Project acronym: **DATAZERO**

Project full title: **DATAcenter with Zero Emission and Robust management using renewable energies**

D6.3 Standardization Plan

Author: Jean-Marc Pierson (University Paul Sabatier, Toulouse 3)

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Author:	Jean-Marc Pierson
Co-Authors:	

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Abstract

The aim of this deliverable is to provide an overview of the standardization aspects in the domain of datacenters, and more specifically operated with renewable energies. It provides an updated overview of the main relevant standards-related organisations (national, international, industry groups, standards bodies and regulators) as well as projects, initiatives and actual standards they oversee and maintain.

The document describes how the consortium plans to interact with the most relevant standards activities. In particular, the document shows how the project will interact with the various levels of standards-related organisations. For example, some of the consortium members are already registered and active in industry groups and discussion forums (e.g. The Green Grid, Think and Do Datacenters) and formal standardization bodies, in particular ISO/IEC JTC1/39.

Keywords

Standardization, regulation, metrics, certification, technical committee, benchmarks, green IT

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1. Executive summary

Standardization is an important part of the DATAZERO project. This document has been prepared partly with (private) deliverables from the FP7 CoolEmAll project (2011-2014), since IRIT participated in this project. Some results linked with standardization issues have been published in [1].

The document identifies several organisations involved in standardization activities, both formal and informal. This includes governmental, industry-related and lobbying groups. A short summary of the possible interactions between the consortium and the related bodies are given. Finally the document examines what actions consortium partners have planned to take given the timeline of the project.

2. Scope of Standardization

This part of the document will describe how standardization is defined in this deliverable. It will define the scope of the standardization activities conducted and to be conducted and it will identify at a broad level the organisations relevant to DATAZERO and the activities that are linked with standardization issues.

2.1. Standards defined

The concept of standardization is a flexible term when applied to IT innovation. While strictly managed standards do exist (such as those managed by the International Organization for Standardization (ISO), the International Telecommunications Union (ITU) and the International Electrotechnical Commission (IEC)) a wide variety of other de facto initiatives, metrics and frameworks that may also be classified as (non-strictly) standards. Some recognition of the role legislation plays in the development of common approaches to IT should also be considered.

Standard type	Degree of structure	Example
Defined standard	Highly structured	ISO, ITU, ETSI, IEC
Framework	Structured	EU Data Centre Code of Conduct (JRC)

Metric	Structured	PUE, REF (Green Grid, ISO)
Initiative	Loosely structured	OCP (Open Compute Project)

Table 1: Classification of standard types

Not all of the formal and informal standards organisations outlined in this deliverable have initiatives that are applicable to DATAZERO at this time. However each activity in the field of data centre energy efficient planning and operation has been reviewed and collaboration efforts estimated where relevant. Even those that may not be immediately relevant to the goals of the project are worth noting as they help to provide a more complete (holistic) view of all the standards within this field.

2.2. Standards bodies defined

As previously mentioned, there are a variety of classes of initiatives that can be categorised as a standard (metrics, frameworks, projects). These various classes of standards are also administered by a range of different organisations from formal government-backed groups, professional bodies, and principally supplier-led organisations.

Standard body type	Nature of standards	Example
International, regional and national and government-backed standards bodies	Highly structured standards, requiring some degree of certification/enforcement	ISO, UN ITU, IEC, CENELEC-CEN, ETSI National standards bodies, for example, AFNOR (France), AENOR (Spain), BSC (UK), DIN (Germany)
Institutes and professional bodies	Structured and de-facto standards, metrics, and projects. Some certification required	BCS, IEEE, ASHRAE, Uptime Institute

Supplier and industry groups	De-facto standards, projects and other initiatives.	The Green Grid, Open Compute Project
Technical initiatives, projects, supplier product development,	Loosely structured initiatives, published research etc.	EC projects

Table 2: Classification of standards organisations

3. Relevant sustainability standards and interaction

Sustainability standards affect data centres in multiple ways. Some standards, such as green building certifications, allow data centres to voluntarily demonstrate a certain level of environmental performance. Other standards, such as American Society of Heating Refrigeration and Air-conditioning (ASHRAE)'s temperature standards, can carry the force of de-facto mandates, or form the basis for true mandates later. Sustainability standards can affect how strongly data centres demand efficiency technologies, and sometimes even which technologies they choose. There are standards that address both IT and data centre facilities.

To help understand the links between the different stakeholders, the Figure 1 is giving an overview (taken from [1]).

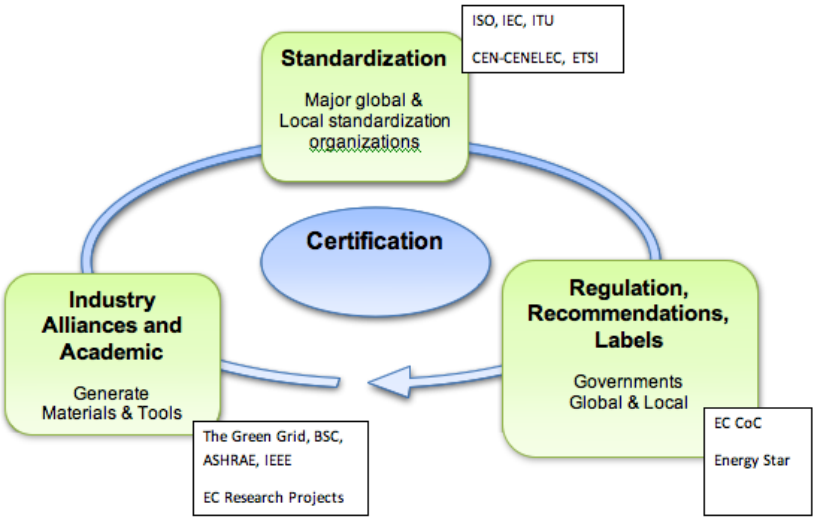

Figure 1. Existing links between standardization stakeholders

On Figure 1, we can see that the first providers of materials and tools that may make their way to actual standards are industry alliances, academic researchers, or both in collaborative projects. Some of the proposed ideas may be presented in one or several standardization bodies to eventually become standards. These standards can in turn be used by governments (national, federal or European levels) as regulations in laws that must (and can) be enforced.

Governments can use directly the materials as regulations, recommendations or labels. While the process for formal standardization take a long time since a consensus have to be achieved between all members (especially states), the direct link with governments is sometimes more efficient.

Finally, it must be noted that some metrics, tools, and methods provided by industry and academia are used directly by final users and may become de facto standards.

In the centre of the Figure is the certification authority whose role is to certify that the measurements, claimed by suppliers of technologies actually follow the standards, the labels or the recommendations.

In the following, the document will investigate separately these stakeholders and their links, focusing on the energy efficiency in data centre part.

3.1. International and governmental standards bodies

During the years several standard bodies have been created both internationally and at a government level. These groups are not always only related to IT but there is a level of cooperation between different bodies and there appears to be progress in the international standardization in the sector of IT, Green IT, and data centre.

3.1.1. ISO

The International Organization for Standardization (ISO) is made up of numerous country-specific standards bodies. Inside ISO, TC207 is interested in environmental management.

ISO has developed a number of standards that maybe relevant to the overall goals of the DATAZERO project. For example, ISO 14064-1 is a standard for reporting on greenhouse gases and makes use of the GHG Protocol. It specifies the principles and requirements for design, development, management and reporting of organisations GHG inventory. The other standards apply to reporting at project level; to validation and verification; and to accreditation or other forms of recognition. ISO 14001 meanwhile addresses the environmental impact of an

organisation in general. Either standard can be used by itself, or an organisation can use both. While ISO 14001 is a good first step to evaluate the 'environmental' health of a company, it does not provide a carbon footprint or measure emissions. The upcoming ISO/IEC 30134-* (see below are the most relevant ones proposed by ISO.

3.1.2. UN ITU

ITU's (International Telecommunication Union) role as creator of the world's most universally recognised information communications standards dates back as far as the organisation itself. Since its inception in 1865, the Union has been brokering industry consensus on the technologies and services that form the backbone of the world's largest, most interconnected man-made system.

ITU-T Recommendations are defining elements in information and communication technologies (ICTs) infrastructure. Today priority work areas include ensuring the needs of developing countries are taken into account in the development of global ICTs; accessibility; adopting international standards to ensure seamless global communications and interoperability for next generation networks (NGN); building confidence and security in the use of ICTs; emergency communications to develop early warning systems and to provide access to communications during and after disasters and the reduction of the impact of ICTs on climate change as well as create better understanding of how ICTs can mitigate its effects.

Within ITU-T, Study Group SG5 is evaluating the ICT effects on climate change, publishing guidelines for using ICTs in an Eco-Friendly way. It is also responsible for studying design methodologies to reduce environmental effects, for example recycling of ICT facilities and equipment. An example is for data centre using direct current (DC), where ITU-T L.1200 specifies the DC interface between the power feeding system and ICT equipment connected to it. It also describes normal and abnormal voltage ranges, and immunity test levels for ICT equipment to maintain the stability of telecommunication and data communication services. The specified interface is operated from a DC power source of up to 400 V. This allows increasing power consumption and equipment power density in order to obtain higher energy efficiency and reliability. This solution permits less material usage than using a lower voltage such as -48 VDC or AC UPS power feeding solutions.

Another example comes with ITU-T L.1300 that describes best practices aimed at reducing the negative impact of data centres on the climate. The best practices defined in this Recommendation can help owners and managers to build future data centres, or improve existing ones, to operate in an

environmentally responsible manner.

3.1.3. IEC

IEC (International Electrotechnical Commission) provides a platform to companies, industries and governments for meeting, discussing and developing the international standards they require.

All IEC International Standards are fully consensus-based and represent the needs of key stakeholders of every nation participating in IEC work. Every member country has one vote and a say in what goes into an IEC International Standard. The International Electrotechnical Commission (IEC) members come from all around the world. While each member is different, they have one thing in common: all of them represent the entire range of electrotechnical interests in their country, companies and businesses, industry associations, educational bodies, governmental and regulatory bodies. All stakeholders are brought together through the country's member National Committee.

The IEC also cooperates with several international, regional and national partners to produce joint publications, to help promote the importance of standardization around the world and to coordinate any potential overlaps in work. The International Electrotechnical Commission is the leading global organisation that publishes consensus-based international standards and manages conformity assessment systems for electric and electronic products, systems and services, collectively known as electrotechnology. IEC publications serve as a basis for national standardization and as references when drafting international tenders and contracts.

Within IEC, TC111 is interested in environmental standardization for electrical and electronic products and systems. Its role is to prepare the guidelines, basic and horizontal standards, including technical reports, in the environmental area, in close cooperation with product committees of IEC. It embeds the eco-design, recycling/reuse, carbon and GHG aspects.

3.1.4. Links between the standardization bodies related to energy efficiency in data centres

ISO and IEC established a number of links for the design of data centres, for instance, ISO/IEC 24764 is interested in the generic cabling and ISO/IEC 14763-2 (Annex E) is based on the planning and installation at customer premises.

Joint Technical Committees are established between ISO and IEC in specific areas. JTC 1/SC 39 is the joint sub-committee on "Sustainability for and by

Information Technology". The focus is on standardization related to the intersection of resource efficiency and Information Technology supporting sustainable development, application, operation and management aspects is investigated.

Based on discussions back in November 2011 ISO/IEC JTC 1 Plenary, JTC 1/SC 39 established a Working Group on Resource Efficiency of Data Centres with the following terms of reference:

- Development of a data centre energy efficiency taxonomy and vocabulary.
- Development of a holistic suite of metrics supporting universally accepted standardized Key Performance Indicators (KPIs).
- Development of a best practices for energy efficiency of data centres.
- Development of an energy management system standard specifically tailored for data centres.

Countries participating in this committee are represented by a national entity nominating individuals. For instance, in France, the AFNOR (Association Française de Normalisation – French Association for Standardization) is the entity in charge for ISO activities and this JTC. Global general meetings are held twice a year while the local branches are meeting every 3 to 4 months.

It can be noted that the activities of JTC1/39 has been developed and drafts of the standard for metrics assessing the energy efficiency of data centres are on their final way. The framework for describing metrics is on the move and must be considered when developing new metric for their standardization. Standards 30134-1 (General Requirements and Definitions), 30134-2 (PUE) are related to these two aspects.

It must be noted that the SC39 has been established only in 2012 and it is a new sub-committee. The team is young and with little exercise on standardization. Normally the time-to-standard is of maximum 3 years, and even if ISO is trying to reduce these delays, it did not apply to SC39 works.

The entry in force for the current 30134-1 and 30134-2 was January 2013. The current versions of the standards are DIS level (Draft International Standard) at ISO/IEC (last level before acceptance, as of January 2016). It will be probably formally accepted during the first semester 2016. The length of the process is mainly due to a combination of factors: the necessary agreements from all members' states participating in the SC, the delay between each iteration, and the relatively small number of contributors.

Other metrics are in discussion in particular ITEE (IT Equipment Energy Efficiency), ITEU (IT Equipment Utilisation), REF (Renewable Energy Factor)… This last one is of key importance for DATAZERO.

Another discussion is currently ongoing on the potentiality of aggregating diverse metrics in one metric. However the consensus is far from being reached to accept such aggregation leading to potential artificial non-sense metrics.

Another standard developed in this group is the 30133 on Guidelines for resource efficient data centre. Discussions are on the way to figure out the possible overlap with the work of ITU-T L.1300 mentioned earlier.

3.1.5. European/regional standards bodies

The European Commission has established a standardization mandate. It requests that the three European standards bodies CEN, CENELEC and ETSI develop standards that enable efficient energy use in fixed and mobile information and communication networks. Looking at a bird eye, concerning European standardization activities on data centres it can be stated the following division: the Network is done by ETSI, the Power infrastructure by CENELEC, the IT management by CEN, the cooling by ASHRAE (not EU specific) and the monitoring by CEN/CENELEC. The need for having joint and coordinated groups is therefore obvious.

The establishment of the Coordination Group on Green Data Centres (CEN-CENELEC-ETSI) helps to harmonize initiatives at the ESO level (European Standardization Organizations). Its basic objectives are: to coordinate standardization activities, to avoid duplication and conflicting content and to define standardization landscape. A report is available online and updated regularly and is a key for understanding the links in the domain [2].

It particular, the definition of several items have been seen necessary in order to everyone can understand the scope of the potential standards. A data centre is

> "a structure, or group of structures, dedicated to the centralized accommodation, interconnection and operation of information technology and network telecommunications equipment providing data storage, processing and transport services together with all the facilities and infrastructures for power distribution and environmental control together with the necessary levels of resilience and security required to provide the desired service availability.
>
> Note: A structure can consist of multiple buildings and/or spaces with specific functions to support the primary function.".

The question of defining Energy-Efficiency and Greenness is also interestingly discussed. Energy-efficiency is “a combination of reduced energy consumption and increased task efficiency, re-use of energy and use of renewable energy”, while Green is recognised to go further in order to incorporate sustainability issues (“conserving an ecological balance by avoiding depletion of natural resources”).

3.1.5.1.CENELEC-CEN

CEN-CENELEC (European Committee for Electrotechnical Standardization) embeds Technical Committee 215 on Electrotechnical aspects of telecommunication equipment. The standards produced by TC 215 are used by a variety of customers including planners and installers of information technology cabling and of those facilities containing significant concentrations of information technology equipment (e.g. data centres), manufacturers of cabling systems and associated components as well as test houses.

It proposes the EN 50600 standard series addressing the design of Data Centre facilities and infrastructures partly based on the criteria of energy efficiency. The first version of the standard has been ratified (September 2012), but is not yet available. Only members can have access to the current version of the standard. It will be composed of several standards to cope with different aspects of data centres: the building construction, the power distribution, the environment control, the telecommunications cabling, the security systems and the monitoring information.

Members of CEN-CENELEC are countries. Each country has an organisation or association to which individuals or institutions can join. CENELEC has a close cooperation with its international counterpart, the International Electrotechnical Commission (IEC). A high proportion of aligned standards (>75%) provides an indicator to the excellent consensus-based way of working CENELEC and IEC have developed and are continually building on. For instance, EN 50173-5 and EN 50174-2 (Clause 11) are the counterparts of the ISO/IEC standards for the design of data centres mentioned earlier.

3.1.5.2.ETSI

ETSI (European Telecommunications Standards Institute) produces globally applicable standards for Information & Communications Technologies. ETSI performs energy efficiency related work in support of European Commission Mandates. The current Mandates in this domain are:

- Mandate 439: Standardization in the field of standby and off modes power consumption measurement for energy using products, defining Global KPIs for energy efficiency for data centres
- Mandate 450: Standardization in the field of measurements of no-load condition electric power consumption and average active efficiency of external power supplies
- Mandate 451: Standardization in the field of power consumption measurement of simple set-top boxes in active and standby modes
- Mandate 462: ICT to enable efficient energy use in fixed and mobile information and communication networks

Some aspects of ETSI's energy efficiency work is done in partnership with other organisations, including ITU-T Study Group 5, the Broadband Forum, the Home Gateway Initiative, CENELEC (for Mandates 439 and 451) and the Global eSustainability Initiative forum (GeSI).

Universities, Public Research Bodies and not-for-profit User Associations can join with a reduced Unit of Contribution of €2 000 per year.

3.1.6. Relevance to DATAZERO

- Directly or indirectly related to DATAZERO project, these bodies will be observed and monitored during the course of the project. Standards defined by ISO, ITU and IEC has a direct impact with DATAZERO, in particular for deciding which metrics should appear as the results of simulations and executions.
- Two partners of DATAZERO are members of the Joint Technical Committee JTC1/SC39 (EATON and IRIT), which is very relevant concerning standardization issues for Energy Efficiency in Datacenters.
- At the European level the three organisations (CEN, CENELEC, ETSI) are of interest for DATAZERO and we aim at presenting our results and potential new metrics at JTC1/SC39 meetings for the CG GDC group.

3.2. Regulations

Through initial work such as the Directive on Energy End-Use Efficiency and Energy Services, National Energy Efficiency Action Plans (NEEAPs), the ICT for Energy Efficiency (ICT4EE) Forum, the Commission is also attempting to establish a common methodological framework by the whole ICT sector for the measurement of its energy and carbon footprint.

3.2.1. European Data Centre Energy Efficiency Code of Conduct (EU CoC)

The European Code of Conduct on Data Centres Energy Efficiency has been developed in response to the increase in energy consumption in data centres and the current needs to decrease the economic, environmental and energy supply security impacts. The aim is to inform and foster the improvement of energy efficiency in the planning and operation of data centres. The Code of Conducts aims to achieve this by raising awareness and recommending energy efficient best practices and targets.[1]

The Code of Conduct is not a legally binding document but a voluntary initiative with the objective of bringing stakeholders together. Parties signing up will be expected to follow this set of best practices recommendations and abide to the principles described therein. The Code contains a comprehensive list of best practices as well as documentary aids and measurement procedures. Data centres may be entitled to use the Code logo if such improvement programs have been recognised by the EU Commission.[2]

It is important to mitigate the energy consumption of data centres by reducing the substantial amount of redundant power and cooling systems. The Code of Conduct poses a set of general principles and practical actions to help all parties involved to address energy efficiency issues. Therefore, data centres owners and operators, data centre equipment and component manufacturers, service providers, and other large procurers of such equipment will be invited to participate in the Code of Conduct.[3] Nevertheless the Code of Conduct is addressed primarily to the data centres owners and operators, who may become "participants" by signing the document, it is also addressed to the supply chain and service providers who may become "endorsers".[4]

The Code of Conduct considers the data centre as a complete system including all buildings, facilities and rooms, which contain enterprise servers, server communication equipment, cooling and power equipment. Therefore, the focus of

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[1] European Commission, The EU-Code of Conduct on Data Centres Energy Efficiency, 2008, p. 3.

[2] Federal Ministry for the Environment, Nature Conservation and Nuclear Safety, Energy-Efficient Data Centres: Best-Practice Examples from Europe, The USA and Asia, 2010, p. 39.

[3] European Commission, The EU-Code of Conduct on Data Centres Energy Efficiency, 2008, p. 4.

[4] European Commission, The EU-Code of Conduct on Data Centres Energy Efficiency, 2008, p. 7.

this Code could be described in two main areas: 1) IT Load: which relates to the consumption efficiency of the IT equipment in the data centre, and; 2) Facilities Load: which includes the mechanical and electrical systems that support the IT electrical load e.g. cooling systems (chillers plants, fans, pumps), air conditioning units, Uninterruptible Power Supply (UPS), Power Distribution Units (PDUs), etc.[5]

The Code of conduct spells out how energy efficient data centres should be run, and sets up a metrics and monitoring system. Participation is voluntary for now, but the CoC is seen by many as a framework document and as a data collection methodology for a future European Directive.

In order to qualify for CoC status, participating data centres must file a detailed report, as well as monthly IT and total facility energy use reports, at least twice a year. In this way, it will create a framework for data collection for the future. Initially, at least, the EU will collect the data, both for auditing and for anonymised analysis. More than 111 organisations accounting (January 2016) for more than 234 data centres are participating, mainly from the EU, but not only. On these data centres, the average PUE was 1.82 in 2013.

A first step in the usage of the CoC is that UK wants all DC to be constructed to be compliant with EU CoC. It can be noted however that a number of places start to use the PUE in order to accept or not the construction of data centre. For instance, the city of Amsterdam is asking a PUE of maximum 1.6 for new data centres.

3.2.2. The ICT4EE Forum

The ICT4EEE (ICT for Energy Efficiency) was established by the European Commission and parties from the IT industry on 23 February 2010, the forum focuses on two key aspects of Eco-efficient IT: first, how the technology industry can curb its energy use; and second, how it can help other sectors do likewise. By mid 2010, four industry associations had signed up to represent the European, Japanese and American ICT industries: DigitalEurope; Global e-Sustainability Initiative (GeSI); the Japanese Business Council Europe (JBCE); and TechAmerica Europe.

The forum is made up of three working groups that started their work in April 2010 looking at: energy efficiency of ICT processes (focussing on the development of measurement standards); using ICT to improve energy efficiency in other sectors (buildings, transport, and energy transformation); and informed and coordinated policy making.

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[5] *Ibid* at p. 5.

3.2.3. Relevance to DATAZERO

Concerning the European Data Centre Code of Conduct, we are following its development, in particular about metrics, monitoring infrastructure and award winning datacentres (for their design and effectiveness).

3.3. Industry groups and professional bodies

Writing a report about standardization there is also the need to take the institutes and professional bodies, groups of parties, into account and to investigate more deeply about their activities and their influence on the ongoing research and on the society. These groups differ in several dimensions: Some are country based, others are at European or global levels; some are activated by governments while others are industry or professional based; some provides standards, others certifications.

It has been decided to organise this section in order of relevance to DATAZERO.

Firstly it is mentioned the groups where the consortium has cooperated and/or participated actively: The Green Grid, EC Projects on data centre energy efficiency. Indeed strong links already exist between members of DATAZERO and these groups.

Then come groups ative and related to DATAZERO: BCS DCSG and OCP. These groups represent very important initiatives in the scope of the project.

Finally, it has been observed and monitored groups providing potential input useful for DATAZERO developments: ASHRAE, US Energy Star, IEEE, GHG Protocol, US Green Building Council, BRE Global.

3.3.1. The Green Grid

The Green Grid is a non-profit, open industry consortium of IT suppliers, end-users, policy-makers, technology providers, facility architects, and utility companies. The aim is to promote the agenda of these suppliers but also unite global industry efforts, create a common set of metrics, and develop technical resources and educational tools. The Green Grid has expanded its mission from "energy efficient IT" to "resource efficient IT", meaning that it will begin looking at water, carbon, materials, waste, in addition to just energy. It is linked to the global ecosystem of technical organisations and government institutions: The American Society of Heating, Refrigerating and Air-Conditioning Engineers (ASHRAE), BCS - The Chartered Institute for IT, China Communications Standards Association (CCSA).

The Green Grid Missions are:

- Data collection and analyses, finding best practices for data centre
- Creating a place for dialogue
- Working across many diverse organisations

Depending on the level of membership different possibilities of rights and participation are possible. Information is limited to members only, except the industrial blog. Twice a year, The Green Grid Forum is usually held, but also local groups are meeting besides.

The Green Grid has developed a number of metrics in the domain of data centre energy efficiency: PUE, WUE, CUE and DCIE, to name a few. These metrics assess the quality of a data centre in terms of efficiency of the resource provided against the resources useful for the IT equipment.

The PUE metric is in process of being standardized and also used in the European Code of Conduct (EU CoC), which could also find its way into laws or procurement documents at some stage. Furthermore, many data centre service providers now report that customers are asking PUE numbers in procurement documents. It should be stressed that there is no regulatory agency that monitors or certifies PUE ratings, and therefore the figures, widely cited, have no legal status, and are prone to distortion by technical and marketing staff. As already stated, PUE metric is currently being proposed for standardization at the ISO/IEC level (see previously mentioned under the JTC1/39 section). Altogether from the first white paper on this metric in 2007, it will take about 9 years to become a standard.

Another initiative of The Green Grid is the development of the Data Centre Maturity Model Assessment Tool (DCMM Tool), already used by more than 400 users to assess their data centres. It outlines current best practices. It may/will be used in the future for the EU CoC.

Finally, it must be noticed that The Green Grid created a Government Engagement Committee to follow (and influence) regulations in governments.

Climate Savers Computing Initiative (CSCI)

Started in 2007, Climate Savers Computing Initiative (CSCI) is a non-profit group of consumers, businesses, and conservation organisations dedicated to reducing the energy use and CO_2 emissions from computers. (In 2012, it became part of Green Grid).

Computer and component manufacturers participate in Climate Savers by committing to make products that meet or exceed current ENERGY STAR standards. Consumers and corporations participate by committing to choose PCs

and volume servers that meet or exceed the standards, and to use power management features.

CSCI's "baseline" efficiency standards for PCs and servers are based on the respective ENERGY STAR standards for PCs and servers. Higher levels of CSCI certification (Bronze, Silver, Gold) add additional requirements regarding power supply efficiency. Climate Savers now has around 700 members and around 250 certified products in its database.

In late 2010, Climate Savers announced that it was expanding its coverage to include networking devices. And, in mid-2011, the organisation began an initiative to address the issue of software interfering with PC/server power management functions.

3.3.2. Think and Do Tank of Datacenters

Gimelec, manufacturer union in the field of electrical industry, has set up a committee in charge of Data Center (CMDC). In order to be more efficient, this CMDC as launched in 2014 a Think Tank open to all Data Center players inside or outside Gimelec. Target of this body is to coordinate French players of the Data Center industry in order to better prepare its adaptation to future trends and be the right unified partner for various official initiatives, including standardization.

Gimelec Data Center Think Tank has several working group, one specifically in charge of standardization is currently active towards SC39, CG.GDC and CoC activities. It also provides guidance for the position to be defined at European level within CG/GDC or Mandate 462.

Two members of Datazero, Eaton and UPS/IRIT, are member of this Think Tank and EATON owns the leadership of the technical group.

3.3.3. Uptime Institute

The Uptime Institute (UI) provides education, publications, consulting, certifications, conferences and seminars, independent research, and thought leadership for the enterprise data centre industry and for data centre professionals.

Founded in 1993, the Institute pioneered the creation and facilitation of end-user knowledge communities to improve reliability and uninterruptible availability—uptime—in data centre facilities and IT organisations. In 2009, The 451 Group acquired the Institute.

3.3.4. Global Task Force

Several international organizations decided to work jointly in the direction of data centre energy efficiency. These organizations are:

- the U.S. Department of Energy through the Save Energy Now and formerly the Federal Energy Management Programs (March 2009 – October 2012);
- the U.S. Environmental Protection Agency's ENERGY STAR Program;
- the European Commission Joint Research Centre Data Centres Code of Conduct;
- the Japan's Ministry of Economy, Trade and Industry;
- Japan's Green IT Promotion Council;
- The Green Grid Association.

From early works on specific agreement to measure the Power Usage Effectiveness (PUE) in February 2011, three additional metrics were released in 2012: Green Energy Coefficient (GEC), Energy Reuse Factor (ERF), and Carbon Usage Effectiveness (CUE).

The last joint statement from the Taskforce outlines the agreements reached as of March, 2014. It provides recommendations for quantifying data centre energy productivity and an update regarding productivity proxies. The main output in terms of recommendations for data centres energy efficiency metrics in this document are summarized hereby:

- Define attributes and measure data centre energy productivity (DCeP). This means that there is a way to quantify the useful work of a data centre.
- Measure PUE, including several power sources.
- Measure GEC, ERF and CUE.

The document also specifies the way to measure the data and to compute these metrics, and give a handful of examples.

3.3.5. British Computer Society (BCS)

The British Computer Society has a number of initiatives – particularly through its Data Centre Specialist Group (DCSG).

In collaboration with the UK Carbon Trust, the BCS DCSG developed open source software that can be used to model energy efficiency and carbon emissions in data centres on a per-service basis (leading and transferred to the commercial Prognose software). The simulation tool has been developed by some of the advisors to the EU on how to measure data centre efficiency. They

developed a set of metrics (DC-FVER: Data centre Fixed to Variable Energy Ratio metric). Although there has been no indication of this, the EU could recommend the use of such metrics in a future iteration of the data centre Code of Conduct. There are about 6 events each year focussing on hot topics, related to new development and communication.

3.3.6. The Open Compute Project

The Open Compute Project has emerged as one of the most disruptive initiatives in the datacenter industry. It was an attempt by Facebook initially to share approaches to energy efficient datacenter design and operation from its own facilities. It has grown into an industry-backed initiative, which aims to put datacenter operators - rather than suppliers - in the driving seat. OCP designs are rapidly becoming seen as amongst the most efficient ways to design servers and racks as well as datacenter infrastructures. Collaboration could be focused on specific groups related to DATAZERO.

3.3.7. ASHRAE

The American Society of Heating, Refrigerating, and Air-Conditioning Engineers (ASHRAE) is an influential standards group whose work impacts data centres in several ways. ASHRAE's guidelines have a significant influence on data centre design and equipment selection, and any changes are inevitably controversial.

One set of ASHRAE guidelines describes the temperature and humidity ranges in which data centre computer rooms should operate. Data centres are intended to operate most of the time within ASHRAE's fairly narrow "recommended" temperature and humidity ranges. For limited periods of time, ASHRAE permits IT equipment to venture outside this recommended range into a broader "allowable" range of temperature and humidity conditions.

Another ASHRAE standard, its 90.1 standard, governs energy efficiency. The new 2010 edition of the standard pushes data centres toward the use of economizers or other technologies that can achieve similar efficiency in cooling. The rules will affect medium and large data centres in most climate zones, although there are exceptions for certain types of critical facilities (e.g., some Tier IV sites, certain financial processing centres).

Although ASHRAE standards do not have the force of law, many jurisdictions adopt them as part of mandatory building codes. Thus, ASHRAE's 90.1 standards strongly affect new data centre construction and major renovations.

3.3.8. IEEE

IEEE, the Institute of Electrical and Electronics Engineers, promotes its IEEE 1680 family of environmental standards for electronic products. Within this family, IEEE 1680.1 addresses desktop personal computers, laptops, and personal computer monitors. The standard covers many environmental aspects of a product, including energy efficiency, materials selection, toxics, packaging, and corporate environmental policies. The energy efficiency portion of the standard references Energy Star. Another branch of IEEE 1680 is covering servers.

3.3.9. US Energy Star Data Center Energy certification

The US Energy Star certification system covers a variety of products from household white goods right up to data centres. It is overseen by the US Environmental Protection Agency (EPA). Regarding data centres, the Energy Star rating is awarded to the top quartile of energy efficient facilities in operation.

The EPA (Environmental Protection Agency) is not alone. Both The Green Grid and the US Dept. of Energy have also initiated data centre energy efficiency data collection and registration schemes. The three groups are co-operating to ensure that data collection techniques are consistent, and it seems likely that these schemes may join together at some stage (see Global Task Force above).

The criteria to get the certification are the following. Facilities must reapply for Energy Star each year, based on their performance over the previous 12 months. Points are awarded on a 1-100 scale. A score of 80 means a facility is more energy efficient than 80% of a group of similar buildings nationwide. Energy Star requires annual PUE to measure efficiency. Facilities must submit data on all of the energy delivered to a building, from all fuel sources, for an entire year. “IT load” is measured at the output of the UPS (Uninterruptible Power Supply).

EPA’s performance scale uses a zip code to calibrate the weather’s influence on PUE, as some sites will benefit more from free cooling opportunities, etc. Although voluntary, the EPA seeks to get data centre operators to improve their energy efficiency by encouraging a certain amount of public disclosure. Energy Star rated data centres are listed in a publicly available registry. Co-location and hosting firms might even win business on the basis of efficiency ratings. Operators who refuse to apply may be looked upon as suspect. Only 72 data centres are listed, with no indication of size or power drawn [EnergyStarDC]. However, for the best ones, one can find details of their design and solutions [EnergyStarDC-Champions] that could give ideas to the DATAZERO project.

3.3.10. Energy Star for Servers, Storage and Power Supplies

As well as rating the overall data centre, Energy Star certification can also be applied to specific equipment including servers, storage and even power supplies. The scheme sets a bar that approves about 25 % of the most energy efficient products, and gives the market time to catch-up. Then it raises the bar again.

The following categories can be considered:

- Energy Star for Servers:
  This relates to the Power Supply Unit and the Idle State Power efficiency, at different load (see [EnergyStarServer] for details).
- Energy Star for Data Storage:
  This relates to large data storage devices such as storage arrays and related networking equipment. This is also in the development stage. Draft 1, Version 1.0 has recently been published.
- Energy Star for Uninterruptible Power Supplies:
  This relates to high specification supplies used in data centres and computing facilities to ensure consistent power.

3.3.11. World Resources Institute (WRI) and the World Business Council for Sustainable Development (WBCSD): GHG Protocol

A partnership between the World Resources Institute (WRI) and the World Business Council for Sustainable Development (WBCSD) led to the development of the GHG (greenhouse gas) Protocol. The protocol provides standards and guidance for companies and other organisations preparing a GHG emissions inventory. It covers the accounting and reporting of the six greenhouse gases covered by the Kyoto Protocol — carbon dioxide (CO_2), methane (CH_4), nitrous oxide (N_2O), hydrofluorocarbons (HFCs), perfluorocarbons (PFCs) and sulphur hexafluoride (SF_6).

The protocol places emissions within a framework that is divided into three categories. Scope 1 is concerned with direct emissions such as those from a factory; scope 2 covers indirect emissions through the products or services bought by the company - for example purchased electricity; scope 3 is focussed on indirect sources such as outsourced services. However, most companies are unlikely to directly interface with the protocol but will rather deal with the standards it states.

The GHG Protocol consists of four separate but inter-linked standards. Two of these, the Corporate Value Chain (Scope 3) and the Product Life Cycle

Accounting and Reporting Standards, take a life cycle approach at the corporate and product levels respectively. The Global e-Sustainability Initiative (GeSI) and the Carbon Trust are working with WRI and WBCSD to lead an ICT Sector Guidance for the Product Life Cycle Accounting and Reporting Standard.

3.3.12. US Green Building Council

LEED (Leadership in Energy & Environmental Design) standard is the de facto measure of building project sustainability in the US. Developed by the US Green Building Council (USGBC), the rating attempts to classify and certify building projects according to their overall sustainability.

LEED is a point-based system by which building projects earn points for satisfying specific green building criteria which include water efficiency, energy & atmosphere, materials & resources, Indoor environmental quality, and innovation in design. Facilities are then certified as Sliver, Gold or Platinum depending on points scored. As well as the one-off certification process, LEED for Existing Buildings: Operations & Maintenance is an additional scheme that allows the on-going sustainability of a facility to be measured. Unfortunately, although some data centres have sought certification, LEED is not widely applicable to computing facilities. However a data centre specific adoption is in the final stages of development.

3.3.13. BRE Global

The UK-developed Building Research Establishment Environmental Assessment Method (BREEAM) standard is widely used. BREEAM, like its younger US cousin LEED, is a points-based system for rating buildings. It is, however, more flexible, in that those seeking certification can select or deselect criteria according to how appropriate they are to certain buildings. It supports the development of bespoke templates that are function-specific. This has made it easier for BRE Global, the approvals and certification body that manages BREEAM, to introduce a new data centre standard. The new data centre specification focuses on buildings with few employees, with high-energy use and where factors such as air quality and natural daylight are less important.

3.4. DATAZERO and the related projects

The European projects (GAMES, FIT4GREEN, ALL4GREEN, ECO2Cclouds, COOLEMALL, DC4CITIES, RENEWIT, Greendatanet…) were/are clearly relevant to Datazero since they addressed globally the same problem of energy efficiency in data centres. Hence the consortium will assess their developments in particular in the domain of metric definition and standardization activities.

4. Conclusion and Standardization Plan

4.1. Conclusion

The following conclusions can be drawn based on the analysis outlined in this deliverable:

Standardization can be interpreted differently: As this document points out, groups interpret standardization differently according to their needs and to the aim of the federation they belong to. To a generalist audience, standardization may be interpreted as ensuring that a technology is widely interoperable and is developed according to generally accepted practices. However, standardization as it is applied to official technical standards has a very specific meaning and refers to the output of a recognised standards body. The consortium is aware of both interpretations and has attempted to satisfy both approaches as ensuring that project outputs are interoperable, as well as adhering (and contributing) to specific standards, are both critical.

Standardization is complex and time-consuming: The complexity of the standards development process and the sheer number of stakeholders, involved will limit the amount of contribution that a finite project can make in this area. At best, a project such as DATAZERO can plan to ensure that the technologies, and research, it develops fits with the broad standards activities of the wider industry. Input and contribution to specific standards efforts will have to be carefully chosen and this will require partners to engage with specific technical committees within the standards bodies to gauge where our effort is most useful and appropriate. Working with intermediary organisations (and proposers of future standards and metrics) such as CG GDC and The Green Grid also helps to maximize the benefits the project can provide to relevant standards activities.

4.2. Standardization Plan

Concretely, the following bodies will be approached directly and regularly (every year, starting March 2016), during the course of the project to present its aim, objectives and results:

- ISO/IEC JTC1/39 (worldwide, through French AFNOR, EATON and IRIT members). Afnor has proposed SC39 to provide a technical specification on the REF (renewable usage KPI), in order to better discriminate advanced renewable data center solutions versus renewable usage based only on certificate endorsement. Datazero could provide support to this work from the technology angle

- Think and Do Tank on Datacenters (France, EATON and IRIT members): Gimelec CMDC is regularly questioned by French government on issues regarding Data Center trends and choices. Datazero could provide with its expertise value to the CMDC advices, thanks to its participation to the Think Tank.

- CG GDC (european)

We believe that presenting at these bodies will help disseminate broadly our work and will help contribute to upcoming standards, so that they take into account innovations in building renewable energies datacenter and assessing their performances.

5. References

[1] Herzog, Christina, Standardization Bodies, Initiatives and their relation to Green IT focused on the Data Centre Side. (2013) In: European Conference Energy Efficiency in Large Scale Distributed Systems (EE-LSDS 2013), 22 April 2013 - 24 April 2013 (Vienna, Austria).

[2] http://www.cencenelec.eu/standards/Sectors/ICT/Pages/GreenDataCentres.aspx

[EnergyStarDC] http://www.energystar.gov/index.cfm?fuseaction=labeled_buildings.showDataCenters

[EnergyStarDC-Champions] http://www.energystar.gov/products/low_carbon_it_campaign/business_case/low_carbon_it_champions

[EnergyStarServers] https://www.energystar.gov/ia/partners/prod_development/revisions/downloads/computer_servers/Program_Requirements_V2.0.pdf

6. List of abbreviations

ASHRAE	American Society of Heating, Refrigerating, and Air-Conditioning Engineers
BCS	British Computer Society
BCS DCSG	Data Centre Specialist Group
CEN-CENELEC	European Committee for Electrotechnical Standardization
CG GDC	Coordination Group on Green Data Centres

CoC	Code of Conduct
DC	Direct current
DCSG	Data Centre Specialist Group
EC	European Commission
EMEA	Europe, the Middle East and Africa
ESO	European Standardization Organizations
ETSI	European Telecommunications Standards Institute
EU CoC	European Code of Conduct
GHG	Greenhouse gas
ICT	Information and Communication Technologies
IEC	International Electrotechnical Commission
ISO	International Organisation for Standardization (ISO)
IT	Information Technology
JTC	Joint Technical Committees
PUE	Power Usage Effectiveness
UN ITU	International Telecommunication Union