Standards and Metrics for Evaluating ICT Service Efficiency

(NOTE: this paper was drawn from a comprehensive study conducted by the Minnesota Pollution Control Agency in 2013[i])

There are a variety of ICT standards and metrics that organizations can request in RFPs to help identify and compare GHG emissions associated with procured ICT services. These range broadly in the scope of considerations, from full environmental life cycle standards that document "cradle to grave" impacts to pledges that companies will take energy-saving steps in ICT management.

1. Full LCA Standards - *Comprehensive approaches that incorporate multiple environmental impacts.*

A. Green Grid Data Centre Life Cycle Assessment Guidelines:

The Green Grid (an association of ICT professionals seeking to dramatically raise the energy efficiency of data centers) developed the Data Centre Life Cycle Assessment Guidelines , intended for use by data center owners, renters, and operators as a common basis so that impacts are comparable across different centers. The guidelines follow ISO 14040/14044 standards for the general steps in conducting a life cycle assessment of a good or service. The resulting LCA would encompass power generation or "grid mix", hardware, cooling systems, and building structure. They recommend 7 primary and 2 secondary impact areas that all data centers should assess.

Primary impacts (shall be considered for all data centers):

- Energy consumption during operation
- Raw material depletion for construction of the data center structure
- Raw material depletion for manufacturing of ICT and facility equipment
- Land use and environmental impacts of the facility
- Mix of energy-generating sources used to support operation − Water consumption during operation
- Reuse, recycling, and/or disposal of ICT and facility equipment and materials

Secondary impacts (should be considered if relevant to a given facility):

- Hazardous substance content of data center building and equipment
- Air pollution during operation

B. European Telecommunications Standards Institute:

ETSI, the European Telecommunications Standards Institute, produces globally-applicable standards for Information and Communications Technologies (ICT), General methodology and common requirements (ETSI TS 103 199 V1.1.1 (2011-11)). The multi impact LCA

standard is based on ISO 14040 and 14044 (the internationally-accepted LCA standard for any type of product and service).

2. Full LCA Standard - *Greenhouse gas impacts only*

A. GHG Protocol's "ICT Sector Guidance"

The Greenhouse Gas (GHG) Protocol ICT Sector Guidance was set up to provide specific guidance on the GHG Protocol Product Life Cycle Accounting and Reporting Standard (the Product Standard). The objective is to provide a consistent approach for assessing the life cycle GHG impacts of ICT services.

The guidance covers ICT services of telecom networks, managed desktops, and cloud/data centers. Guidance on calculating life cycle greenhouse gas emissions from hardware and software products is also provided.

3. GHG Metrics

A. Carbon Usage Effectiveness (CUE) (Green Grid and Energy Star)

The relatively new Carbon Usage Effectiveness (CUE) metric is very useful. It is a metric of the GHG emissions associated with a specific data center. This is emerging as an extremely important factor in the design, location, and operation of these facilities today and in the future. CUE was developed by the Green Grid. CUE, combined with the Power Usage Effectiveness (PUE, see below) metric enables data center operators to quickly assess the relative efficiency and sustainability of their data centers.

$$Carbon\ Usage\ Effectiveness\ (CUE) = \frac{CO2e\ (kg)\ from\ data\ center\ energy\ consumption\ (electricity\ use)}{total\ IT\ energy\ consumption\ (kWh)}$$

Alternatively

$$CUE = Power\ Usage\ Effectiveness\ (PUE)\ x\ GHG\ Electricity\ Emission\ Factor$$

The GHG emissions from data energy consumption are calculated by multiplying the data center's electricity use total by the GHG emission factor of the electric utility provider or regional electricity grid system. The CUE's ideal value is zero (a zero carbon data center); CUE does not have a theoretical upper bound. Both CUE and PUE simply cover the operations of the data center. They do not cover the full environmental burden of the life-cycle of the data center and ICT equipment. For now, CUE is specifically limited to GHG Scope 1 and Scope 2 emissions.

B. GHG intensity of information (e.g. CO2e/TB of information)

This metric is similar to a GHG LCA result for certain ICT services; the difference is that the metric only covers the GHG emissions from the data center operations. It excludes emissions from manufacturing data center hardware. It requires the vendor to know the total energy usage, emission factors of the energy sources, and the total amount of information processed and delivered to customers. In an informational phone call CenturyLink indicated that they are currently calculating CO_2/terabyte (TB) of information at the request of several customers, suggesting that this would be a reasonable metric for state purchasers to request as well.

Other applicable denominators are length of service (e.g. 5 minute phone call between two parties, or 30 minute webinar with 10 participants, etc.) or per application run (e.g. one database search). The appropriateness of different calculation denominators will depend on the type of ICT service procured. There is currently no "gold standard" for calculating this metric.

4. Energy efficiency standards, certifications, and metrics

A. Power Usage Effectiveness (PUE)

The PUE metric was developed by Green Grid. It has been widely adopted by industry according to the Green Grid.[ii] ENERGY STAR has also adopted the PUE calculation. PUE measures the ratio of data center facility energy use to the energy in the ICT services delivered to end consumers, where facility energy includes everything that supports the ICT equipment, like lighting, heating, cooling, and the ICT equipment energy is the servers, computers, network equipment. A 100% efficient data center would have a PUE of 1.0, where every kWh of supporting energy serves a kWh of ICT equipment energy. According to a GreenGrid/EPA joint presentation, a 2.0 PUE is typical in the industry; 1.2 PUE is best in class.[iii]

$$Power\ Usage\ Effectiveness\ (PUE) = \frac{Total\ Facility\ Energy\ (kWh)}{IT\ Equipment\ Energy\ (kWh)}$$

B. Energy intensity metric (bits per kWh)

Another metric developed by the Green Grid is the bits per kWh consumed, a performance metric. This metric measures the output of a data center (in data unit 'bits') compared to the amount of energy used to deliver the bit to a customer. A bit is the basic unit of information in computing and digital communications.

5. Energy efficiency benchmarking

A. Energy Star Data Center Guidance/Certification w/ Portfolio Manager score >75

Energy Star's Portfolio Manager is an interactive energy management tool for facility managers. It now includes data center building types in the tool. Data centers can be Energy Star certified by achieving a Portfolio Manager score of 75 or more. Asking for Vendors' data center Portfolio Manager scores may be a useful metric for state purchasers

6. Company-wide GHG and energy inventories or pledges.

A. Energy Star Low Carbon ICT Campaign - Pledge

The ENERGY STAR Low Carbon ICT Campaign is a nationwide effort to assist and recognize organizations for reducing the energy consumed by their ICT equipment. Companies that take the pledge help ENERGY STAR evaluate its efforts and improve the campaign. In return for a company's pledge, the organization will have access to a number of free resources to help them lower their ICT energy usage.

Organizations that have taken the low carbon ICT campaign power management pledge: http://www.energystar.gov/index.cfm?c=power_mgt.pr_power_mgt_low_carbon_participants

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[i] Lahd, H., (2013, September). *Procured information communication and technology (ICT) climate impacts and procurement recommendations*. Minnesota Pollution Control Agency.

[ii] Avelar, V., Azevedo, D., French, A. (eds.) PUEtm: A Compresensive Examination of the Metric, 2012, The Green Grid. https://datacenters.lbl.gov/sites/all/files/WP49-PUE%20A%20Comprehensive%20Examination%20of%20the%20Metric_v6.pdf accessed 5/19/2015

[iii] Patterson, M (2010). The Green Grid EPA Data Center Assessment. The Green Grid. Accessed August 8, 2014 from http://www.thegreengrid.org/~/media/TechForumPresentations2010/EPA_Data_Center_Assessment_Report.pdf?lang=en