Certification concepts for energy efficient data centres

Comparison of certification services in the EU

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1 Summary

Energy efficiency in data centres and server rooms has only recently become a major issue of concern for IT and infrastructure management [EPA 2007, E-Server 2007] as power demand and related energy costs for infrastructure and cooling has increased. The awareness of energy efficiency originally came from the data centre infrastructure level where limitations regarding power supply and cooling started to cause problems, particularly in larger data centres.

Scenario calculations from different international studies suggest a doubling of energy demand within a few years unless effective energy saving measures are put into place [E-Server 2007, EPA2007]. The same studies indicated that the implementation of new efficient technology would allow energy savings in the order of 20-60% and possibly more.

In the meantime several concepts and tools have been proposed and implemented at international level to support energy efficiency measures in data centres including energy efficiency metrics and monitoring, guidelines for procurement and best practice as well as comprehensive management and certification concepts.

In this paper, the main management and certification concepts available in the EU are briefly evaluated and compared regarding their practical effectiveness and specific benefits.

The most prominent approaches to date are the EU-Code of Conduct for data centres, certificates by the TÜV and Blue Angel in Germany and a new concept recently implemented by CEEDA in the UK.

The oldest and best established concept so far is the EU Code of Conduct (CoC), which was implemented in 2008, and is currently used by more than 50 data centres in different EU countries. The approach is largely based on best practice guidelines, and an energy monitoring and management concept. The Code of Conduct provides a label for external marketing of energy management by participants and endorsers. However, the approach does not include formalised external auditing and certification such as those typically offered by environmental management schemes like ISO 14000 or EMAS. Thus, the CoC is not a full management or certification standard comparable to other environmental standards in the EU.

The Blue Angel for data centres (developed and introduced by RAL GmbH in cooperation with the German Ministry of Environment in 2011) provides a standardised certification scheme including external auditing. Although originally designed for the German market, this approach would also be applicable in other EU countries. However, due to some shortcomings in the design, this concept has not yet been successfully established, or has not been accepted by the market so far. An overall revision of the approach is currently on-going.

Different TÜV companies in Germany have been offering certification like concepts for data centres since 2009. The approaches include the typical elements of standard certifications involving the implementation of energy management, periodical monitoring and external auditing. Some TÜVs provide global certification for companies in Asia and other regions. The approach typically involves a co-operation between the TÜV and local consulting companies. TÜV certificates are not standardised and differ between TÜV companies.

In 2011, CEEDA in the UK developed a new certification approach primarily for application in the UK region. The approach is partly similar to the EU Code of Conduct, but it offers a more standardised and formalised external certification evaluation.

Finally in the US, the Energy Star Programme provides support for data centre certification. However, the US approach mainly builds on US Energy Star requirements for building design and does not comprehensively cover the IT hardware level in data centres.

To summarise the results of this short assessment: so far no certification approach is available that provides comprehensive and standardised support for energy management and best practice, benchmarking, and information and communication purposes. Thus there is no formalised and comprehensive certification approach available to date. All approaches show different benefits and drawbacks regarding the support of efficiency measures and communication.

All concepts include elements that significantly support the improvement of energy management processes. Thus the selection of a specific approach depends on the individual goals and preferences as well as on the size and location of the data centre.

The PrimeEnergyIT Consortium, February 2012

2 Introduction

Energy efficiency in server rooms and data centres has only recently become a major issue of concern for IT and infrastructure management (EPA 2007, E-Server 2007). This happened, when it was realised that the growing demand for high performance computing services led to a drastic increase in energy consumption in the IT service sector. According to scenario calculations, a doubling of energy demand is expected within a few years unless effective energy saving measures are implemented. However, it was also realised that the application of efficient technologies would allow energy savings in data centres in the order of 20-60% and sometimes more.

Several initiatives, such as the *EU Code of Conduct for data centres, The Green Grid* and the *Energy Star Programme,* address these energy saving potentials in data centres. A number of best practice measures and technologies have been investigated to improve efficiency both at the hardware and the infrastructure level. Many companies have already started to implement energy efficiency strategies. Recent studies have indicated that these activities have already led to a positive trend. Compared to earlier scenarios from 2007, which indicated a doubling of energy consumption in 4-5 years, world-wide energy consumption of data centres has “only” increased by about 56% between 2005 and 2010 (Koomey 2011). Thus the expected rapid increase of energy demand has been slowed down to some extent.

Nevertheless, a strong need and large potential for improvements still remains both in data centres, but also in small to medium size facilities. New technologies have become available, which more effectively address energy efficiency potentials at the hardware and the system level for IT and IT infrastructure.

This report developed within the IEE project *PrimeEnergyIT* provides an overview and assessment on primary certification approaches for data centres that have been developed to support energy management and communication of best practice.

Certification of environmental management for companies in the service sector already has a long tradition since the 1990s with the EU EMAS and ISO 14000 schemes. In the meantime an EN standard for energy efficient management has also been established (ISO 16000). Since 2007, several initiatives for a voluntary certification of energy efficient data centres have started. To date no common international standard has been developed but several local and EU-wide initiatives provide different types of certificates. The most prominent approaches are the EU Code of Conduct for data centres, the Blue Angel Label for data centres, certifications by TÜV, a new scheme developed by CEEDA in the UK and, finally, the Energy Star for data centres (currently only applied in the US).

This paper provides an overview on the concepts and evaluates advantages and disadvantages of the major approaches regarding practical application and specific benefits for companies.

3 EU-Code of Conduct for data centres

3.1 General concept and goals

The EU Code of Conduct for data centres was one of the first international approaches addressing energy efficiency management in data centres in 2008. The voluntary scheme was developed by the JRC ISPRA in cooperation with partners in the UK and Denmark.

The Code of Conduct is basically a voluntary commitment of companies that own or operate data centres. The main goal is to support a reduction of energy consumption in data centres by applying best practice.

The main objectives are among others:

- Awareness raising for managers, owners and investors
- Provision of tools for a cost efficient implementation of energy saving measures
- Support of the development of easy to understand metrics for energy consumption monitoring
- Support of energy efficiency procurement by criteria and best practice
- Harmonisation with other international activities
- Open process and discussion forum for participants and supporters

This initiative includes the typical elements of environmental management schemes including an energy efficiency strategy, energy efficiency monitoring and best practice measures. Fig.1 shows the major elements of the CoC approach.

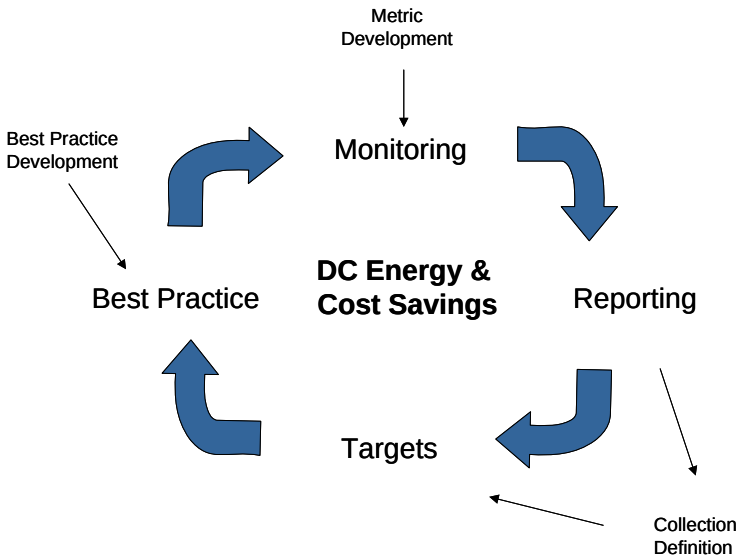

Fig 1 Major elements of the CoC approach

Participants of the CoC scheme have to implement the following measures:

- an assessment of the initial situation in the data centre (including a monthly measurement)

- specification of a clear energy saving goals and a concrete action plan
- implementation of best practice measures for improvement.

Progress reporting must be done on an annual basis to the responsible management body at the Joint Research Centre in ISPRA. However, the CoC partnership is issued for a 3 years and the data centre is reassessed by ISPRA in a 3 years cycle.

Different from other environmental certification schemes the CoC approach is based on a comprehensive set of best practice measures, which are revised on a regular basis by JRC. Best practice covers DC planning and management for IT, cooling and power supply (see Fig.2). The concept considers a classification of measures for the following specific situations:

- Standard operations in the data centre
- Replacement and procurement of IT hardware
- Renewal and redesign of data centres (infrastructure)
- Design of new data centres

Table 1 shows an example of best practice measures. Measures are furthermore structured in aspects that are mandatory for all CoC-partners, and aspects that are more advanced. Partners are required to implement measures applicable for their specific situation. CoC participants are grouped into categories according to which parts of each data centre they have control over, and based on responsibility for possible efficiency improvements. Depending on responsibility, different best practice measures may apply.

Since 2010 new data centres can also apply for Code of Conduct partnership. New data centres have to demonstrate best in class designs and must have implemented all expected practices applicable to the specific DC type.

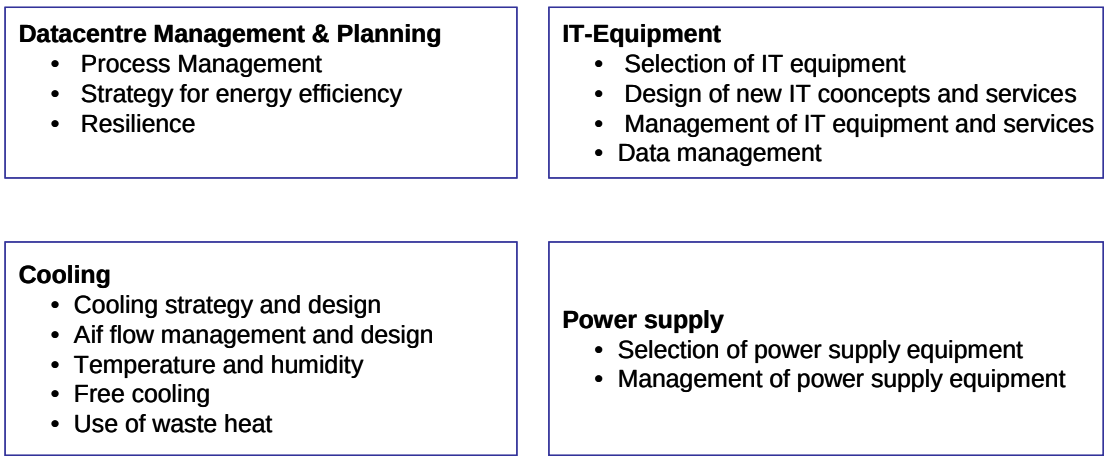

Fig. 2 Main areas for best practice measures in the CoC-scheme

Tab.1 Example of best practice measures defined by CoC

No	Measure	Description
4.1.1.	Multiple Tender for IT-hardware - power	Include the energy efficieny performance of the IT device as a high priority decision factor in the tender process. This may be through the use of Energy Star or SPECPower type standard metrics or thorugh application or deployment of specific user metrics aligned to the target environment which may include service level or reliability components.
4.1.2.	Multiple Tender for IT-hardware - Basic operating temperature and humidity range at equipment intake	Include the operating temperature and humidity ranges at equipment intake of new equipment as high priority decision factors in the tender process. The minimum range, at the air intake to servers is 18-27°C and 5,5°C des point up to 15 C dew point and 60% RH.
4.1.6.	Enable power management features	Formally change the deployment process to include the enabling of power management features on IT hardware as it is deployed. This includes BIOS, operation system and driver settings

3.2 Documentation of energy consumption and energy efficiency metrics

The CoC specifies requirements and options for the measurement and monitoring of energy consumption in the data centre. It is recognised that energy consumption in DC facilities, particularly in shared use buildings is not always be easy to measure.

Participants are invited to provide more detailed metering reports that can be made available to assist the further development of the Code of Conduct concept. This may cover metering of individual parts of the data centre such as chillers and CRAC units, or metering of the power to and from the UPS system.

Regarding energy efficiency metrics, the Code of Conduct is based on the traditional metric Data Centre infrastructure Efficiency (DCiE) and Power Usage Effectiveness (PUE). Additional metrics addressing the energy efficiency of IT equipment and IT services will be applied as soon as available.

3.3 Benefits and limitations of the CoC approach and current state of participation

Overall, the Code of Conduct provides a transparent international initiative to support and visualise energy efficiency in data centres. The major benefit is the implementation of a management and monitoring approach in DCs supported by concrete best practice guidelines.

The CoC highlights the following specific benefits for participants:

- Use of the Code of Conduct Logo for communication purposes
- DCs with very low energy consumption may use the title “Code of Conduct Low Energy Champion” and may apply for the annual Data Centre Award.
- Participation in the CoC stakeholder forum for information exchange
- Benefits from the Code of Conduct Promotion Campaign

To date about 50 data centres participate in the CoC scheme across the EU. A comparably large number of participants are found in the UK. This is due to the fact that some UK organisations were significantly involved in the CoC development and promotion. About 60% of the participants are DCs

providing data hosting and 22% are traditional data centres in companies. The remaining share is split by telecom and scientific applications. About 60% are stand-alone data centres, the rest are mixed buildings. The average energy efficiency of the infrastructure currently expressed as PUE is about 1.8.

Overall participation in the Code of Conduct can be recommended especially for larger data centres that want to focus on best practice for energy efficiency.

The current shortcomings of the CoC are the lack of a completely formalised management body for the CoC process, equipped with adequate resources for increasing management and promotion tasks. In contrast to other established environmental management schemes, the CoC is not an official international management standard with management bodies, but a voluntary initiative supported by the JRC and some partners in EU Member States. This makes the approach very flexible and allows dynamic changes, but limits the effectiveness of operation and promotion.

Overall the lack of formal organisation and limited management resources may bring about the following problems:

- Administrative processes may slow down as the number of CoC participants rises
- Resources for adequate promotion are lacking
- CoC may not become as effective and accepted as other international EN/ISO certification standards.
- The whole administration effort has to be covered by the management body in ISPRA

To exploit the full power of the Code of Conduct approach, it would be advisable to revise some elements of the CoC approach to make it more comparable to other EU environmental management standards. This would allow shared effort and responsibilities between different bodies at JRC and in EU Member States.

Further specific advantages and limitations of the Code of Conduct are discussed in section 6.

4 Blue Angel for energy efficient data centres

4.1 General concept and goals

In July 2011, the German Ministry of Environment and the German Federal Environmental Agency implemented an environmental label for energy conscious data centres. Owners or operators of centres fulfilling defined requirements can apply for the label at RAL GmbH. The label is provided per DC building or DC location. Thus different locations require individual applications.

In general, the environmental label requires the implementation of an energy management system according to EN 16001. This includes a transparent energy efficiency strategy, a plan for concrete energy saving measures, a monitoring system and clear definition of responsibilities in the data centre.

Applicants have to provide a basic analysis of the data centre according to specified guidelines. This has to include information on the Energy Usage Effectiveness (EUE) measured over a period of 12 months. Data provided must not be more than 3 months old. Furthermore the applicant has to fulfil a number of requirements regarding procurement and management of the IT and infrastructure.

For the IT level the following major criteria have to be fulfilled:

- Server hardware must comply with a minimum SPECpower benchmark of 2000 and the virtualisation level in the data centre must be 2 at minimum.
- Energy efficiency of power supplies must meet at least gold level of the 80plus programme.
- Settings for humidity and temperature must comply with ASHRAE specifications.
- Life cycle costs have to be calculated and considered for all equipment purchased.

Regarding cooling and power supply efficiency the following criteria have to be fulfilled:

- Energy Efficiency Ratio > 4, Seasonal Energy Efficiency Ratio > 3.5
- Inlet air temperature at the CRAC must not be lower than 18°C, outlet air temperature must not be lower than 28°C. Server room temperature at 1.2m above ground should be at least 28°C
- Application of a modular cooling concept and use of free cooling. Avoidance of halogenated hydrocarbons for refrigerants.
- The effectiveness of the power supply must be 90%, 85%, and 80% at 100%, 75% and 50% load, respectively.

4.2 Documentation of energy consumption and energy efficiency metrics

One central criterion of the Blue Angel is the monitoring of the energy consumption, temperature and IT-load. The concept for the energy measurements is shown in Figure 3. Apart from energy monitoring, a continuous monitoring of the temperature and IT load is required. The IT-load includes the server load (CPU/memory), storage load (storage/disk capacity %) and network load (bandwidth in %).

An annual energy efficiency report has to be provided. This includes information on the Energy Usage Effectiveness and the Energy Management System.

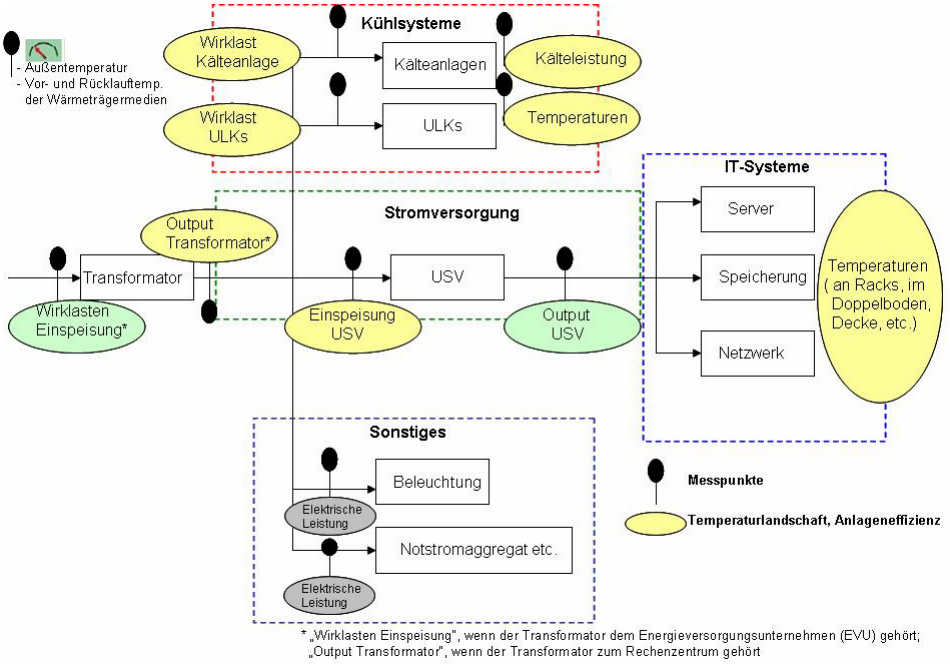

Fig. 3 Concept for the energy consumption measurements

4.3 Benefits and limitations of the Blue-Angel concept and current state of market acceptance

The Blue Angel label was implemented in the summer of 2011. However, to date no companies have been certified and the approach is currently undergoing a complete revision.

The main benefits of the Blue Angel concept can be summarised as follows:

- Support of the implementation of an energy management and monitoring system

- Several useful requirements for procurement and management of IT and infrastructure equipment
- Option to use of the label for communication and marketing purposes

The management and procurement requirements, and the monitoring system stimulate the implementation of energy efficiency measures in data centres.

The national approach primarily addresses target groups in Germany. The rather restrictive and inflexible criteria, however, cause potential disadvantages for users:

- The impact of the label for communication and marketing purposes is mostly limited to German speaking countries, where the label is well known and applied. The national approach clearly limits the international relevance of the concept, and also the option of benchmarking internationally.
- Some of the requirements appear as static and not optimised for data centre level management approaches. For example, the required SPECpower benchmark and the temperature settings are not optimised. A single static requirement for servers based on SPECpower is not appropriate for several reasons. SPECpower values vary depending on the performance of a server. They have been changing over time due to technological developments.
- Temperature requirements at the CRAC level are not really effective.

5 Certificates by TÜV

5.1 General Aspects

In Germany, several TÜV companies offer certification of energy efficient data centres. However, due to independent management of the TÜV companies, the certification concepts are different. Some TÜV companies also provide certification at an international level outside the EU and also offer an efficiency label for this. For example, certification has been provided to Indian companies by TÜV-Rheinland (see below).

5.1.1 TÜV Saarland with TEKIT

The TÜV-Group Saarland, for example, provides a label for data centres with the efficiency classes A+ to D. D-class is the efficiency baseline. TÜV Saarland evaluates the following criteria:

- Data centre costs
- Consolidation and virtualisation
- Efficiency of air conditioning/ data centre cooling
- Efficiency of power distribution and UPS
- Power generation and use of waste heat

The certification typically covers the following aspects:

- Efficiency of products and services
- Processes
- Monitoring of products and services
- Tests and audits
- Employees qualifications

The rules for the assessment are defined together with the customer. The assessment and auditing is conducted in cooperation with the consulting company TEKIT Consult Bonn. The certificate and TÜV label is valid for one year, and can be used for communication and promotion purposes.

5.1.2 TÜV Rheinland and Fujitsu

TÜV Rheinland in cooperation with Fujitsu provide an energy efficiency assessment and certification for data centres that comprises the following aspects:

- Energy efficiency check
- Energy management assessment
- Certification concept

Fujitsu mainly supports the first two elements of the concept and TÜV is responsible for the certification process (see also fig. 5.1).

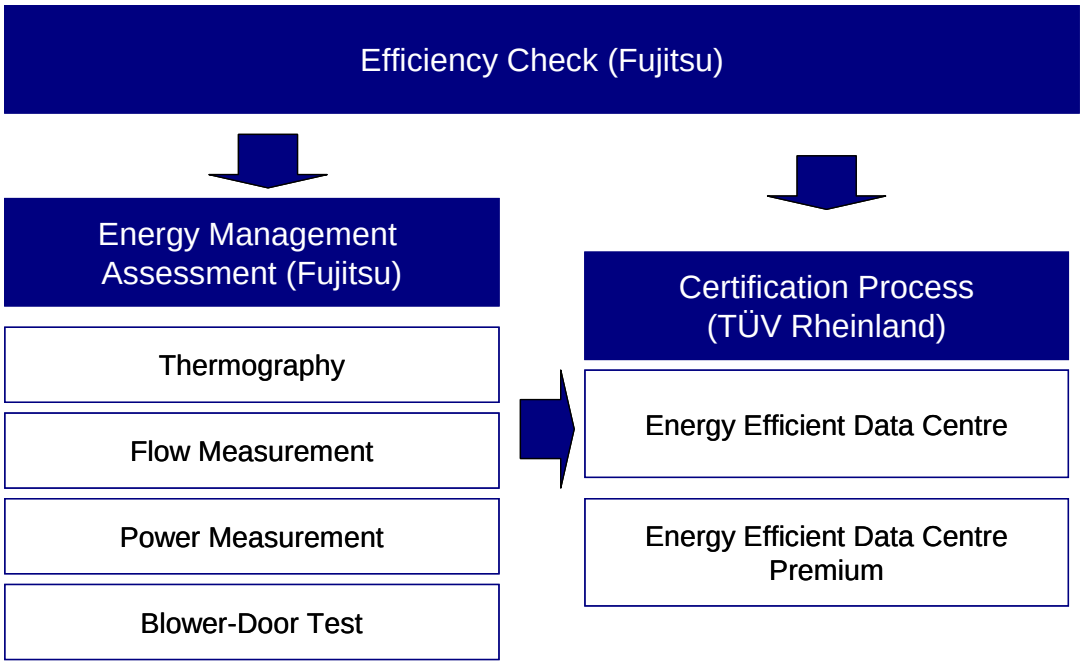

Fig. 4 Assessment and certification concept offered by TÜV Rheinland and Futjitsu

The first module called *Energy Check* provides a first basic analysis of the data centre and includes among others the following issues:

- Definition of thresholds for the Data Centre
- Audit using the TÜV list of criteria
- Data Centre inspection
- Inspection of relevant documents
- Short report including a list of weak points and estimation of the potential for improvement

The efficiency check is limited to a two day short assessment.

The second module called *Energy Management Assessment* includes an extensive energy-related measurement, a detailed investigation of potential improvements measures and expert recommendations. The Energy Management Assessment comprises the following steps:

1. Temporary measurements of energy consumption (approx. 4 weeks minimum)
2. Analysis and demonstration of weaknesses by thermography
3. Specific measurements of air flow and temperatures of the air-conditioning system
4. Calculation of Power Usage Effectiveness (PUE) averaged over the measurement period

The certification conducted by TÜV based on the previous assessment steps is designed to support a continuous improvement process over a period of three years. The following steps have to be covered as a basis for the certification:

- At least 60% of the rating points achieved from the criteria catalogue are required
- Continuous monitoring of energy efficiency through stationary operated measurements is mandatory
- The data centre must implement instruments for analysis, monitoring and continuous improvement of energy use
- The data centre is committed to improving energy efficiency and to be annually audited by TUV Rheinland

In addition to the certification "Energy-Efficient Data Centre", Fujitsu offers a further certification. This recognises that the process of continuous improvement in energy efficiency is implemented, and formal measurement technologies are utilised.

5.2 Benefits and limitations of the concept

According to market research, the brand TÜV is very well known in Germany (98.7%) and receives high acceptance even outside the EU region. Thus, there is a strong marketing benefit of the concept.

Futjitsu and TÜV Rheinland highlight the following advantages for companies:

- Participants are free to choose the level of involvement from “Efficiency Check” inspection to full formal certification
- The process provides detailed insight into the current energy efficiency of the data centre
- Planning of improvements is supported based on comprehensive feedback on optimization potentials and weak points
- Implementation of a continuous improvement process
- The certification from TÜV allows to demonstrate the commitment to Green IT

The TÜV approach is clearly focussed on internal improvement of energy efficiency in data centres, and not on supporting the comparison between data centres. As such the certification mainly provides an internal benchmark for improvement. The different local approaches also impede a comparison of TÜV certifications.

However due to wide acceptance of TÜV the label may be used at international level for communication purposes.

6 Certification by BCS – Certified Energy Efficient Data Centre Award

6.1 General aspects and concept

BCS (the Chartered Institute for IT) has launched a new data centre award approach that is intended to be offered internationally, but primarily addresses the UK market. The award is based on a comprehensive assessment of the data centre including the following aspects:

- Data centre utilisation
- IT equipment and services
- Cooling
- Power equipment
- Data centre building
- Monitoring

The basic concept is based on the EU Code of Conduct best practice. However, CEEDA is not linked to the CoC process. Thus, CoC and CEEDA are independent. CEEDA recognition does not automatically mean CoC recognition and vice versa. The CEEDA concept involves a tiered 3 level certification award involving Bronze, Silver and Gold levels.

Table 6.1 shows some examples for aspects and best practice issues assessed for the certification. The CEEDA process involves the following steps:

1. Short self-evaluation of the data centre based on CEEDA checklists
2. Additional data collection advised by CEEDA
3. One day on site assessment with the CEEDA assessor as a basis for compilation of the information to be sent to the Auditor ITAASL.
4. Further clarifications with the auditor or full audit and assessment in case a CEEDA Gold level certificate is envisaged
5. The audit is finally sent to BCS who grants the award.

The award is valid for a period of 2 years.

ITAASL (International Technology Audit and Advisory Services Ltd) conducts the audits as an independent company. ITAASL specialises in auditing services for the IT sector. The company provides services internationally in the EU, US and Asia.

Tab. 2 Examples for best practice measures considered in CEEDA

	Bronze	Silver	Gold
Have you decommissioned and removed any unused IT services?	[•]	[•]	[•]
Do you have a data management policy?	[•]	[•]	[•]
Do you use blanking plates to improve rack air flow management?	[•]	[•]	[•]
Do you review your cooling requirements before making IT equipment changes?	[•]	[•]	[•]
Have you reviewed and raised the air intake temperature of your IT equipment?	[•]	[•]	[•]
Have you reviewed and increased the working humidity range in your data centre?	[•]	[•]	[•]
Have you reviewed the set point temperatures for air and water?	[•]	[•]	[•]
Do you understand and have you reviewed the impact of your cooling system operating temperatures?	[•]	[•]	[•]
Do you turn off lights when areas are unoccupied?	[•]	[•]	[•]
Are you using low energy lighting in your data centre?	[•]	[•]	[•]
Do you have an incoming energy consumption meter that exclusively measures your data centre energy consumption?	[•]	[•]	[•]
Have you installed IT energy consumption meters?	[•]	[•]	[•]
Have you established an approval board with the various data centre stakeholders within your organisation (Apps, IT, FM...)?	–	[•]	[•]
Have you audited existing equipment to maximise any unused existing capability?	–	[•]	[•]
Do you include the energy efficiency performance of the IT device as a high priority decision factor in the tender process?	–	[•]	[•]
Do you include the operating temperature and humidity ranges of new equipment as high priority decision factors in the tender process?	–	[•]	[•]
Do you enable power management features on your IT hardware?	–	[•]	[•]
Do you provision power to the as-configured power draw capability of IT hardware?	–	[•]	[•]
Have you implemented an ITIL type Configuration Management Database and Service Catalogue?	–	[•]	[•]
Have you optimised your raised floor air flow management?	–	[•]	[•]
Is your data centre designed in a Hot / Cold aisle configuration?	–	[•]	[•]
Have you fitted perforated doors to your racks?	–	[•]	[•]

6.2 Benefits and limitations of the concept

BCS claims the following benefits for companies using the CEEDA certification approach:

Participants

- receive advice for energy efficiency improvement
- harness major cost savings through energy efficiency
- receive industry recognition by clients and public for energy efficiency
    - position themselves as an industry leader

- meet the needs of increasing energy efficiency and carbon legislation

Overall, the benefits regarding advice and recommendations for best practice are similar to the Code of Conduct for data centres, as the best practice concept is mainly based on the CoC. However, besides supporting similar strategies at technological level, the two approaches differ in several aspects such as:

- The Code of Conduct supports international information exchange between participants in annual meetings
- The CEEDA approach offers a staged labelling concept (Bronze, Silver, Gold) that indicates a range of energy efficiency levels. This label concept offers a better option for marketing purposes.
- The CEEDA process involves a specified international independent body for auditing. Thus the assessment and auditing process, and the final certification is supported by two independent entities.

7 Energy Star for data centres

Energy Star has for a long time been announcing a certification scheme for data centres. The first activities to prepare such a scheme were launched in 2007 with a report to the US Congress.

In the meantime Energy Star has developed a few tools to support data centre assessment in practice and provides data centre certification. This, however, is still mainly based on earlier Energy Star building standards.

In contrast to the Energy Star requirements for office equipment, the scheme for data centres is applied so far only in the US. To date it has no specific relevance for companies in the EU.

8 Summarising comparison of concepts

8.1 General approach

The certification approaches for energy efficient data centres presented in this paper have been implemented between 2008 and 2011 with the goal to stimulate energy efficient management in DC services. The Code of Conduct was the first approach implemented, addressing target groups in the EU, primarily with a best practice based approach. The concept was followed by initiatives in Germany and the UK following more a labelling oriented strategy. In parallel, Energy Star has been proposing energy efficiency certification in the US. However, the Energy Star concept is largely based on US Energy Star for buildings. No specific concept for data centres has been developed.

Depending on the specific goals and the location of a data centre, the different concepts presented provide different benefits. For some companies communication and information to stakeholders may be the primary interest, whereas others focus on process improvements and benchmarking. For companies located in the UK and Germany, the national approaches may be more appealing.

8.2 Support of communication and marketing

One essential benefit of certificates for companies is marketing and stakeholder information. The certificate provides a means to communicate and promote a data centre's environmental activities and the high efficiency to stakeholders. Regarding this specific aspect, the four concepts differ markedly.

While the EU-Code of Conduct, being the first approach on the market in 2008, receives broad acceptance in the EU, it is in fact not primarily designed for communication purposes. The concept is mainly focussed on process improvement and internal benchmarking. The Code of Conduct logo that can be used for information purposes mainly indicates the participant status, and is not specifically a marketing oriented label.

In contrast, both the Blue Angel and TÜV concepts build on a long tradition of labelling for quality and environmental efficiency. Labels from TÜV and the Blue Angel have been used for various products and processes in the past and are well known quality standards - however with a stronger focus on the German market. While the Blue Angel provides only a static label, TÜV also offers concrete information on the efficiency level and provides efficiency classes. However, a significant disadvantage of the TÜV concept is the lacking standardisation even within Germany.

CEEDA in the UK currently provides the most marketing oriented label involving a three class labelling scheme with a Bronze, Silver and Gold level.

Concerning the acceptance of both the Blue Angel approach and the CEEDA approach, no comprehensive evaluation can be provided to date as both approaches were implemented less than a year ago. However, according to current information, market acceptance of the Blue Angel has not yet been achieved and the concept therefore is already undergoing a complete revision.

In general regarding communication and marketing, none of the current concepts provide an optimum approach. Even though it receives relatively broad acceptance, the CoC is not very marketing oriented. The other concepts while being more marketing oriented have yet not demonstrated broad environmental acceptance.

8.3 Support of continuous process improvements and benchmarking in data centres

A second essential element of certification concepts besides communication and marketing is the support of continuous process improvement and benchmarking in DCs. For that purpose, concepts should effectively support the implementation of management systems, internal monitoring and best practice in a continuous approach.

The CoC provides all these essential elements and consequently provides a good basis for continuous improvements. The Blue Angel also requires the implementation of an energy management system. However, it so far follows a more static approach bound to a set of specific criteria. The TÜV approaches also cover the central elements of energy management, but no general evaluation can be provided as approaches from the various TÜV companies are different and not completely transparent. TÜV Rheinland provides an effective process oriented certification concept in cooperation with Fujitsu.

CEEDA provides a dynamic process oriented concept, which is designed to motivate certified companies to gradually improve processes from Bronze to Gold level.

Overall all concepts support continuous process improvement while the Blue Angel and TÜV approaches appear a bit more static and less long-term oriented. The CoC provides the largest set of best practice recommendations.

8.4 Process for implementation and certification

The four concepts show clear differences regarding the way the certification and auditing process is supported and conducted. While the Blue Angel, TÜV and CEEDA involve different bodies for consulting, assessment, auditing and certification, CoC is based on one official body at the JRC ISPRA. This can be seen as one disadvantage of the CoC approach compared to the other concepts. The centralised management of all process elements does, for example, not allow on-site assessment or auditing in the CoC approach. CoC therefore is strongly based on a self-assessment of participating companies combined with a review of the assessment documents by JRC ISPRA.

In the other concepts, a shared responsibility involving separate bodies for assessment auditing and certification allow a more standardised assessment approach. Especially the approaches by TÜV and CEEDA allow on-site consulting.

Both the CoC and the Blue Angel involve a 3 year certification cycle, but requires annual reporting from participants. TÜV provides both a one-time assessment of customers as well as continuous monitoring over several years. Thus there is no standardised approach. CEEDA provides certification as an award dated with the specific year. There is no automatic update cycle.

8.5 Overall comparison

Table 4 shows an overall comparison of the different concepts. To date no general recommendation can be given for a primary approach for certification purposes. All concepts have their advantages and disadvantages depending on the primary goals of the data centre. Larger data centres mainly interested in continuous application of best practice may consider the Code of Conduct. Data centres more interested in consulting services may opt for the TÜV approaches, while more promotion and com-

munication oriented DCs may consider CEEDA or finally the Blue Angel. However, regarding the Blue Angel concept, it should be considered that the concept has not yet been fully applied in the market and is under revision. It is therefore recommended to wait for the revised concept that may already be more fully aligned with general market requirements.

Overall to date, no comprehensive standardised certification concept for data centres is available that would combine the strength of a formal standardised processes with the benefit of strong communication.

Tab. 3 Comparison of the certification concepts

Certification Approach	EU-Code of Conduct	Blue Angel	TÜV	CEEDA
Benefits for communication and marketing				
International application/acceptance of approach	Yes (EUwide)	No (Germany)	Yes (application beyond Germany)	International application expected (for the moment UK)
Information exchange between data centres	Yes	No	No	No
Visibility of Label for communication/promotion purposes	moderate	good	moderate to good depending on specific TÜV approach (some TÜVs provide A-D Label)	Good (3 level concept: Gold , Silver, Bronze)
Date of implementation	2008	July 2011	2009	2011
Appropriateness for internal benchmarking and continuous process improvements in DCs	good	moderate	moderate	good
Guidelines for best practice	Yes	No	No	Yes
Fixed compliance criteria	Yes	Yes	No	Yes
Continuous Monitoring required	Yes	Yes	No	Yes
Size of data centre addressed	large	small to large	small to large	small to large
Requirement of implementation of energy management for DCs	Yes	Yes	Yes	Yes
Process for implementation certification				
Comparative benchmarking between DCs	No	No	No	No
Specific body separate from management body responsible for auditing	No (JRC Ispra responsible for whole process)	YES (RAL GmbH)	Cooperation between TÜV and local consulting partners (TEKIT, Fujitsu etc.). Preparation and Consulting by partners auditing by TÜV	Assessment by DCProfessional Development Ltd., Auditing by Technology Audit and Advisory Services Ltd (ITAASL), Certification by BCS
Cycle of assessment and certification	3 years certification period but annual reporting		different concepts inlcuding one-time and dynmaic assessment	Certificate as award indicating the specific year of evaluation. No automatic cycle
Consulting for implementation (including on-site assessment and evaluation)	No	No	Yes	Yes
Cost criteria				
Cost/effort for implementation of measures	variable depending on specific services and size of company	variable depending on specific services and size of company	variable depending on specific services and size of company	variable depending on specific services and size of company
Specific aspects, advantages, disadvantages	"+": International information exchange between partners "-": Limited supporting structure and missing separate auditing body	"+": high degree of brand awareness in Germany "-": Partly rigid non flexible criteria	"+": high degree of brand awareness in Germany; strong consulting partners "-": No standardised TÜV concept but different local concepts	"+": Tiered label (Bronze-Gold) supports longterm motivation for improvements. "-": Limited to UK so far, general acceptance compared to related CoC not known so far

9 References

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