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September 30, 2011

California Energy Commission
Efficiency Policy Committee
Karen Douglas, Commissioner & Presiding Member
1516 Ninth Street
Sacramento, CA 95814

Regarding: Docket No. 11-AAER-1, Scoping for 2011 Title 20 regulations

Dear Commissioner Douglas and Committee Members,

Google would like to thank you for this opportunity to provide comments on the scope of future proceedings to amend California's appliance efficiency standards. Our comments address computers and servers specifically.

Google is a California-headquartered company whose Internet search and cloud-based services are used by more than a billion people each month. Though we do not sell computers and servers, we do employ a large number of such machines in our business. We have designed and built most of the servers in our datacenters ourselves, in part because the energy efficiency we sought was not readily available in the market. We have also engaged over the years with industry groups that address energy efficiency, including The Green Grid and the Climate Savers Computing Initiative, which we helped found.

We are providing comments for three reasons:

- First, we would like to offer our expertise to the Commission, as a company that not only has deep knowledge of computing hardware, but one that has built up expertise in computer energy efficiency through designing, building, and operating our own systems.

- Second, as a large purchaser of computing hardware, we benefit from widespread availability of cost-effective, energy-efficient hardware of all types. This could include paying slightly higher up-front capital costs for equipment if lifetime operating savings are reduced commensurately.

- Third, environmental sustainability is a core value at Google.

Because others will present to you various proposals with details on suggested sources of energy savings, we will not try to do so here. However, we would like to convey some of our company's experience with energy efficient computing.

As a company that earns most of its revenues through providing services over the Internet, operational costs of our servers are of high importance. We operate a large fleet of servers all over the world that run 24x7. In order to reduce operational costs, we strive to make our infrastructure as energy efficient as possible. To that end, we have designed ultra-efficient data centers. But we have also, not seeing appropriate products on the market, designed and built our own servers.

Building servers has been a learning experience for Google, but we have found over the years that there has been ample room to cost-effectively make servers more energy-efficient than what is typically found in the market. Together these energy efficiency measures have saved Google hundreds of millions of dollars in energy-related costs over the years. We have employed, among other things:

- High efficiency power supplies (90% and higher)
    - When we started, industry power supply units (PSUs) were commonly in the 60-70% range. Now, some personal computers (PCs) and most servers are in the 80%+ range, due in part to the Ecos 80+ program[1] and the Climate Savers Computing Initiative[2], but there is still room for improvement. In 2006 we published a whitepaper[3] on this topic.
- Right-sizing of power supplies
    - PCs and servers often ship with PSUs with substantially higher capacity than required for the as-shipped configuration of the computer. As a result PSUs operate at low levels of loading relative to their capacity, an inefficient regime. Simply "shrinking" the PSU to a more modest capacity can increase efficiency.
- High efficiency voltage regulator modules (VRMs) for on-board DC-DC conversion
    - In addition to the main PSU that converts from AC to DC for the server to use, DC-DC converters provide various lower DC voltages needed on the motherboard. Such converters vary in cost and efficiency, and more efficient VRMs can be cost-effective.
- Efficient, variable-speed fans
    - In general, careful design of airflow can allow for operation with less fan power, saving energy. This is particularly important for servers that will be operated in

[1] http://www.plugloadsolutions.com/80PlusPowerSupplies.aspx

[2] http://www.climatesaverscomputing.org/

[3] http://research.google.com/pubs/pub32467.html

higher-temperature data centers (which are themselves more efficient than traditional "chilly" computer rooms) since fan power can impair or reverse the energy-saving advantages of higher ambient temperatures.

- Systems to avoid uninterruptible power supply losses
    - Google has used on-system battery backup to avoid the AC-DC-AC conversion losses incurred by traditional uninterruptible power supply (UPS) systems. Other companies have turned to dual-input PSUs that can be fed either AC power or DC power from rack-level batteries. Regardless of the specifics, there exist opportunities to avoid extra power conversion losses due to UPS systems in server environments.
- System telemetry that allows health and power monitoring
    - Most of the major server manufacturers offer system health monitoring systems, but they are largely incompatible. Thus, operators of heterogeneous facilities have no central way to aggregate and examine system temperature and health variation. This makes it harder to optimize a facility by finding "hot" system inlets and making airflow adjustments.

Google has adopted all of the enhancements discussed above in various systems in our data centers, described on our blog[4] and on our data center site[5]. Because energy costs of our servers are a major component of our operational costs, they receive commensurate attention and analysis. Every design decision affecting our data center facilities and the servers within them is subject to a "total cost of ownership" (TCO) analysis. Many efficiency improvements cost a few more dollars initially, but a computer running 24x7 for several years provides ample time to earn back the cost and more in saved energy and reduced building infrastructure costs. In short, we care about energy efficiency as a company value and we strongly believe that energy-efficient computer and server technologies are cost-effective; we would not use them if they did not make excellent business sense. Google is not alone in this respect. For example, a recent EPA study[6] found that Energy Star servers do indeed save money on energy over equivalent non-Energy Star models.

Google pursues energy efficiency in desktop and laptop hardware as well, and looks to buy machines that are above average in this respect, such as computers that meet or exceed Energy Star requirements. This is not always possible because of the limited numbers of such models. As purchasers we would benefit if some of these features were common across a larger variation of personal computers.

Many of the various potential improvements mentioned above fit into a general philosophy of "energy proportional computing." What this means is the amount of energy used by a computer is roughly proportional to how much work it's doing. In a perfect world, an idle computer or

[4] http://googleblog.blogspot.com/2009/04/designing-lean-green-energy-saving.html
[5] http://www.google.com/about/datacenters/inside/efficiency/servers.html
[6] http://web51305.aiso.net/wordpress/wp-content/uploads/2011/06/ES_server_case_study1.pdf

server would draw almost no power. Current technology cannot achieve that, but system manufacturers are making strides.

Google has found the types of efforts discussed above to be cost-effective for our business, but we understand that the Commission must weigh the broader economic, environmental, and societal impacts of potential changes to computer hardware. We stand ready to work with the Commission as it considers these issues. Should you have further questions, please feel free to contact David Jacobowitz, Program Manager, Green Engineering and Operations (djacobow@google.com), or Michael Terrell, Energy Policy Counsel (mterrell@google.com).

Sincerely,

/s/

Urs Hölzle
Senior Vice President, Operations

cc: docket@energy.state.ca.us