Climate Neutral Data Centre Pact

Water Usage Proposal - Summary

Preamble

This document is capturing the outcome of the CNDCP Water Usage group workshops held from March to November 2021.
The methodology as well as source of data used are listed in the Annexes herein to support the rationale of the results.
The objective is to allow all signatories of the self-regulatory initiative to run the proposed model and confirm its consistency with their business reality in the field and take the appropriate steps to comply with it.

Synthesis

The Water Usage group has concluded that a responsible use of water should be reflected in a single KPI that drives the most responsible choice of cooling technology for a given location.

The chosen metric is the **Water Usage Effectiveness - Site** value (WUE – category 1) as per **ISO/IEC DIS 30134-9.** The Pact will establish a **location dependent maximum** value under which data centres can operate.

This maximum WUE is a combination of factors that consider three main influencing parameters:

- Climate
- Water availability
- Water type

The two first parameters are beyond the operator's control (and are assessed through European public statistical databases) while the third one is the operator's responsibility.

The proposed model is summarized by the following formula:

$$WUEmax = K_0 . K_{1_{climate}} . K_{2_{water\ stress}} . K_{3_{water\ type}}$$

New data centres at full capacity in cool climates that use potable water will be designed to meet a maximum WUE of 0.4 L/kWh in areas with water stress. The limit for WUE can be modified based on climate, stress and water type to encourage the use of sustainable water sources for cooling.

Deviation from this target is allowed to consider lower water stress situation, higher ambient temperatures and the quality of the water used.

The correction factors to calculate the deviation are set below:

K_0	K_1 Climate		K_2 Water Stress			K_3 Water Type	
	Cooling degree days (CDD)	K_1	WEI+(or similar metric)	Risk	K_2	Water type	K_3
0,4 l/kWh	CDD<50 (Cold)	1.0	0-10	Low	5	Portable/Fresh water	1
	CDD ≥ 50 (Hot)	1.1	10-20	Low-Medium	4	Grey Water	3
			20-40	Medium-High	2.5	Black/Brackish/Sea Water	6
			> 40	High	1		

The Water Working Group proposes that this location based maximum WUE value will have to be respected by all members of the CNDCP pact for **all new data centres in 2025**.

For existing data centres starting on Jan 1st 2025, the maximum WUE values shall be respected when revamping the cooling systems of a signatory data centre once the **service life of the cooling system has expired**, and **not later than 2040**. This phase out from old technologies will ensure all data centres to be compliant by 2040, whatever the cooling technologies currently in place.

Tables below show the results per type of water used (rounded to the second decimal).

Potable/Fresh water	Cold climate	Hot climate
Low water stress	1.20 l/kWh	1.32 l/kWh
Low-medium water stress	1.00 l/kWh	1.10 l/kWh
Medium-high water stress	0.72 l/kWh	0.79 l/kWh
High water stress	0.40 l/kWh	0.44 l/kWh

Grey water	Cold climate	Hot climate
Low water stress	3.60 l/kWh	3.96 l/kWh
Low-medium water stress	3.00 l/kWh	3.30 l/kWh
Medium-high water stress	2.16 l/kWh	2.38 l/kWh
High water stress	1.20 l/kWh	1.32 l/kWh

Black/Salty water	Cold climate	Hot climate
Low water stress	7.20 l/kWh	7.92 l/kWh
Low-medium water stress	6.00 l/kWh	6.60 l/kWh
Medium-high water stress	4.32 l/kWh	4.75 l/kWh
High water stress	2.40 l/kWh	2.64 l/kWh

Climate Neutral Data Centre Pact

Water Usage Proposal - Annexes

1.1 Context and challenges

Data centres consume energy, which results in the release of a heat flow making it necessary to cool the systems. The cooling of data centres (DC) currently involves a wide range of technologies, some of which use a fluid.

In some cases, the fluid may be water. As a result, water resources are affected, especially since cooling consumption can be substantial and therefore compete with other uses, including environmental uses such as river flows or groundwater levels. It might reach the point that is has an influence on the overall water resource of a territory in a context of water scarcity.

1.2 Objectives of the Water Working group

The working group aims at enforcing a **responsible use** of water across the DC industry.
Responsible use needs to be assessed based on simple physical principles, understandable, and ultimately quantified by a single metric.

The key drivers of this initiative are to:

- Remain simple in the way to model a complex topic
- Keep a holistic view
- Define the most relevant parameters to be considered in the calculation
- Base the calculation on undisputed physical data measured, updated and made available to the public

1.3 Influencing parameters considered

1.3.1 Climate

Though the European climate looks quite homogenous at a worldwide scale, it is more accurately split into hot and cold regions. This is modelled off the approach taken by the Pact for calibrating PUE.

To simplify the approach 2 regions (Cold and Hot) are considered. Cold regions being an ideal candidate for “non mechanical” cooling technologies while Hot regions impose a need for mechanical cooling technologies to be complemented by “non mechanical” cooling technologies to keep the PUE at the levels established in self-regulation.

1.3.2 Water availability

The water availability/scarcity is commonly known as water stress. The water stress refers to the water balance available in a certain location in relation to the needs of that location. It is defined by a ratio associated to a risk indicator. This indicator helps determine territories according to risk scales.

To simplify the approach, four stress levels are included in the metric: low, low-medium, medium-high, high. Low stressed regions are good candidate for systems that require substantial level of potable water consumption, while in high stressed regions it is responsible for DCs to restrict the use of potable water.

1.3.3 Water type

Volume of consumed water in the cooling system is a concern but should be analysed with respect to the origin of the water.

Using potable water to cool the systems is a cheap and easy to implement, but can have a short-term impact on the environment, even more so in regions where fresh water is scarce.

On the other hand, using recycled water, still has a mid/long-term impact on the environment, but should be promoted in stressed regions and recognize the investments necessary for the recycling process.

To simplify the approach three water types are considered: (1) potable/fresh water (2) grey water, (3) black/brackish/sea water.

1.4 KPI

A commonly used KPI to measure the consumption of water in the cooling process is the **WUE (Water Use Effectiveness).** The WUE which focuses on the volume of water consumed as part of the cooling system. WUE looks at the water consumption in litres for every kWh (or alternatively in cubic metres for every MWh) used to power up the IT equipment (energy required for the ancillary services is exempted from the calculation of WUE). The calculation will be based on Category 1 (WUE_1).

Source	Category 1 (WUE_1) basic
Considered water input	Physical water input of the DC.
Considered water output	No water reuse; water input equates to water use.
Additional reporting	No.

$$\eta_{U,W} = \frac{U_W}{E_{IT}}$$

For category 1, I_w is equal to U_w. For the water output in category 1 there is no reuse of water considered. This means that all the water that goes into the DC is leaving the DC as used water. WUE_1 requires only basic measurements for the water input. Measurements for the water output are not necessary. For WUE_1 an additional reporting of regional water stress level and land consumption is not necessary.

The calculation is made based on annual data and reported as an annual average as per the **ISO/IEC DIS 30134-9**.

As rainwater is not discussed in ISO/IEC DIS 30134-9, for the purpose of the WUE target operators can include it in Category 1, but they are not allowed to utilise it to reduce the total amount of Category 1.

Information technology – Data centres – Key performance Indicators – Part 9: Water Usage Effectiveness (WUE)

6.2.2.2 WUE category 1: water usage without reuse

WUE_1 is a metric considering total water consumption of the data centre. For the water output there is no distinction of water use and water reuse in category 1 (see Figure 1). For WUE_1 the significance of regional water shortage and land consumption is not considered.

NOTE For the water input, potable water and non-potable water are considered.

WUE_1 includes the water used at the DC location for operation of the data centre. This contains water used for humidification and water evaporated on site for energy production or cooling of the data centre and its support systems.

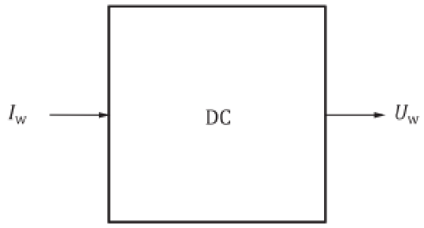


Figure 1 — WUE category 1

The WUE for category 1 is calculated using Formula (3):

$$\eta_{U,W,1} = \frac{U_W}{E_{IT}} \quad (3)$$

For category 1, I_W is equal to U_W. For the water output in category 1 there is no reuse of water considered. This means that all the water that goes into the DC is leaving the DC as used water. WUE_1 requires only basic measurements for the water input. Measurements for the water output are not necessary. For WUE_1 an additional reporting of regional water stress level and land consumption is not necessary.

It is to be noted that WUE and PUE (Power Usage Effectiveness) are inversely “proportional” to each other, and the search for balance or compromise between these two parameters is crucial in designing the systems and heavily dependent on the location of the DC and climate considerations of a particular location.

1.5 Modelling principles

The model aims at considering the three above-mentioned parameters by combining them into a single formula setting the modified **WUE maximum value** for each DC depending upon its local conditions.

To remain simple the modelling chosen is to convert these influencing parameters into a correction factor applied by multiplying them to a reference value.

$$WUEmax = K_0 \,.\, {K_1}_{climate} . {K_2}_{water\ stress} .\ {K_3}_{water\ type}$$

Where:

- K0 is the reference metric (in l/kWh or m^3/MWh)
- $K1_{climate}$ is a correction factor taking into account the climate of the DC location
- $K2_{water\ stress}$ is a correction factor taking into account the water stress of the DC location
- $K3_{water\ type}$ is a correction factor taking into account the type of water used to cool the DC

1.6 Influencing parameters measurement

1.6.1 Climate region assessment

The model uses the same data source that the Pact used for establishing hot and cold climate for the purpose of setting the PUE requirement. This is the ambient temperature as per Eurostat records and the **CDD (Cooling Degree Days)** index that is derived from them.

CDD will be determined by the definition given in Annexes to the EED Delegated Regulation:

> Cooling degree days ("CDD", in degree-days) shall be determined as the number of cooling degree days for the location of the reporting data centre **during the last calendar year**, by using the methodology used by Eurostat and the Joint Research Centre or equivalent, and with a **base temperature of 21 degree Celsius**.
> Open access sources shall be used to determine the cooling degree days.

To make it consistent with the Power Usage working group it has been agreed to set the reference temperature at ***21°C/69.8°F*** leading to the following formula.

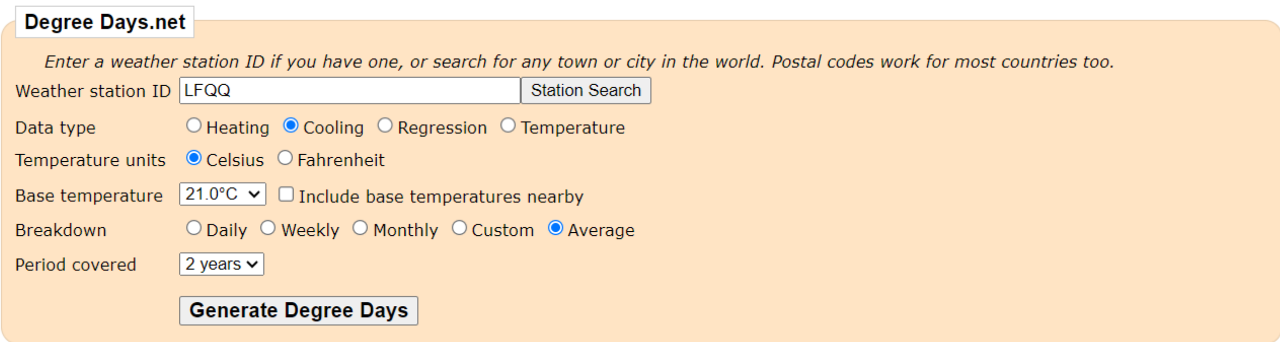
$$CDD = \sum_i T^i_m - 21°C$$

Climate will be assessed based on the following CDD threshold

CDD
CDD < 50 => Cold
CDD ≥ 50 => Hot

Useful links and tools:

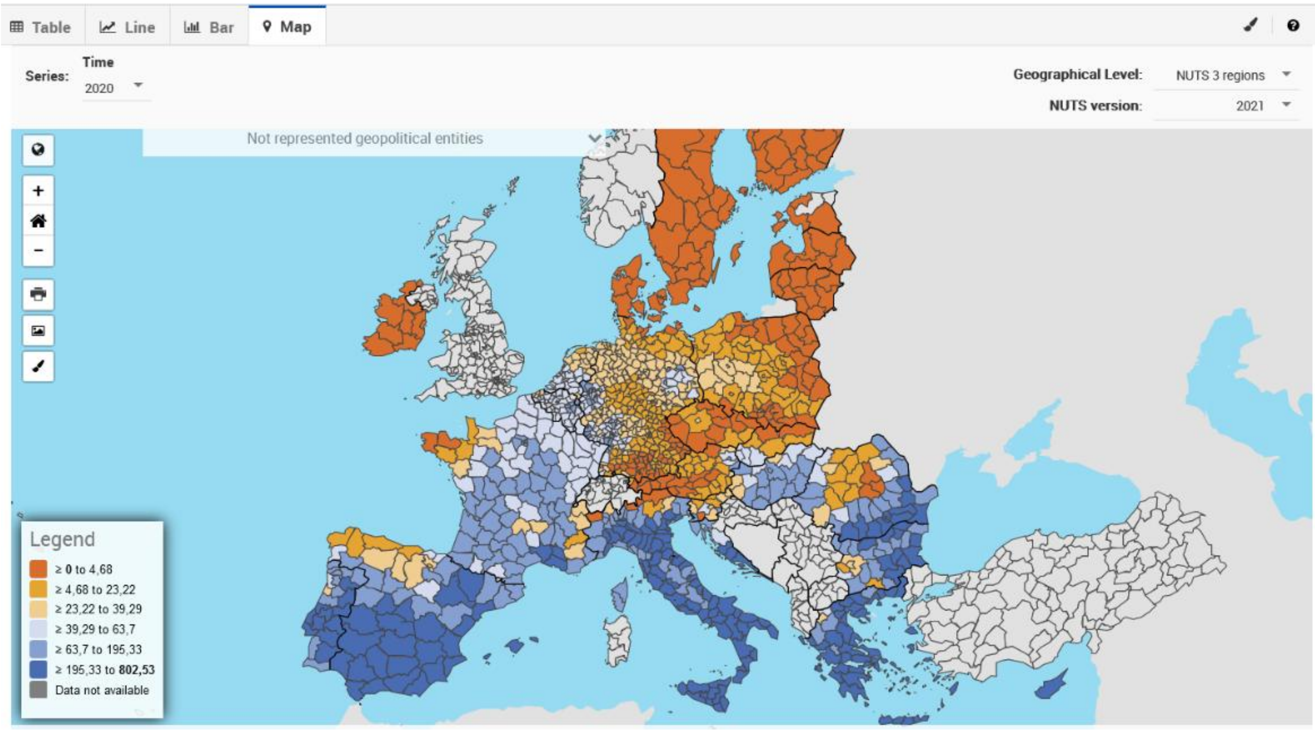
Tool below shows an example of how to easily approximate the CDD online (The tool only allows for an estimation of a minimum of 2 years).



Figures can be obtained as well from Eurostat.

Table | Line | Bar | Map

TIME / GEO	2016	2017	2018	2019	2020
European Union - 27 countries (from 2020)	93.49	111.79	97.85	110.54	98.53
Belgium	25.37	16.76	35.77	39.72	52.49
Région de Bruxelles-Capitale/Brussels Hoofdstedelijk ...	24.85	17.71	40.87	43.35	57.28
Région de Bruxelles-Capitale/Brussels Hoofdstedelijk ...	24.85	17.71	40.87	43.35	57.28
Arr. de Bruxelles-Capitale/Arr. Brussel-Hoofdstad	24.85	17.71	40.87	43.35	57.28

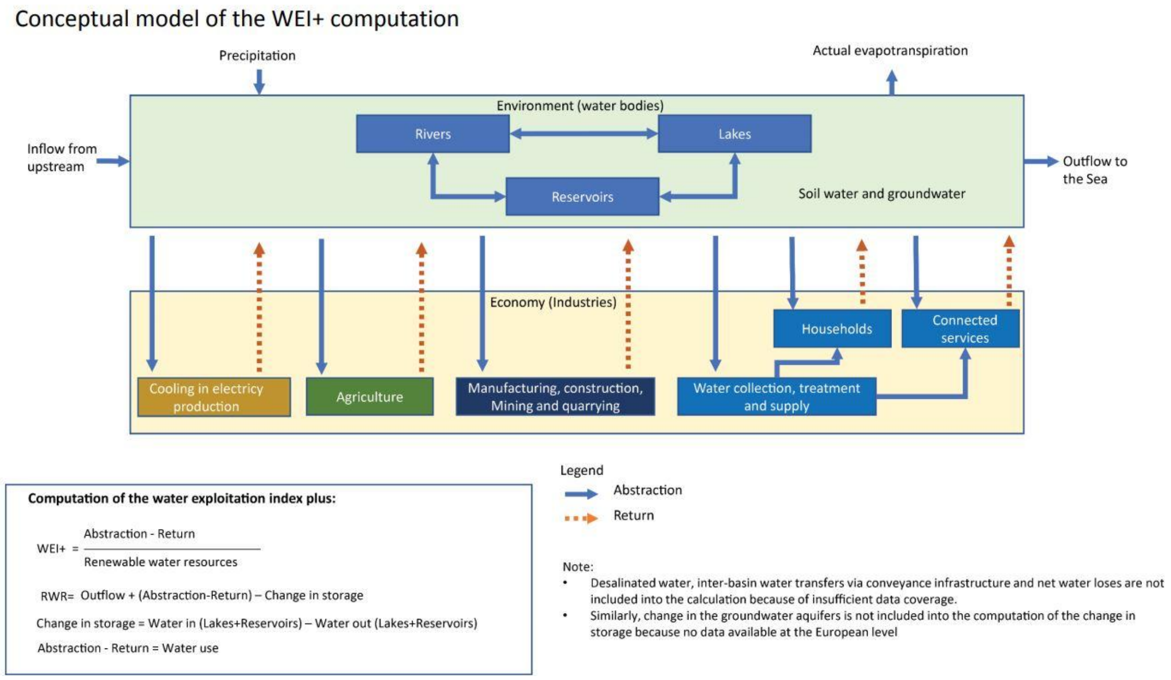


1.6.2 Water stress assessment

While a wide range of indicators and calculation methods are available to measure water stress, such as:

- the Water Stress (Aqueduct Water Risk Atlas) from the World Resources Institute and;
- the WEI+ (Water Exploitation Index) from European Environment.

For single country operators, the working group suggests utilising the WEI+ index:

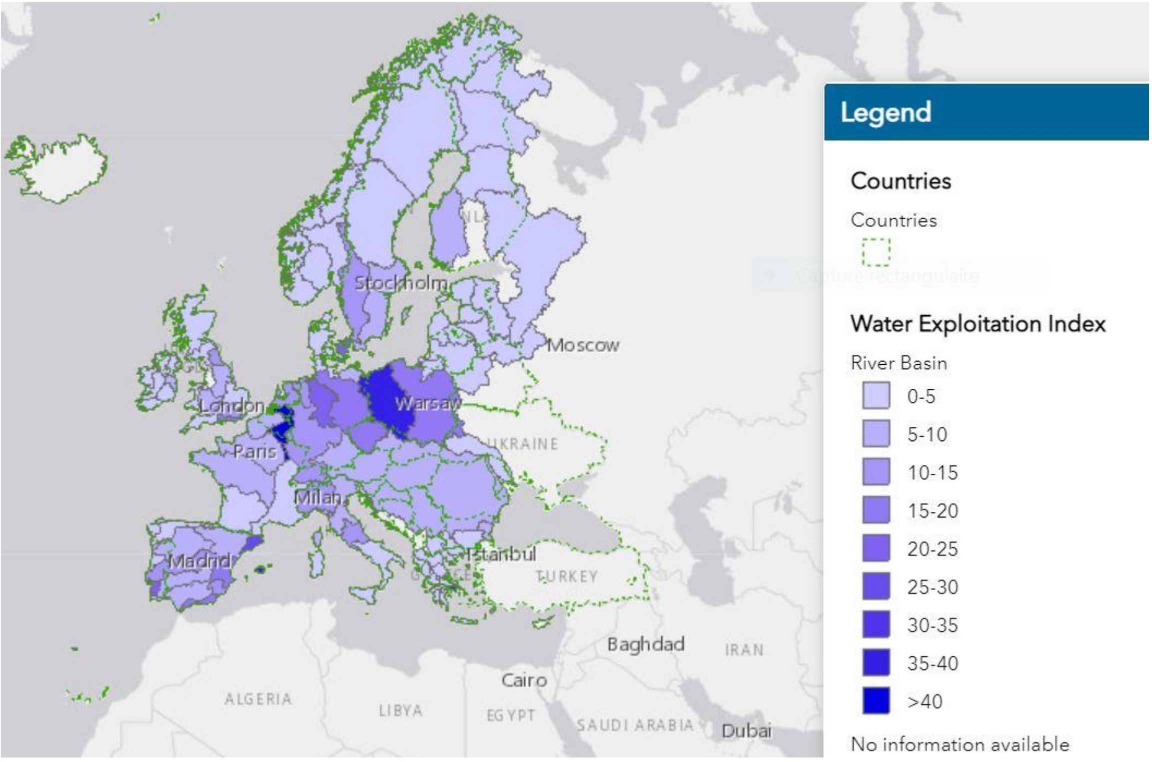


WEI+ calculation will be based on the maximum (over the last 25 years) of the quarterly local records as per Eurostat database.

The value taken from the WRI water stress metric should be multiplied by 100 to adjust the value.

Water stress will be assessed based on the following WEI+/WRI ranges

WEI+/WRI	***Risk***
0 --> 10	Low
10 --> 20	Low-medium
20 --> 40	Medium-high
> 40	High



1.6.3 Water type classification

Below the miscellaneous water sources available to cool the systems. The following definitions are based on ISO 6107:2021 (en).

Potable water: water intended for human consumption, will not cause harm over lifetime of consumption and does not contain detectable objectionable contaminants, either chemical, radiological or infectious agents

- **freshwater**: naturally occurring water having a low concentration of salts, or generally accepted as suitable for abstraction (3.3) and treatment to produce potable water
  Note 1 to entry: Freshwater typically contains less than 1 000 mg/l of dissolved solids. The concentration of total dissolved solids can vary considerably over space and/or time.

- **greywater/sullage**: waste water from household baths and showers, hand basins and kitchen sinks but excluding waste water and excreta from water closets(Reuse potential of water means the water can be reused without further treatment.)

- **blackwater**: waste water and excreta from water closets, excluding water from baths, showers, hand basins and sinks
Note: Within the context of this standard blackwater includes toxic water contaminated with infectious agents, toxic chemicals, and radiological hazards.

- **seawater/brackish water**:
water containing dissolved solids at a concentration higher than acceptable standards for intended use
Note: The concentration of total dissolved solids in brackish water can vary from 1 000 mg/l to 10 000 mg/l. Brackish water is less saline than sea water (1 000 to 10 000 mg/l of TDS for brackish vs up to 35 000 mg/l for sea water).

To simplify the model and to group together water types that have a similar impact on the environment, the Water Working Group merged the water types into three categories.

Water type will be assessed based on the following water categories

Water type
Potable water / Fresh water
Grey water
Black water / Brackish water / Sea water

1.7 Model adjustment

After the Water Working Group defined the parameters, members of the Working Group ran the model on data from the field. As a result, the correction factors were adjusted to allow for technological solutions to stay below the maximum value in extreme conditions across the EU (e.g. a DC in a hot region with high water stress vs a DC in a cold region with low water stress).

$$WUEmax = K_0 \,.\, K_{1_{climate}} . K_{2_{water\ stress}} .\ K_{3_{water\ type}}$$

These principles are reflected in adjustments to the model:

- K0 should be set at a low value to bring down the volume of water allowed as per model
- K2 and K3 factors should globally compensate each other because in high water stress regions we should promote the use of black or salty water, while in low water stress regions we should not penalize the use of potable water
- The span between the lower and the upper values of the correction factors should be high enough to induce a differentiation effect

K_0	K_1 Climate		K_2 Water Stress			K_3 Water Type	
	Cooling degree days (CDD)	K_1	WEI+(or similar metric)	Risk	K_2	Water type	K_3
0,4 l/kWh	CDD<50 (Cold)	1.0	0-10	Low	5	Portable/Fresh water	1
	CDD ≥ 50 (Hot)	1.1	10-20	Low-Medium	4	Grey Water	3
			20-40	Medium-High	2.5	Black/Brackish/Sea Water	6
			> 40	High	1		

1.8 Model analysis

By setting the reference WUE value (K0) at 0.4 l/kWh the industry will take a major step in bringing down the volume of water allowed to cool a DC. Current cooling technologies lead to values ranging from 0 (mechanical cooling) to >6 l/kWh (cooling towers) so a 0.4. is a significant step change for the industry.

Under extreme circumstances (hot climate with high water stress), the use of potable water would lead to a maximum WUE value of 0,44 l/kWh (0.4x1.1x1x1) making it impossible to use systems other than:

- Mechanical cooling (to the extent that it does not affect the PUE that should stay below 1.3/1.4 as per self-regulation)
- Adiabatic cooling with dry coolers featuring an optimized water flow control system of the misting nozzles
- Adiabatic cooling with humid media (pads installed on the dry coolers)
- A mix of these three systems (hybrid cooling)

Should the DC operators wish to use different technologies (for example cooling towers), it will become mandatory to implement water treatment units to use black/brackish/sea water.

At the other end of the spectrum (cold climate with low water stress), the use of potable water would lead to a maximum WUE value of 1.2 l/kWh (0.4x1x3x1) making it impossible to use other systems than:

- Mechanical cooling (to the extent that it does not affect the PUE that should stay below 1.4)
- Adiabatic cooling with dry coolers featuring an optimized water flow control system of the misting nozzles
- Adiabatic cooling with humid media (pads installed on the dry coolers)
- A mix of these three systems (hybrid cooling)

*Examples of maximum WUE for **potable** water use based on the model:*

1. Brussels
CDD = 47 => K1 = 1
WEI+ = 32 => K2 = 2.5
Potable water => K3 = 1

WUE max = 1 l/kWh

2. Madrid
CDD = 596 => K1 = 1.1
WEI+ = 132 => K2 = 1
Potable water => K3 = 1

WUE max = 0.44 l/kWh

3. Tallinn
CDD = 96.5 => K1 = 1.1
WEI+ = 2 => K2 = 5
Potable water => K3 = 1

WUE max = 2.2 l/kWh

4. Maastricht
CDD = 37,6 => K1 = 1
WEI+ = 116 => K2 = 1
Potable water => K3 = 1

WUE max = 0.4 l/kWh