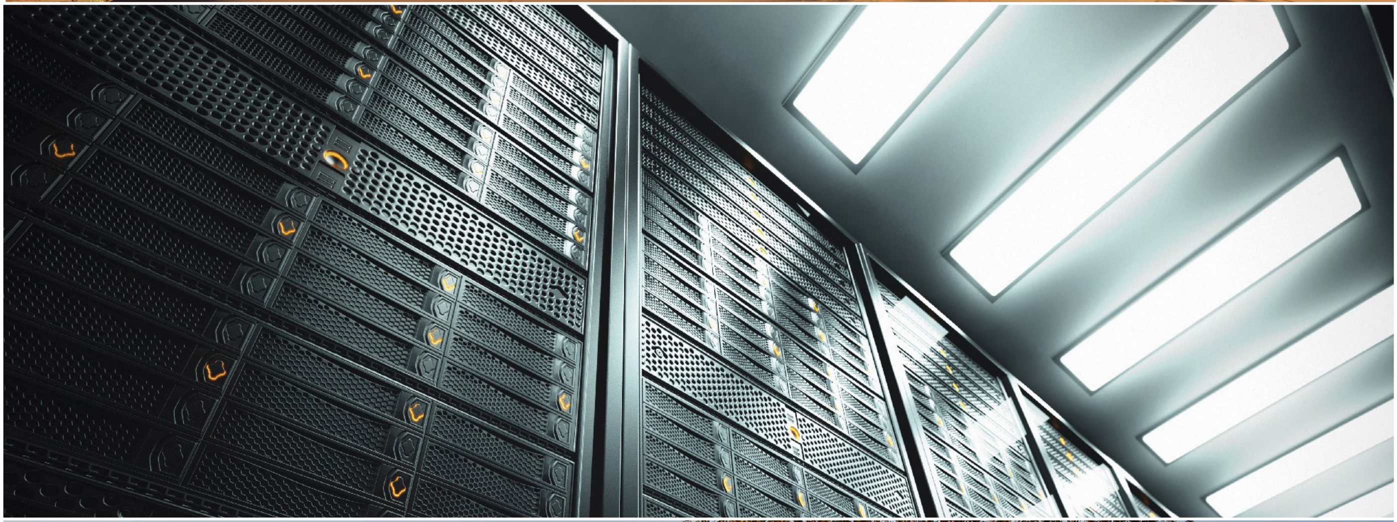


White Paper

African Climate & Datacenter PUE 2021

CAP DC

AFRICA DATA CENTRES ASSOCIATION

PREFACE

Olivier LABBÉ
General manager Cap DC

Africa is the last continent in which data center growth is still ahead of us. The question is not whether this industry will develop there massively in Africa but when and in which order.

This white paper was produced under the aegis of the ADCA (Africa Data centres Association) and aims to present, after the first 2020 survey, an second output of the Datacenter Energy Performance and Climate impact from the African industry.

Apart from the intrinsic technical results it provides, this White Paper is also the opportunity to demonstrate to the « outside world » that the African continent is contrastive, when it comes to analysis of the industry from the economic point of view, the cultural point of view, and also the… climate point of view.

Africa is not only the classic suppositional format of Sahara desert, where the temperature climbs at 50 °C during the day and can drop below zero during the night! Between Algeria, Congo, the highlands of Ethiopian plateau and the temperate and oceanic weather of Republic of South Africa (RSA), the diversity of climate is obvious.

Adding to that, the capacity of the African Datacenter industry has great ability to rely on modern technologies. This white paper confirms that the climate in Africa won't be an obstacle to it's Datacenter industry growth.

We decided also this year to explore the African innovative potential in using renewables energy as well as hydrogen storage technologies to supply Datacenters. On top of a good performance in energy consumption, these are also some scopes in which the continent could lead the way in the coming years.

I hope you will share in my enthusiasm in discovering the results of this white paper.

summary

INTRODUCTION

This White Paper is based on a survey performed by the African Datacenter Association (ADCA) during summertime 2021 and with the most important Datacenters providers in Africa.

Twenty-six Datacenters owners accepted to share their technical data in order to allow this second dashboard about African Datacenter industry performance.

Even if the number of Datacenters is still limited in Africa, the Continent proves that despite the non conducive climate, there is no obstacle to develop local IT infrastructures.

The survey results has been analyzed by the energy specialists from Cap DC (Cap Ingelec group), an engineering company specialized in Datacenter design&build and operating in Africa from 5 branches.

Part 01

AFRICAN PUE

The PUE (Power Usage Effectiveness) is the most common parameter used by the Datacenter industry. This metric is used to determine the energy efficiency and is obtained by dividing the amount of power entering a data center by the power used to run the computer infrastructure within it. The PUE is therefore expressed as a ratio, with overall efficiency improving as the quotient decreases toward 1. The PUE was created by members of the Green Grid, an industry group focused on data center energy efficiency.

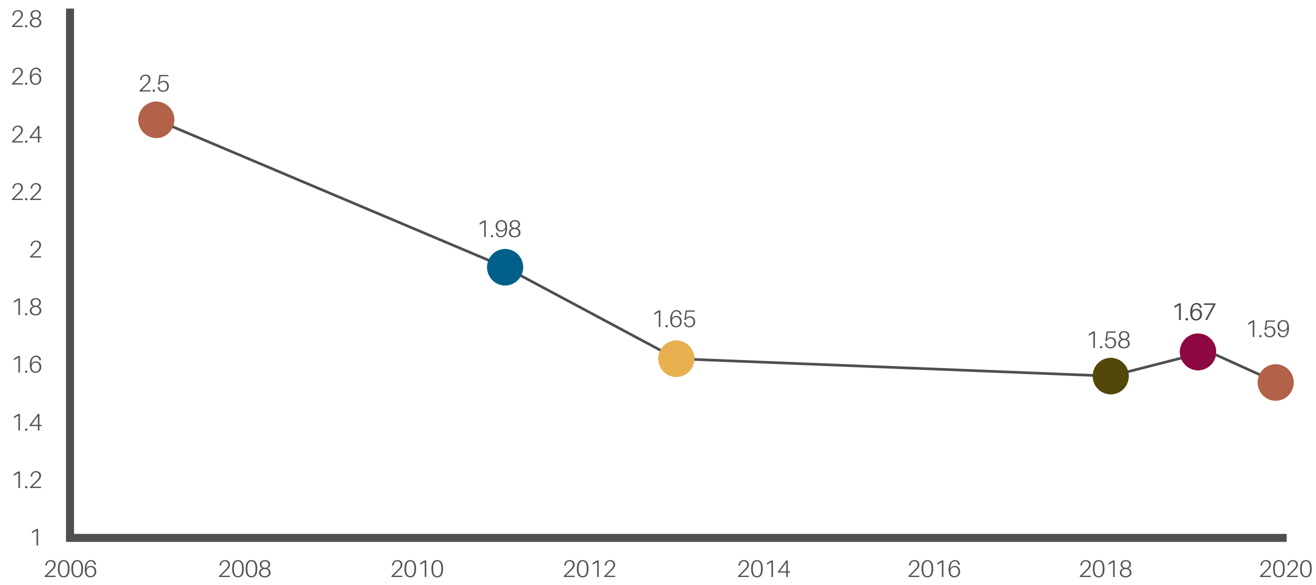
The Datacenter Industry agrees to the fact that the PUE is only a very basic concept, as evidenced some examples (among others) given hereafter :

- With adiabatic architecture, you can improve your PUE while increasing your water consumption, thus deteriorating your overall environmental impact.
- A more sophisticated resiliency architecture level will increase, for the same IT load, the PUE. As a consequence, the PUE is not an immediate and unique consequence of the energy performance, but depends also clearly of usage typology requests.
- Multiple parameters not direclty linked to the energy performance may have an impact on the PUE, such as the load of the IT room, the electrical density etc...
- The PUE doesn't take into consideration the energy mix of the local electricity provider, which has a direct impact on the Datacenter effective carbon impact.

Nevertheless, this parameter is very relevant in order to qualify a statistic situation of a market.

According to Uptime Institute, the average WW PUE in 2020 was 1.59

Part 01. PUE



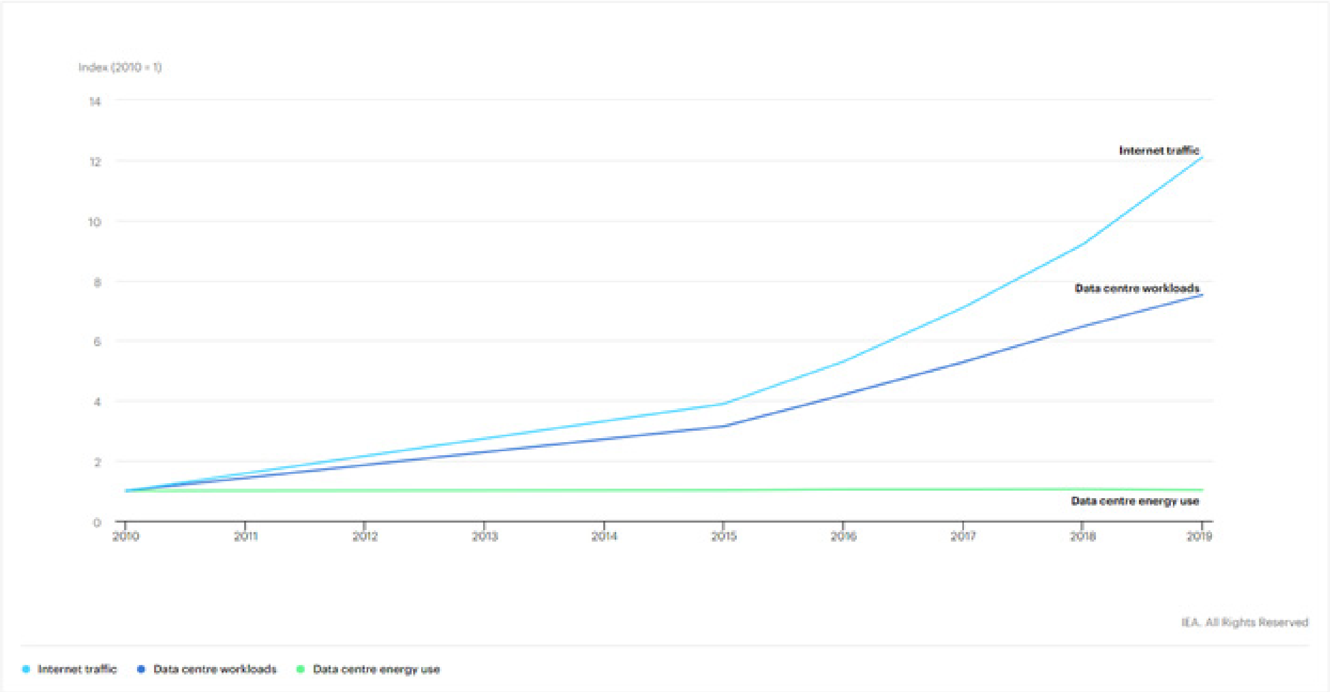
Source : https://journal.uptimeinstitute.com/

Whereas the PUE has almost been halfed in over ten years, but it seems that a we are now reaching a floor, that specialists explain by various series of elucidations:

- After a full concentration momentum symbolized by the Hyperscale model, the industry also currently experiences some decentralized trend such as Edge computing (for 5G, IOT, … usage). This reversal towards decentralization will mitigate PUE improvment.
- The temperature rising on the planet, even still low, is felt all over the world and so impacts 100% of the Datacenters.

Finally, this PUE improvment target is very valuable and the Datacenter industry know-how and effort is paying back. As described by the International Energy Agency (IEA), while the Datacenter workload increased by 8 times during the last decade, their energy use, remained quite flat. The Datacenter energy efficiency is therefore a key asset to allow for in the digital growth.
Africa must demonstrate its capacity to keep this momentum while it's Datacenter industry is booming.

Part 01. PUE

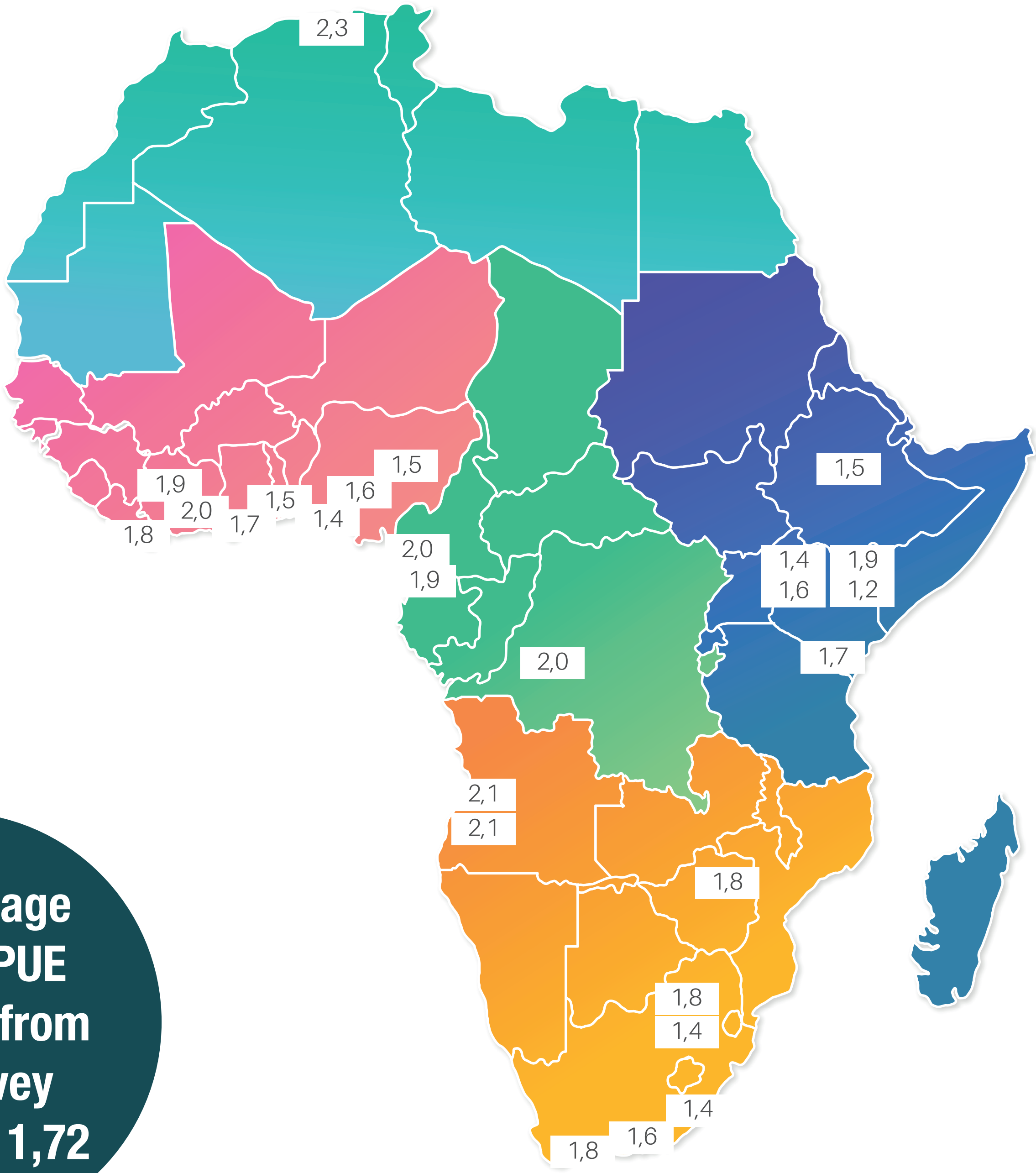


Source : IEA

Part 01. PUE

The average African PUE resulting from the survey stands at 1,72, that's to say only 8% above the worldwide average. This result comes from a sub average of 1,47 for Datacenters running with Free-cooling or Free-chilling and 1,81 for the others.

Average with FC	1.47
Average w/o FC	1,81
Average	1,72

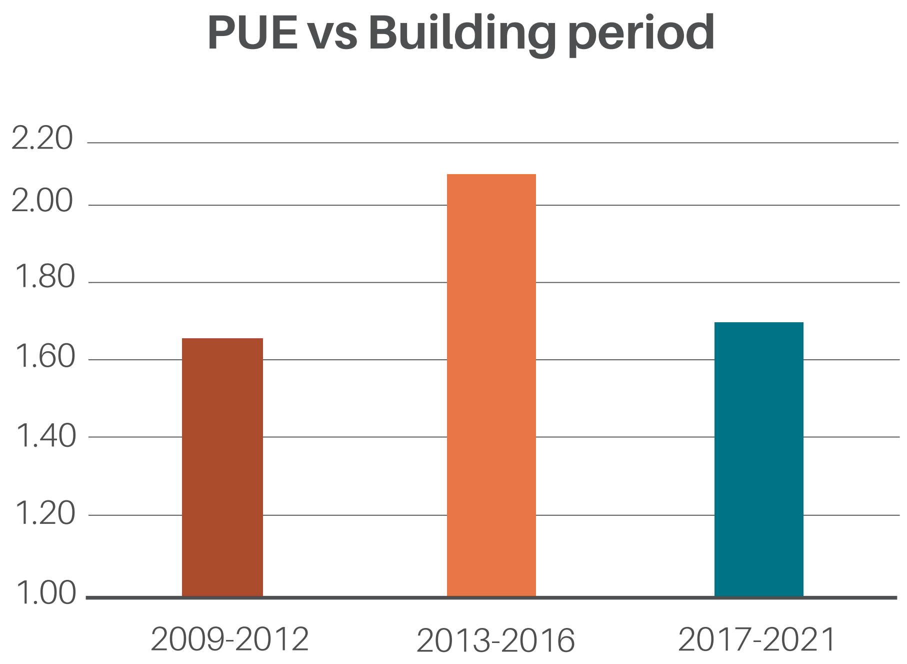


The average African PUE resulting from the survey stands at 1,72

This relative good result can be explained at first glance by:

- A very recent park (54% of the Datacenters has been built after 2015, and if we take into consideration only the Datacenters built after 2017, the average PUE resulting from this survey stands at 1,53).
- Very few Datacenters are located in the very hot African climate areas (most of them are closed to the coast or, also in areas of high altitude). Indeed, the medium of average yearly temperature for the locations involved in this survey sample is « only » 22.2 °C.

- Let's also notice a slight progress vs the 2020 survey, that showed a 1,79 average PUE in Africa, improving from 4% vs last year.

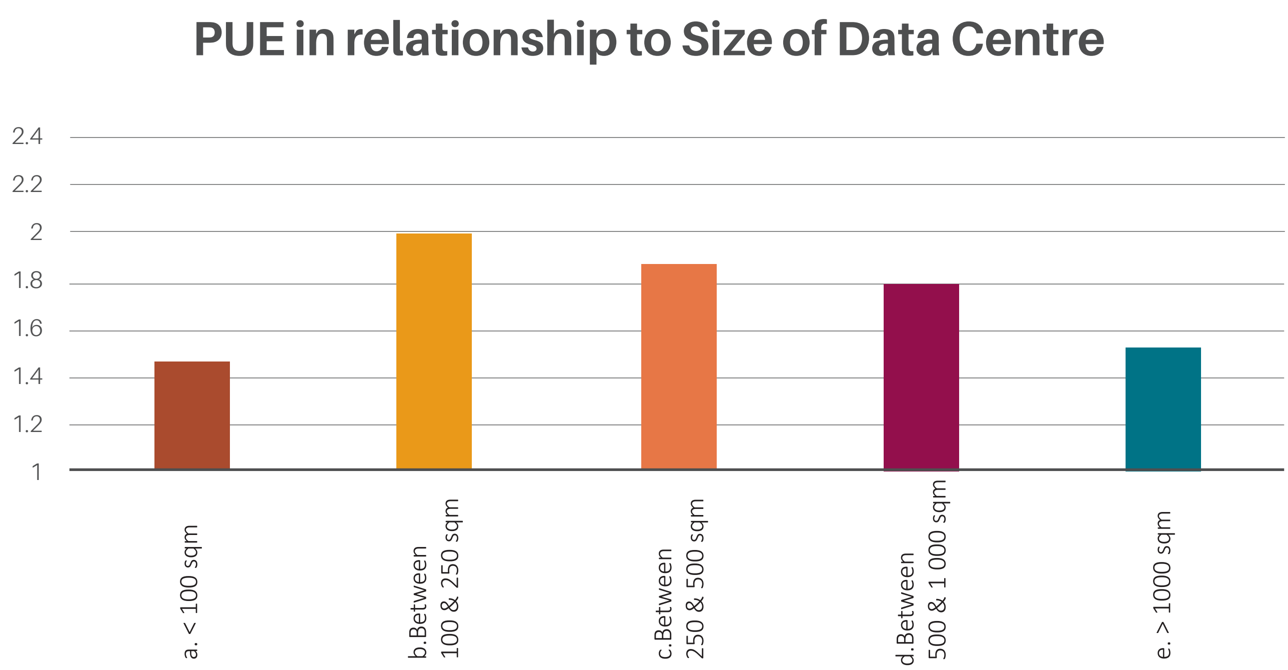


Part 02

DATACENTER SIZE & PUE

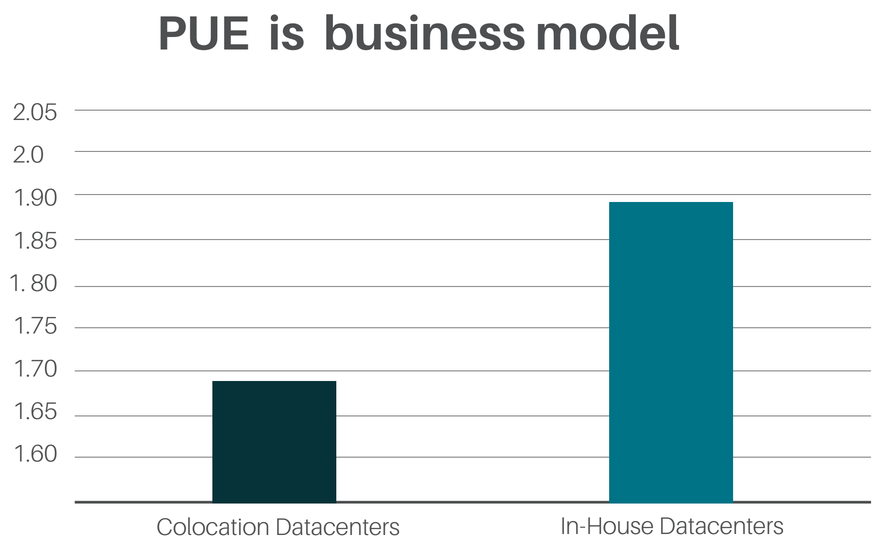
Part 02. DATACENTER SIZE & PUE

The size of African Datacenters is still modest, although the first Hyperscales are recently entering the South African market.
This survey demonstrates nevertheless that the Industry is able to mutualize investment on professional energy performance architectures, especially in case of large capacities.
Indeed, apart from the very small Datacenters, for which the correlation doesn't work, the larger the Datacenter, the better the PUE stands.
For the smallest Datacenter, some reasons may explain the result : if we focus on this specific survey sample, we figure out that this scope consist mostly in small Tiering and small density... On the other side of the graph, the most important take- away is that the big African Datacenters are definitely providing a very impressive average PUE at 1,56.



Part 02. DATACENTER SIZE & PUE

Unsurprisingly, if we focus on colocation Datacenters (vs in-house Datacenter), we also observe a better PUE, doubtless resulting from stronger investment capacities. This gap kept on increasing vs the 2020 survey.

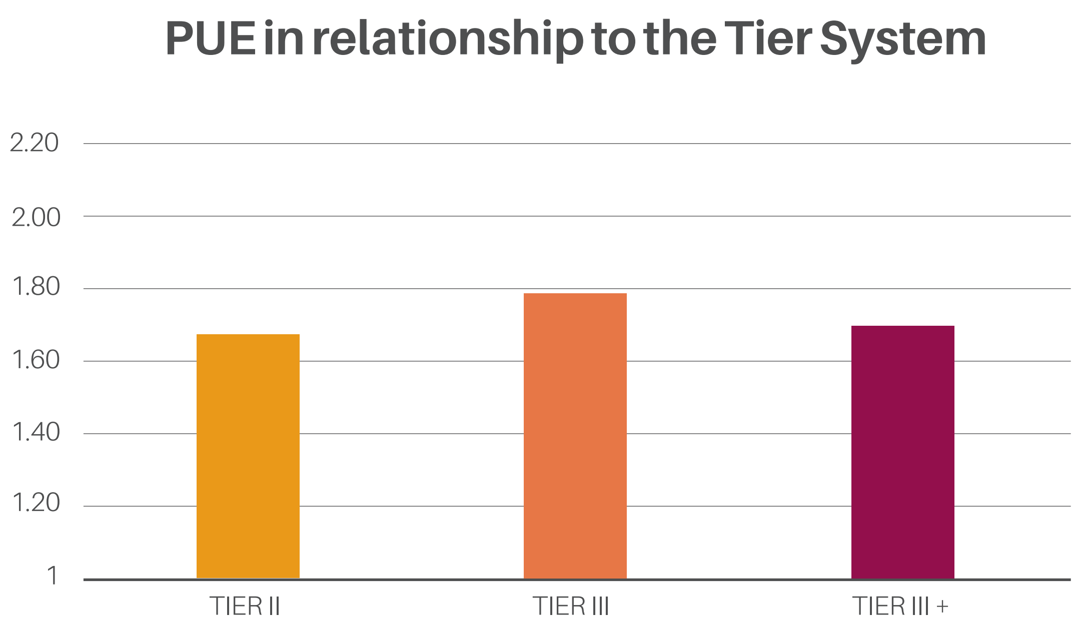


Part 03

PUE & TIERING

Part 03. PUE & TIERING

We also analysed tthe PUE performance resulting of the Tiering. The survey figures has been given in regards of the Uptime Institute tiering, which is the most commonly accepted parameter to define the level of resiliency reached by a Datacenter. We didn't question during the survey if the tiering was an estimate of the Datacenter capacity or a real certification. At the end of the day, no Tier IV were identified inside the survey, and we had knowledge of only 3 possible options in the sample : Tier II, Tier III and Tier « III+ », the last level describing usually a situation with aditionnal options resulting in a more resilient architecture than a Tier III (for instance, one UPS on each of both electrical paths), but without reaching a upper official level according to Uptime Institute.
Theoritically, the higher the Tier level, the higher the PUE, as the redundancy architecture doesn't optimize the load of electrical component.
The survey result shows this trend, except for the Tier III+, certainly resulting on higher investment, wheras 100% of the Tier III+ were declared by colocation providers. For instance, modular UPS technology may mitigate the « non- nominal » usage impact, or, in the HVAC scope, a good design may also take advantage of architecture redundancy.

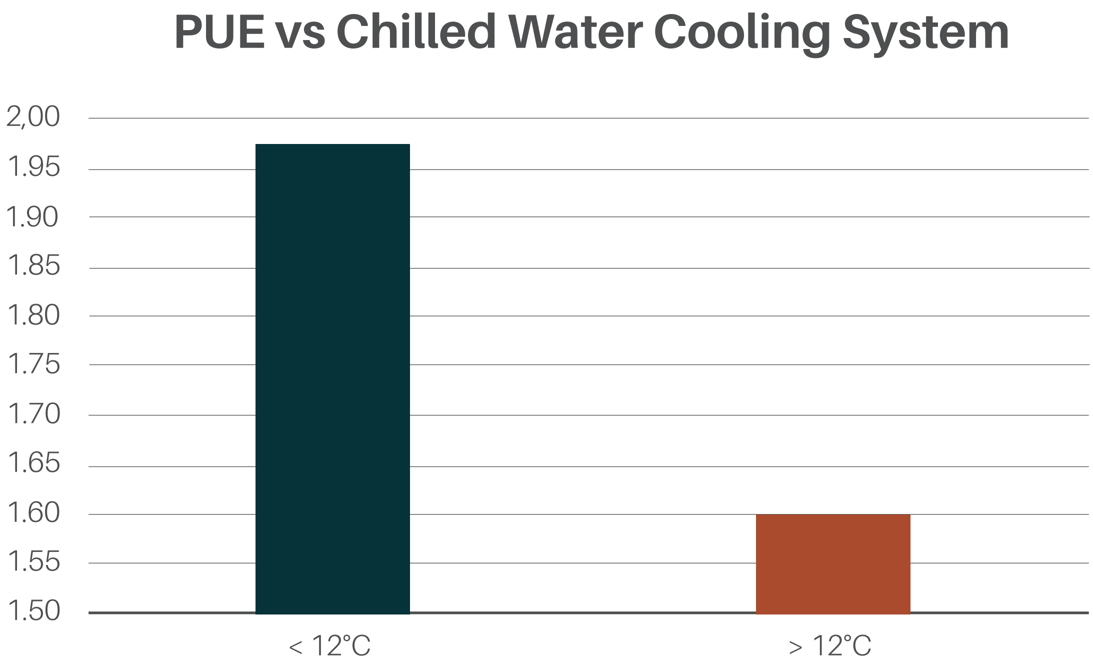


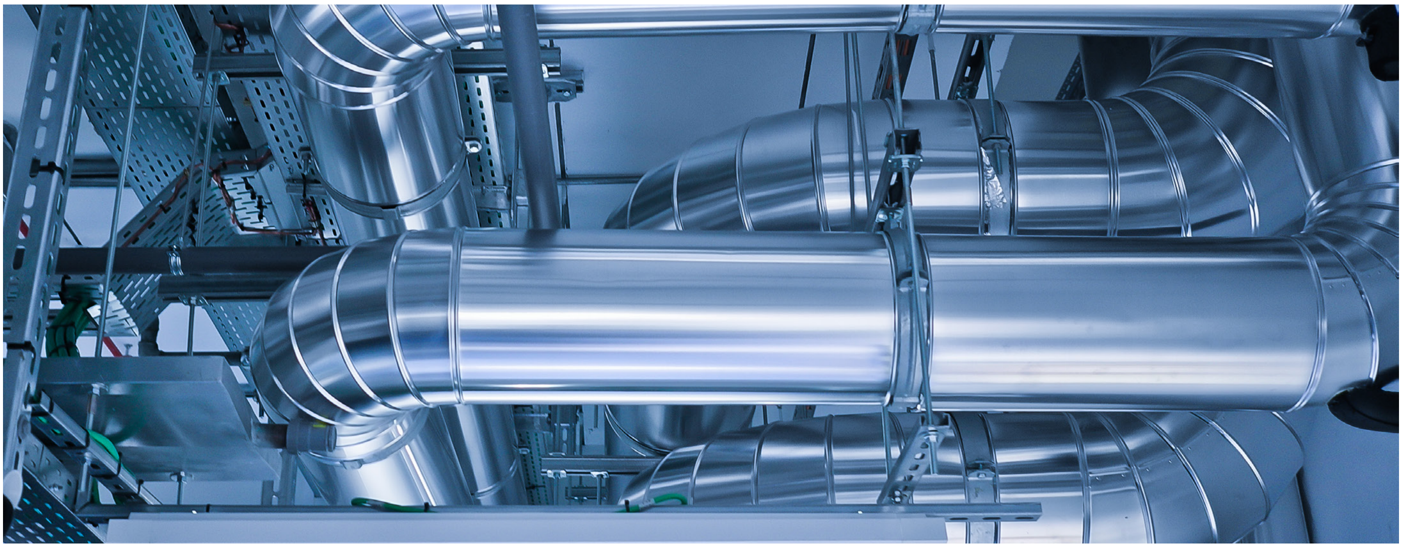
Part 04

PUE & CHILLED WATER TEMPERATURE

Part 04. PUE & CHILLED WATER TEMPERATURE

Without any surprise, in the case of Datacenters cooled through chilled water, the supplied water temperature set point choice impacts dramatically on the PUE. Low temperature option leads to poorer PUE result. The chart here below, is a clear demonstration of this incidence. Generally, a low temperature set point is selected to compensate a bad urbanization, suffered within the old facilities. 100% of the new Datacenters entering in this 2021 survey are using a set point above 12° C.





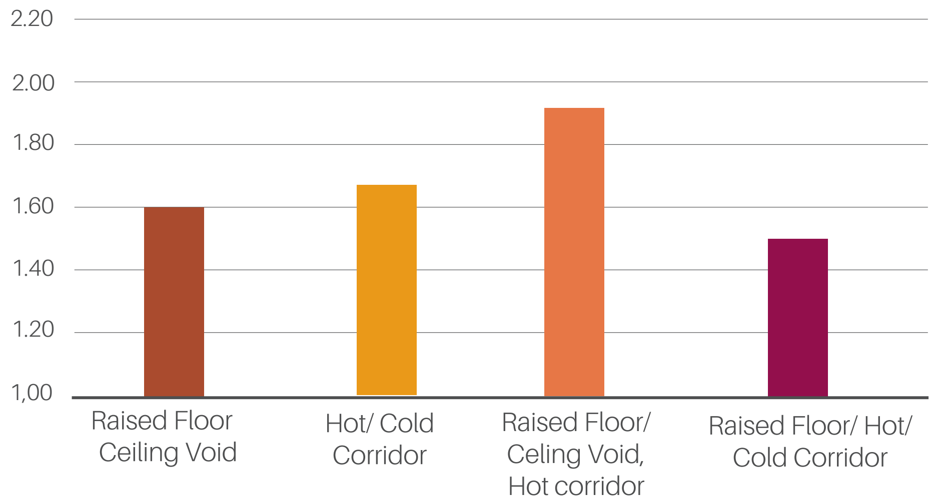
Part 05

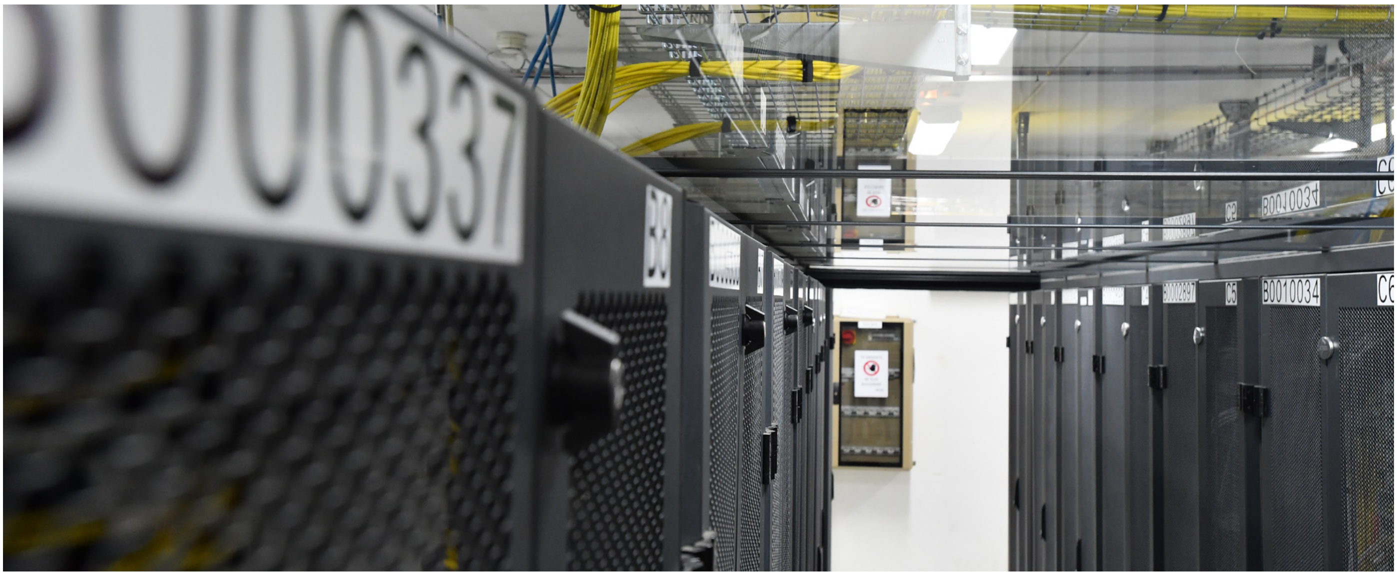
TYPES OF CONTAINMENT

Part 05. TYPES OF CONTAINMENT

Usage of containment solution is massively already deployed inside the African Datacenters, with 65 % at least using either Cold or Hot Corridors.
This is due to the fact that the pack is quite recent and definitely benefited from the late design best practices. This mass adoption of containment contributes certainly to the good PUE performance highlighted in this survey.
Among the multiple architectures declared, the best result is obtained with a combination of Raised Floor + Hot/Cold corridor.

Containment architectures





Part 06

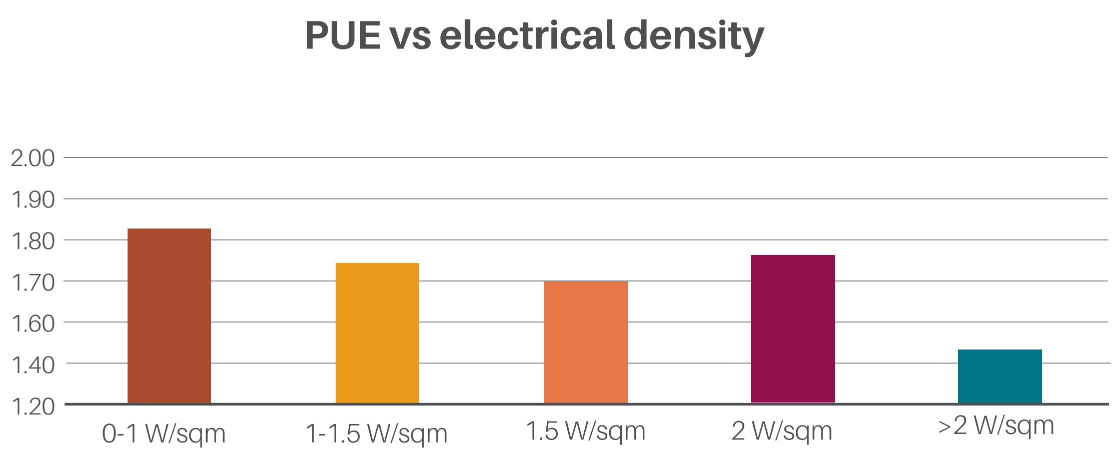
PUE & ELECTRICAL DENSITY

Part 06. PUE & ELECTRICAL DENSITY

In 2020, the WW average electrical density in the IT room was 8,4 kW/racks, showing a multiplication by ten during the last decade (Source : "Uptime Institute global data center survey 2020"). This leads to a current global trend between 2 and 3 kW/sqm.

The figures received through this survey show that Africa are still dealing with lower density as compared to the other markets (Africa average : 1,72 kW/sqm), but in growth from 22% over one year.

As shown in the chart here below, the higher the electrical density, the better the PUE. We thus know that under roughly 1 kW/sqm, raised floors are sufficient, whereas for higher electrical density requirements, in-row technology becomes mandatory. While avoiding containment investment, some African datacenters with low density, may suffer in PUE performance.



Part 07

IS CLIMATE A DETERMINING CRITERIA

Part 07. IS CLIMATE A DETERMINING CRITERIA

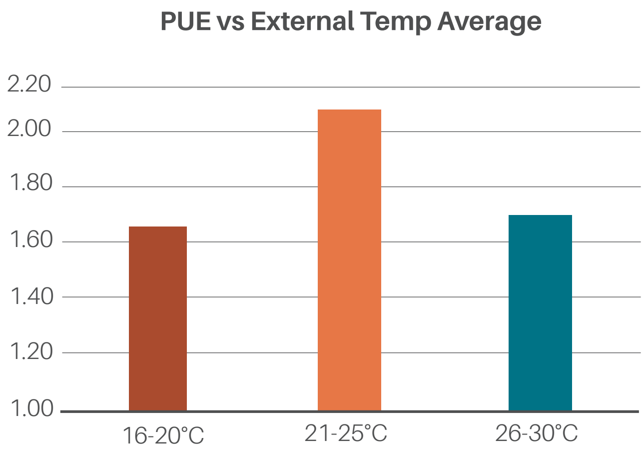
Going back to basics, the intuitive feeling about African PUE was pessimistic regarding climate impact.

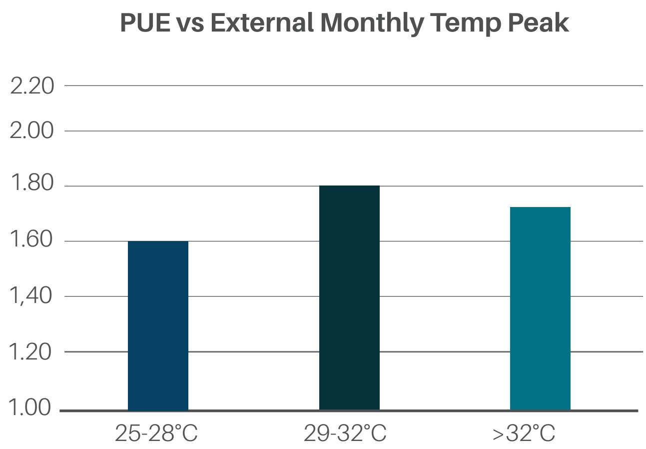
We already described the fact that the Datacenters in Africa are massively located in coastal areas, where the climate is not too excessive.

In addition to that first conclusion, we tried to correlate the local weather and the PUE performance. The « good » news is that there is no real adverse findings.

The two graphs here below show that neither the yearly average nor the peak temperature period can alone irreparably affect PUE.

This is actually a good news for the African continent, demonstrating that there is no impediment to build a sustainable and strong Datacenter industry in Africa, if the stakeholders follows the design best practices and accept to dedicate relevant investments for energy efficency.





Part 08. IS CLIMATE A DETERMINING CRITERIA

Once acknowledged that the energy performance of the African Data Centre industry is adequate, let's open a new question mark : will these Data Centres benefit from a better renewable energy potential ?

Recognizing the carbon and energy-intensive nature of data centres, and being pressed by global climate change mitigation targets, these facilities are forced to look to renewable energy in a bid to reduce their reliance on fossil-based electricity supply and contribute their fair share of climate change mitigation efforts.

Niraj Shah, VP of Business Development & Sales for IX Africa DataCentre, collected some examples in Africa and share its feedback.

The transition to renewable energy in Africa has been progressing impressively over the last decade, with many countries working to increase renewable energy capacity in recent years. Data centres play a key part in enhancing the digital infrastructure that is vital for improving internet access across Africa. Conversely, they are energy-intensive, and hence the importance of moving to renewable energy – energy that is green, low cost and provide consistent power. In Africa, the number of people gaining access to electricity doubled from 9 million a year between 2000 and 2013 to 20 million people between 2014 and 2019, outpacing population growth. As a result, the number of people without access to electricity, 610 million in 2013, declined to 580 million in 2019. This drive comes from a small number of countries leading the progress, in particular Kenya, Senegal, Rwanda, Ghana and Ethiopia. In Kenya, the access rate rose from 20% in 2013 to almost 85% in 2019. The majority of progress over the past decade in Africa has been made as a result of grid connections, but a rapid rise has been seen in the deployment of off-grid systems. Kenya, Tanzania, and Ethiopia accounted for around half of the 5 million people gaining access through new solar home systems in 2018 (up from only 2 million in 2016) Africa has shown great progress in the development of its solar energy markets over the recent years, with the continent experiencing a growth of over 1.8W of new solar installations, mainly driven by five countries; Egypt, South Africa, Kenya, Namibia and Ghana.

Part 08. IS CLIMATE A DETERMINING CRITERIA

Over the past few years, Africa's renewable energy solutions have proven to be economically viable, he says, underpinned by significant innovations across technologies. In particular, the costs for electricity from utility-scale Solar photovoltaics (PV) fell 82 per cent between 2010 and 2019, while similar trend in wind project reflected a 50 - 60 per cent decline between 2010-2019. Consequently, Africa's renewable energy mix has gradually shifted from traditional hydropower and thermal plants to renewable solutions to both accelerate energy access and support sustainable economic growth.

In a recent article from the International Monetary Fund's quarterly publication Finance and Development, researchers explore how scientific advances in renewable energy technology, its falling costs, and the continent's geography can contribute to renewable energy becoming a prominent, affordable, and competitive source of electricity in Africa. An integrated energy mix dependent on renewable energy can support strong growth, reduce low emissions, and provide an ecologically sustainable future. Most of Africa's current energy mix is almost wholly composed of fossil fuels and biomass. But a substantial reduction in renewable energy costs is enabling Africa's renewable energy transformation. The most dramatic change is the steep decline in the cost of solar photovoltaic energy, which decreased 77 percent from 2010 to 2018. Solar – 0.28USD per KWH declined to 0.07 USD per KWH Trailing this are both on- and off-shore wind, which experienced notable declines in cost.

Wind farm - Desert in Egypt

Part 08. IS CLIMATE A DETERMINING CRITERIA

Supply instability concerns with renewable energy have been mitigated by technological advances in energy storage and hence has strengthened solar energy's reliability.

As renewable energy necessitates high capital expenditure, African countries' governments should have an agenda to mobilize public, private, and multilateral and bilateral donor financing to raise funding focused for renewable energy infrastructure projects and mitigate the expensive upfront costs. Some African countries already switched to green energy and can show a very positive carbon-free energy to supply the Datacenter industry.

Kenya as an example:

Kenya is ahead of the game as its current energy production is predominantly 90% green, being generated from clean sources (mainly geothermal, hydro and wind). The installed generation capacity currently stands at 2,791MW compared to the peak demand of 1,926MW, giving a margin of over 30%. According to data provided by EPRA, as at April 2020, the renewable energy mix was as follows:

- Geothermal: 48.4%.Hydro: 35%.
- Thermal: 4.2%.
- Wind: 10.4%.
- Imports: 1.1%.
- Solar: 0.9%.

Geothermal energy has the potential to support the African power sector as it moves away from being reliant on hydropower and becoming drought resilient. Africa's known geothermal potential is predominantly present in the geologically active area of the Great Rift Valley. With only 0.6% of Africa's known geothermal potential being exploited, this energy source is a hidden gem in sub-Saharan electricity production. Kenya is currently the largest geothermal energy producer in Africa, with its power production contributing to nearly 50% of the country's electricity generation. The East African nation has successfully harnessed its geothermal capabilities, generating an estimated 630 MW. Wind power production in sub-Saharan Africa is currently booming, and East Africa is leading the way with Kenya's recently unveiled wind power project – the Lake Turkana Wind Power Farm, which is the largest wind farm in Africa producing 310 MW of reliable, low-cost energy to the national grid. dlapiper.com

Other countries with geothermal programmes are actively aligning and engaging with Kenya as a partner in geothermal development. Kengen has been awarded a contract to drill geothermal wells in Tulu Moye project in Ethiopia. The other Africa states that are various stages of geothermal development are: Uganda, Tanzania, Djibouti, South Sudan, Sudan, Zambia and the Comoros.

Part 08. IS CLIMATE A DETERMINING CRITERIA

DATA CENTRES AND SOLAR POWER

While the electricity distributed in some countries is predominantly green (i.e Kenya), the data centres industry is directly benefiting from this favorable "quasi carbon-free" impact.
In order to move one step more beyond in "green" countries, or when the country energy is still fossil originated, the Data Centre industry is taking the lead and directly investing into PV (photovoltaic) systems for production of solar energy dedicated to the Data Centre, creating a hybrid power supply.

As an example :

ADC is targeting a 1MW PV system to support the current 400 rack data centre in Nairobi, while iCOLO has installed a 200KWp PV solution to support its Mombasa data centre of 675KW, hence solar compensating for 40% of its IT load during the day and a 190KWp system for its 825KW site in Nairobi – solar compensating for approximately 20% of its IT power during the day.
IXAFRICA Data Centre will have a 550KW PV system for its first phase which will scale up to an approximate 1MW to support its 18.9MW campus. This will lead to solar energy compensating 10% for the IT load.
ONIX in Accra, Ghana has a 405 KW data centre (1st Module IT load) that is powered by a 726KWp solar solution. The DC is powered by solar for its IT load requirement during the day.
21st CENTURY TECHNOLOGIES LTD, based in Lekki, Nigeria has a 12 MW IT data centre. A 1 MW solar plant is in place to power part of the initial 4 MW.

The key requirement for solar is the availability of space for the solar panels; while land is expensive in major cities in Africa the roof tops of the data centres are the ideal space to install solar panels.

Century21 Data Centre, Lagos, Nigeria

Part 09. Hydrogen in Africa

Hydrogen is certainly one of the hottest innovative item to make the WW Data Centre industry take one more step closer to the environmental responsibility.

Solar and wind are seen as likely contenders to help datacenters achieve decarbonization, as explained in Part 08. However, because of the intermittent nature of these resources, ensuring the security of supply will prove to be a challenge. Given the limitations of these variable renewable energy sources, a transition to green hydrogen (green H^2) power for datacenters in Africa is a must. In turn, this will not only fast-track the energy transition, but will also help the industry reduce bulk operating costs while simultaneously achieving much needed deep decarbonization.

As a Business Developer with a focus on the Southern and East African markets for HDF Energy, Khanyiselo Kumalo is responsible for the development of this technology with relevant market players.

According to reports by the International Energy Agency (IEA), Shell and the International Renewable Energy Agency (IRENA), while there are various pathways for producing H^2, natural gas and coal are the two dominant primary resources used for H^2 production today. The reliance on natural gas and coal is the driver behind the carbon-intensive nature of the H^2 production process globally.

Green H^2, on the other hand, is produced using carbon-free electricity (typically wind and solar) to split water, by electrolysis, into H^2 and oxygen (O^2). H^2, which offers long term storage capacity, is then used through fuel cells on demand to produce the electricity, converting the H^2 back to water (H^2O).

Datacenters are operational 24/7 and are heavily reliant on stable power for their operational needs. Solar and wind can only supply electricity when the sun is up and when the wind is blowing, presenting a mismatch between the resource's generation profile and a centres' energy needs. It is at this point that the prospects of green H^2 power become a valuable alternative to variable renewable energy sources for datacenters. Owing to its versatility, hydrogen can be used as a storage medium, allowing excess hydrogen to be stored in large quantities, over long periods.

Ongoing Hydrogen projects

HDF is one of the main actors in this space. The company is developing a 1.5 MW high power fuel cell that will be dedicated to data centre applications. Artificial intelligence (AI) will be used to analyse forecasted weather conditions (meteorological data), renewable energy production forecasts, and thus identifying renewable energy supply gaps. In turn, a day-ahead profile will be created through AI, it will be reconciled with the available green H^2, where an electricity production pattern for the fuel cell is then defined.

Part 09. Hydrogen in Africa

Microsoft announced in July 2020 an Azure data centre outfitted with fuel cells, a hydrogen storage tank and an electrolyser that converts water molecules into hydrogen and oxygen could be integrated with the electric power grid to provide load-balancing services.

The hydrogen cells have powered a row of Azure data centre servers for 48 consecutive hours, which was certainly one of the first test for this size of facility.

This initiative is a collaborative effort between HDF Energy and Atos Bull, where the aim is to develop bespoke solutions that can cater to the commercial needs of data centres across the board. Concerning timelines, HDF expects to have the fuel cell installed on Atos Bull's site in France by 2023/24, where the demonstration project will run for a period of 3-4 years.

Two key things are achieved through the success of this demonstration project:

I. A rigorously tested, commercially ready solution that can accurately and reliably supply the missing renewable electricity that would otherwise be sourced from fossil-based power.

II. By demonstrating that HDF's fuel cell can respond to the load fluctuations of a high performance computing (HPC) data centre, there is a high degree of certainty that this solution can be adapted to fit the needs of any datacenter.

In closing, green H^2 power coupled with fuel cells is the vital missing link that data centres need to achieve autonomy and decarbonize their footprint. The use of clean hydrogen power and fuel cell technology will target a clean and futureproof solution that can offer data centres with the same operational flexibility that they enjoy today.

Atos HDF POC

ACKNOWLEDGEMENTS

Paul-François CATTIER, ADCA Bord Member

Olivier LABBE, Cap DC, ADCA Member

Niraj SHAH, IX Africa DC, ADCA Member

Khanyiselo KUMALO, HDF, ADCA Member

Solenn DEPRÉ, Cap Ingelec

Benoît PLOUX, Cap Ingelec