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](image-url)
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.