MEASURING ENVIRONMENTAL IMPACT USING LIFECYCLE ASSESSMENT

Beth Whitehead, sustainability engineer at Operational Intelligence, describes how energy consumption and mix, and the number of servers provide data centers with the biggest opportunity for environmental impact savings

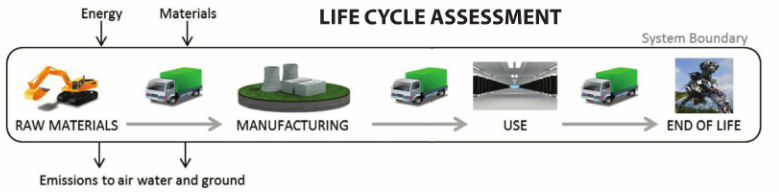
There is no denying the data center industry is acutely aware of the energy it consumes. But is energy consumption the only demon in the data center? Metrics such as power usage effectiveness (PUE) are widely used by the industry, and their adoption has opened up the dialogue on environmental impact. But once a facility's PUE is optimized where should attention be turned to next? Should the IT energy consumption or perhaps the embodied impact of the IT equipment be reduced? Or has the improvement in PUE resulted in an environmental impact in another area of the data center?

These questions are hard to answer in isolation. Understanding trade-offs is incredibly complex, but to ensure the driving down of energy does not result in pollution shift, environmental impact needs a more holistic approach that goes beyond just the energy used to operate a facility.

LIFECYCLE ASSESSMENT

Lifecycle assessment (LCA) considers the energy and raw materials used at every stage of a product's supply chain, and the emissions that are created as a result of this consumption. The method studies this consumption and resulting emissions from the moment materials are extracted to the point the component is made, used and then disposed of at its end of life. Using cause-effect analysis, the contribution each emission has to a specific environmental impact – such as climate change, land use and carcinogens – is then quantified, much like the use of global warming potentials to compare refrigerants. By considering every component of the data center together and beyond operation, environmental trade-offs can be quantified and managed.

For example, consider energy consumption and apply it to servers. Server inlet temperatures are raised to enable a reduction in operational cooling energy. These higher temperatures can increase server fan energy, minimizing operational savings from reducing cooling loads. If the server could be increased from 1U to 2U to allow better flow of air across the equipment there would be additional energy used but a potential saving in this additional fan power. By using LCA, the subtleties in this example can be quantified and total life time energy consumption, and other environmental impacts, minimized.



LCA is not a new concept. It has existed since the 1960s when Coca-Cola used it to understand the environmental implications of changing from glass to plastic bottles. Today it is used extensively by the chemical and construction materials industries, and there are signs that the data center industry is joining the revolution. Perhaps the most significant sign is the release of a white paper on the topic by The Green Grid, suggesting that it should eventually be included in the Data Center Maturity Model. We have also seen the emergence of ICT studies that look at the impact of embodied carbon pre- and post-operation, and operational carbon and the creation of the Electronics Disposal Efficiency metric which monitors the impact of electronic equipment disposal.

IMPACT OUTCOMES

Results from a recent research project run by HP and the London South Bank University (LSBU) yielded some interesting outcomes with respect to the lifecycle environmental impact of data centers.

Figure 1 (below) shows that the impact in the data center is dependent on the type of environmental impact under consideration. For example, impact from climate change and fossil fuels is most significant during the operational phase of a facility. The greatest opportunity to reduce a data center's contribution to

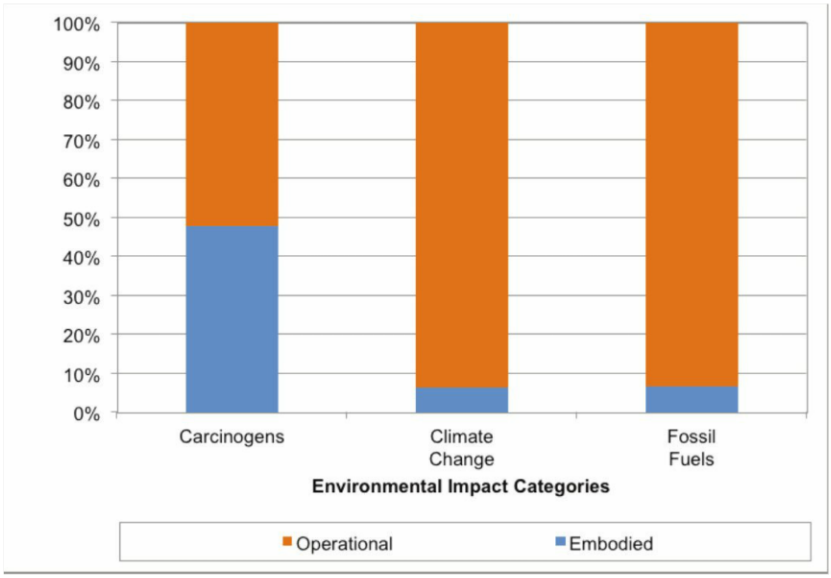
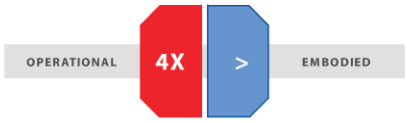


Figure 1: Share of impact from the studied data center for various environmental impacts

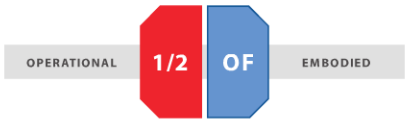
these impacts is therefore by improving the efficiency with which IT and power and cooling infrastructures consume energy. When considering the impact from carcinogens, however, the impact embodied in the facility is almost equal to the operational impact. To reduce this impact, there needs to be an effort made throughout the life time of the facility. Environmental load is therefore not derived only from operating the data center.

Data center design can vary enormously and it is clear that environmental impact also varies, according to the systems used. The following is an example of three data center studies focusing on impact.

1. This baseline UK data center used free cooling. The facility replaced servers every three years and was fully populated with servers that used 50% of peak power to idle and were 30% utilized. This resulted in an operational impact four times the size of the embodied impacts.



2. When the same baseline facility was modeled in Sweden, with an annual server refresh and an improved energy consumption from measures, such as consolidation and virtualization and reduced idle power, the embodied impact was almost double that of the operational impact.



3. When the above scenario was studied in the UK, and not in Sweden, the operational and embodied impacts were almost equal in relevance for this study.

These are not radical scenarios, they represent facilities where every effort has been made to improve energy efficiency and which include rapid refreshing of IT. These scenarios help to show three main areas within the data center that currently offer a sizeable opportunity to reduce environmental impact. These are:

- Energy consumed in operation by the IT equipment, for cooling and in power losses;
- Mix of the energy used to produce the electricity, as shown in Figure 2;
- Levels of IT equipment used across a facility's life time.

ATTENTION TO DETAIL

To ensure any reduction does not create an impact elsewhere, the continual monitoring of the total lifecycle impact is important. But LCA is not for the faint hearted and requires endless attention to detail, as well as time to compile the studies. For the process to be adopted, the industry needs tools to lighten the workload.

The research project conducted at LSBU with HP included the development of a software tool that enables designers and operators to track environmental impact. Using the tool is simple. It requires quantities of the various materials, building services and IT equipment found in a specific data center. The user is then provided with results.

The tool is incredibly important. For the first time, it makes it possible for designers and operators to understand the environmental trade-offs from different design choices for the building shell and all its contents, and omits the need for every user to be an expert in compiling complex environmental models.

With the tool comes the opportunity for the industry to benchmark its impact on the environment in a holistic manner. It creates the ground work from which a data center rating system can be compiled.

INTERNET EDUCATION

The industry is often considered in isolation, and in many cases efforts are made to reduce the symptoms – that is the impact from the data center – without considering the cause, which in this case is how the Internet is used.

Consumers should think about the way in which ICT is used, from storing photos online in various locations to streaming videos on YouTube. There needs to be more education to ensure internet users understand there is a physical backbone to the Internet, and internet use has an environmental impact.

MIXED MESSAGE

Of the three opportunities for reducing environmental impact, energy mix of the country's electricity supply is perhaps the most interesting. There are many difficulties for a data center when it comes to using renewables, such as space required to implement onsite renewables and lack of power if there is not wind or daylight. It's clear the industry needs to be creative in its approach – for example by considering staggering work load – and it should put pressure on government to increase the renewables content of the energy mix.

While the industry has gone to great lengths to reduce its consumption of energy, there is a cogent argument for the need to assess and monitor more holistically the environmental impact of data centers. ■

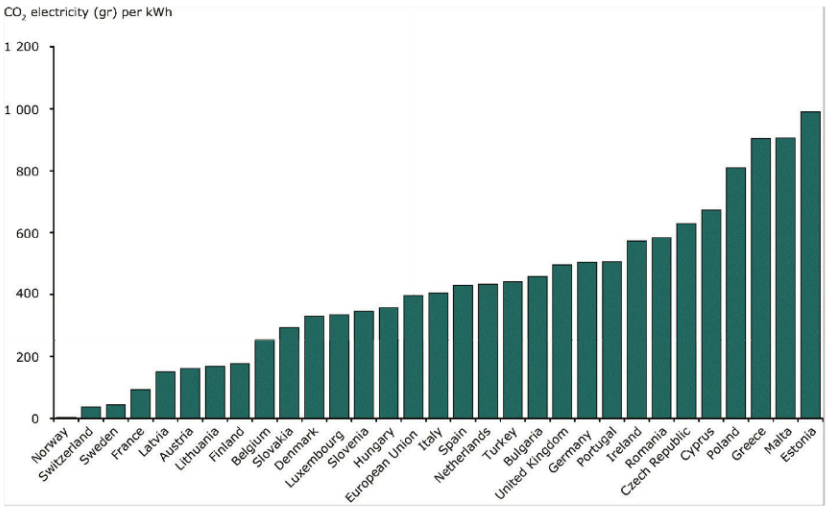


Figure 2: CO_2(gr) per kWh in 2009 (electricity only) per EU member country