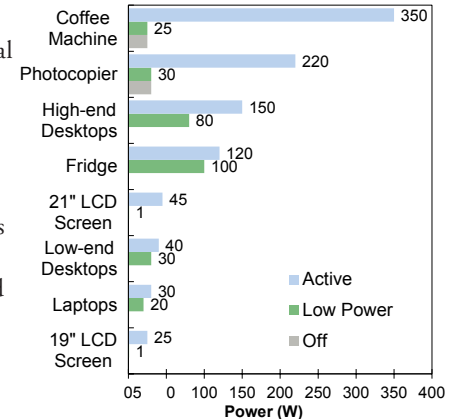
### Paper Industry

- Global paper use increased 4% from 2000-2014 but has decreased 6% since 2011.<sup>30,31</sup> Annual consumption of printing and writing paper is expected to rise from 109 to 274 million metric tons between 2006 and 2060.<sup>32</sup>
- The U.S. accounts for approximately 18% of global printing and writing paper consumption.<sup>30</sup>
- Depending on the process, producing one ton of paper consumes 12 to 24 trees.<sup>33</sup>
- The average annual greenhouse gas emissions of the U.S. pulp and paper manufacturing industry are 176 million metric tons CO<sub>2</sub>e, approximately equivalent to the annual emissions of 51 coal-fired power plants.<sup>34,35</sup>

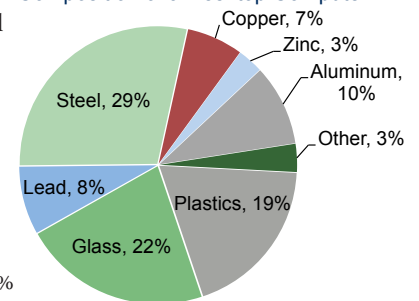
End Use Electricity Consumption of U.S. Data Centers<sup>2,3</sup>



Office Equipment Power Demand<sup>12</sup>



Composition of a Desktop Computer<sup>21</sup>



# Sustainable Alternatives

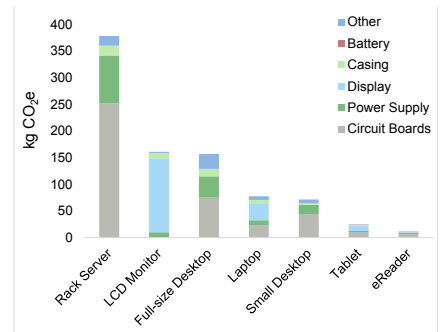
## Technology

- Virtualization enables one physical server to run many independent programs and/or operating systems.<sup>36</sup> This technology reduces the number of physical servers needed and promotes greater utilization of each server. With virtualization, each machine can run at 80% capacity rather than 10%.<sup>37</sup> Virtualization reduces cost, material waste, electricity use, server sprawl, and cooling loads, saving money while reducing the environmental burdens of running a data center.<sup>36</sup>
- Data center energy efficiency can be improved by utilizing combined heat and power systems. Heat recovered from electricity generation in the form of steam or hot water can be used by an on-site chiller to cool the data center.<sup>38</sup>
- Multi-function office equipment can reduce energy consumption and waste. To save money and energy, Energy Star recommends choosing a machine that combines multiple functions, like printing and scanning, instead of purchasing two different machines.<sup>39</sup>
- Video teleconferences can greatly reduce business travel impacts. One study found that a video conference requires 500 times less energy than a business trip including a 1,000 km (663 miles) flight.<sup>40</sup> Telecommuting, in which employees work in distributed locations, is increasing in frequency. One study found full-time telecommuting could prevent 3,700 lbs of CO<sub>2</sub> emissions per employee per year.<sup>41</sup>

## Reduce Energy Consumption

- Office equipment energy consumption could be reduced by 23% if all office equipment had and utilized low-power mode. If all desktop computers and printers were turned off for the night, energy consumption would be further reduced by 9%.<sup>42</sup> If every PC in the world were shut off for one night, the energy saved could light the Empire State Building for over 30 years.<sup>43</sup>
- Energy Star certified computer servers are, on average, 30% more energy efficient than standard servers. Replacing a conventional server with an Energy Star server could save up to 1000 kWh annually. If all servers sold in the U.S. met Energy Star standards, \$800 million per year would be saved in energy use.<sup>45</sup>
- Energy consumed by devices in standby mode accounts for 5-10% of residential energy use, adding up to \$100 per year for the average American household. Unplug electronic devices when not in use, or plug them into a power strip and turn the power strip off.<sup>46</sup> Turning off a computer when it is not in use can save \$50, 505 kWh, and 662 lbs of CO<sub>2</sub> per computer annually.<sup>14,47</sup>
- When leaving computers on, the EPA recommends setting computer monitors to go to sleep after 5-20 minutes of inactivity, and to enter standby after 15-60 minutes.<sup>48</sup>

Embodied Greenhouse Gas Emissions: Computing and Electronics Products<sup>44</sup>



## Take Action

- Make informed purchases. Energy Star's Excel-based calculators estimate energy and cost savings for office equipment, appliances, electronics, and lighting.<sup>49</sup> The EPA's Electronic Product Environmental Assessment Tool (EPEAT) rates the environmental impacts of computer products across multiple criteria, including energy efficiency, material toxicity, and recyclability.<sup>50</sup>
- Purchase Energy Star certified products, consolidate multiple devices into all-in-one equipment, and turn off devices when not in use.<sup>51</sup>
- The average American uses 434 pounds of paper each year, and 45% of printed paper in offices is discarded by the end of the day. Save resources by not printing or, when a paper version is necessary, by printing double-sided on recycled paper.<sup>52,53,54</sup>
- Extend the life of personal computers to delay the energy and materials burdens associated with making new equipment.<sup>18</sup>
- Recycle your unused electronics. Responsible Recycling Practices (R2) and e-Stewards offer third-party certification for electronics recyclers to ensure the proper disposal of used electronics.<sup>55</sup>

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