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Issue	Section	Change Description	Author	Date
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1.2	1.1.2 / header	Removed 'Doc ref'; additions to practical case examples	Esther van Bergen; John Booth; Dirk Harryvan	25/09/15

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1 EXECUTIVE SUMMARY

1.1 General

The key objective of EURECA is to support energy / resource efficient and environmentally sound procurement actions within the European Public Sector for data centre and related products and services.

The aim of this deliverable is to report on the project's analysis of the current data centre industry standard, framework, guideline and KPI/metric best practices, and their relevance for public procurement. It also reports on the identification and analysis of current procurement practices relevant to the scope of EURECA. Following the evaluation of the current state-of-play on both the supply and demand sides, the deliverable provides a recommended procurement scenario approach for use and consideration throughout the remainder of the project, as well as needs and principle options to go beyond current best practice. This report is produced as part of WP1 DC Procurement Analysis. The review of each standard, best practices, and other supporting material will form the basis of the initial input for WP2 to develop the EURECA tool-set and will be used as a starting point to enable the procurement of resource efficient sustainable data centres products and services.

1.2 Findings

The report in this Deliverable first provides an outline of scope, the approach and methodology used for the analysis and evaluation. This is followed by an overview of the research performed and an initial regional analysis on industry and procurement practices (Task 1.1), a SWOT analysis (Task 1.2) of the existing state of play from experiences gained through various interactions undertaken in the first stages of the project, confirming many of the demanding challenges faced and provides the baseline information for the GAP analysis (Task 1.3) which highlights the areas where key bottlenecks are creating gaps and if these can result in opportunities for the EURECA framework.

This Deliverable also provides a catalogued Evaluation Framework (Annex 1) of standards, KPI's and practices (potentially) relating to data centre energy and environmental performance. Within each element of the Evaluation Framework there are benchmarks relevant to both the assessment of this performance (or capability) of data centres and also the procurement and market navigation for related innovative products and services.

The results from this report will be used as a foundation for the Needs Assessment (Task 1.4), Evaluation measurement analysis (Task 1.5) and the first stages of WP2. The summary results of this Deliverable can be found under Chapter 5 Summary conclusions and Chapter 6 Benchmark recommendations

2 Introduction

2.1 Purpose of this document

This document is to describe current procurement practices in the target "Tier 1" countries (UK, The Netherlands and Germany) and to catalogue the (Industry) standards, best practices and other relevant material that can be used to assist in the definition of more sustainable data centres and products. The main target of exercise is to provide a wide ranging review of available benchmarking solutions to achieve the goal of highlighting the need for energy / resource efficiency in data centres and to encourage participation, suggestions and validation of the project results.

2.2 Objectives

The DoW (Description of Work, see the Definition of Terms in Section 3) specifies the following activities to be performed for the 'Procurement practices and recommended evaluation benchmarks Report' within work package 1:

- To provide a regional analysis regarding current state of practice of 'Green DC Procurement' by Public sector.
- To provide a regional analysis regarding current and emerging standards, KPI's and guidelines within the industry and relevant to DC products and services
- To engage with various stakeholder groups (as identified under work package 6), with a specific focus on current procurement and industry (best) practices through workshops (such as those identified under work package 3), interviews and other means of interaction.
- To perform a cataloguing and evaluation of both the identified procurement (best) practices and industry standards, KPI's and guidelines.
- To perform a SWOT analysis of existing scenarios for the procurement, including PCP and PPI, of environmentally sound data centre products and services, also taking into account noteworthy regional differences.
- To perform a GAP analysis between existing procurement and environmentally sound procurement, this includes an evaluation of potential gaps between current procurement practices and industry best practices, and to identify needs and principle options to go beyond industry best practices.
- To deliver a recommended initial approach to different procurement scenarios for WP2
- Insights of empirical data and qualitative feedback that support the benchmark.

2.3 Deliverable Scope

Both the Industry and (Public Sector) Procurement practices (be it a standard, guideline, framework, specification or KPI/metric) highlighted in this Deliverable serve as examples of what the project team has come across during its research activities and has analysed (and evaluated) for the purpose of tasks 1.1, 1.2 and 1.3 of WP1. The practices mentioned are considered to have value for the EURECA framework and tool, however this does not imply that the EURECA framework and tool will be limited to these practices only. The level in which

these practices are used as inspiration, applied, integrated or referenced to in the framework and tool may eventually vary significantly.

The scope of this deliverable is determined by the activities as outlined in the DOW. This report includes the information and results from the activities related to the Regional analysis of green data centre procurement, the SWOT analysis of existing procurement of environmentally sound data centre products and services and the GAP analysis between existing procurement and environmentally sound procurement.

The project has performed extensive desk-research and engaged with a significant number of stakeholders. However, we cannot presume that our research encompasses all possible relevant practices (either established, emerging or as part of R&D). Based on the fact that both the project and the end-users of the EURECA framework and tool are aimed at European Public Sector Procurement, the project's research has focused primarily on European (used) practices. These may include practices initiated and/or developed outside the EU.

3 Definition of Terms

EURECA means the Datacentre EURECA Project

CBA stands for Cost Benefit Analysis.

Commission means the European Commission.

Dissemination level **'PU'** means Public

C3IT means Carbon3IT Ltd

D1.1 means the Deliverable identified as number D1.1 within Work Package 1 of the EURECA project

Deliverable means a formal contract deliverable item under the EURECA project

DoW means Description of Work. The EURECA project signed a project agreement identified as project number 649972 for a project under the call H2020-EE-2014-3-MarketUptake. This document contains a table with work plans, and it is this information to which this table refers.

Environmentally Sound stands for *"A low overall environmental impact per provided Data Center service (computation/data services) based on present day available solutions." This 'environmental impact' includes impacts such as climate change, acidification, particulate matter, etc. but also primary energy consumption and water scarcity* (see 4.2 'Defining context' for determining the definition of this term).

GITA stands for Green IT Amsterdam

Green stands for: see 'Environmentally Sound'

GPP stands for Green Public Procurement.

GHG stands for GreenHous Gas(ses)

(Procurement) Scenario(s) provides an indication of the scenario the Public Sector body should initiate a tender for that meets the actual procurement need (related to data centre products or services). By providing an assessment to determine the actual needs, the EURECA framework and tool can help establish the right Procurement Scenario for tendering.

ITT stands for Invitation to Tender.

Industry stands for data centre and related ICT industry

LCC stands for Life Cycle Cost.

LCA stands for Life Cycle Assessment.

MAKI stands for maki Consulting

PCP stand for Pre-Commercial Procurement (PCP).

PPI stands for The Public Procurement of Innovative solutions.

Practice stands for the use of a standard, framework, guideline, specification or KPI/metric

RFI stands for Request for Information.

RFQ stands for Request for Quotation.

RFP stands for Request for Proposal.

Task 1.1 stands for the first task as described in the EURECA project's DOW under WP1, consisting of a Regional analysis of green data centre procurement.

Task 1.2 stands for the second task as described in the EURECA project's DOW under WP1, consisting of a SWOT analysis of existing procurement of environmentally sound data centres and of related products and services.

Task 1.3 stands for the third task as described in the EURECA project's DOW under WP1, consisting of a GAP analysis between existing procurement and environmentally sound procurement.

Work Package 1 (or WP1) of the EURECA project covers 'Green DC Procurement Analysis'.

Work Package 3 (or WP3) of the EURECA project covers 'Knowledge Sharing'.

Work Package 6 (or WP6) of the EURECA project covers 'Dissemination'.

4 Industry and Procurement practices analysis (T1.1)

4.1 General

This section describes the content of Deliverable D1.1 which has been implemented in accordance with the contract requirements.

4.1.1 Approach

In order for the project to deliver a thorough report on industry and procurement practices and to develop qualitative recommendations on evaluation benchmarks for the possible procurement scenarios, the project first needed to establish the scope of the projects' envisioned framework, tool and training facilities. This required the identification of which areas and categories needed to be analysed.

Establishing the scope then allowed the project to identify what the best assessment method would be and refine the identification of the various related stakeholder groups with which the project expects close interaction and collaboration throughout the project, starting with engaging them on current (best) practices to serve as input for the analysis and the establishment of an evaluation benchmark as described in this Deliverable.

4.1.2 Scope for EURECA analysis

At the start of the project in March 2015 the consortium soon found that it was possible to include a wide variety of topics that could be of added value. This would not only impact the design of the EURECA framework and tool *and* the research and analysis to be performed for WP1 but also impact the scope for training (WP4) and the exercise in validation and evaluation (WP5). The EURECA consortium therefore deemed it necessary to define the initial scope for EURECA. This is mostly due to three contextual facts:

- the EURECA project is targeting procurement related to resource efficiency
- the EURECA project is targeting procurement related to data centre products and services , and
- the time-span available to the project.

Through a series of scoping sessions the project determined the research and analysis scope parameters within the contextual defining factors of *resource efficiency* and *data centre products and services (within sphere of influence).* Within each main category several subcategories were identified based on the data needed for WP1 - WP6 to be able to deliver the expected results. This resulted in the following scope categories:

Organisational drivers / barriers: Technical, Social, Legal, Economic and Environmental

Current procurement practices: Procurement / tender stages, supporting (technical) facilities, strategic and organisational, (environmental) targets and objectives

Industry (Best) practices: Technical areas, strategic and organisational, focus areas and characteristics

Procurement Scenarios: (DC/ICT) Solution avenues from procurement perspective

Life-cycle Management: Aspects to (high-level) life-cycle stages production, use and end-of-life

This formed the basis for targeted research and formulate questions for stakeholder engagement during interviews, survey and events. It was also used to develop the Evaluation and Cataloguing Framework to perform an analysis assessment (see chapter 4.2).

4.1.3 Stakeholder groups involved

For the activities within WP1 EURECA engaged with the following stakeholders groups (in line with those defined in the initial DOW and refined in WP6 (DEL6.1)):

- (External) The **Public Sector managers and decision makers** The Public Sector in the regions of London, Berlin and Amsterdam form the initial starting point of the project.
- (External) **Public procurement organisations and groups** EURECA also aims to engage with bodies or groups that influence or operate services on behalf of groups of Public Sector organisations.
- (External) The **Policy Makers** Government organisations that represent and influence procurement of Data centres and has a large overlap in general.
- (External) **Public Sector IT Managers** Stakeholders who influence the services that data centres support are taken into account as a separate target group.
- (External) **ICT Suppliers and Service Providers** The EURECA tool depends on support from suppliers and service providers, which are needed to both demonstrate and to respond to procurement procedures for high energy efficient performance products and services.
- (External) **Standards Committees and Best Practice Communities** The ultimate aim of DC EURECA is to develop the EURECA tool to support the uptake of energy efficient and environmentally aware methodologies. Therefore it is essential to ensure relevant input and liaisons are in place to support the EURECA tool development and its future relevance.

The EURECA project team has engaged with above groups via several channels, both for the purpose of gathering their input and their expertise as for the purpose of identifying potential candidates for the Special Interest Group as part of the D3.1 directory. The project has engaged in the following activities with stakeholders:

Table 1 - Engaged Stakeholder Groups

Activity	Stakeholders	Type of engagement
Articles Industry sites	• ICT Manager • DC Manager • ICT Suppliers	Dissemination: create visibility, create awareness of EURECA, invite to website
Articles Public Sector / Procurement sites	• Public Sector procurers • Public Sector Groups • Public Sector Managers	Dissemination: create visibility, create awareness of EURECA, invite to website

Face to Face interviews	• ICT Manager • DC Manager • Public Sector procurers • Public Sector Groups • Public Sector Managers • Policy Makers	Extensive set of questions (and follow-up) in interview form.
Procurement and public sector fora	• ICT Manager • DC Manager • Public Sector procurers • Public Sector Groups	Become forum member, create posts to inform about EURECA, request for input.
Survey	• Public Sector procurers • Public Sector Groups • Public Sector Managers	Extensive set of questions (and follow-up), some in yes no, some multiple selections, some free text.
Knowledge Sharing event 1 - London	• Public Sector procurers • Public Sector Groups • Public Sector Managers • Policy Makers	Short outline EURECA project; interactive discussion sessions current procurement practices (using SWOT indicators); first GAP exploration.
External events	• ICT / DC Industry • Standard bodies/committees • Public Sector procurers • Public Sector Managers	Presentations, networking, short input conversations.
Standard Body committee sessions	• ICT /DC Industry • Standard bodies/committees	Active participation in ongoing standard development; input conversations

4.2 Evaluation and Cataloguing methodology

4.2.1 Defining context

When speaking of 'Green' or 'Environmentally Sound' data centre (or related product or service) it is necessary for all involved to operate with a common understanding of what this means. Developments and improvements in relation to energy / resource efficiency, and sustainability in general are continuously moving forward, which is exactly what EURECA aims to stimulate and contribute to itself, specifically in relation to the technology sector and the procurement of their services by the Public Sector. However, this results in a challenge to define such terminology.

Moreover, EURECA addresses a range of different ways to provide DC-specific hardware and services. This ranges from improving in-house DCs through hosting, co-location and up to cloud solutions. A primary concern for the end-user at the public body, is the provided computational performance of the solution. This means any initiatives towards adopting more environmentally sound technology should ensure that it does not result in flawed or insufficient computational performance. Any such procurement initiatives should also enable a way to compare different ways of providing DC hardware and services can be compared with each other in this area, the computational performance needs to be integral part of this. The EURECA approach and later framework will hence necessarily capture the environmental performance, bringing the environmental impacts and energy consumptions in relationship to the technical (here: computational) performance.

At the same time, will it often not be possible to access all the necessary data to perform a more accurate assessment of the environmental and computational performance. To ensure applicability also in those cases, where e.g. the environmental impacts of the DC building or the hardware can only be estimated or e.g. no information is readily available about the extent of waste heat reuse, a somewhat simplified approach is needed. In such cases, the use of qualitative and semi-quantitative information and the general maturity level of the facility will allow for a basic and comparable assessment. This continuous improvement does provide to opportunity to relate any definition to potential maturity levels as part of a maturity model. These maturity levels (and its model) must also be regularly re-evaluated and maintained as future developments may (yet) be unforeseen at its current time. However, the use of maturity models has been a proven method to identify how well someone or something (process / organisation) performs in a variety of areas at a certain point in time. It also allows for the quick identification of ambitions and next steps.

As such EURECA uses the following definition when mentioning 'Environmentally Sound' data centre (product or service):

"A low overall environmental impact per provided Data Centre service (computation/data services) based on present day available solutions." This 'environmental impact' includes impacts such as climate change, acidification, particulate matter, etc. but also primary energy consumption and water scarcity.

The environmental impact will be calculated using data centre inventory data plus life-cycle background data where these are available, or will otherwise be approximated using

qualitative or semi-quantitative information of the data centre build and operation as well as the achieved EURECA maturity level.

4.2.2 Selected assessment method

To perform an assessment that allows for uniformity throughout different areas and limits the risks of becoming ambiguous, the project has opted for a combination of several sets of characteristics to catalogue and evaluate. These are:

- Main characteristics of any item (any kind of practice) to provide context
- Specifics regarding technical areas DC products & services
- Coverage of data centre topics (DC-ICT practices only)
- Supported areas (procurement practices only)
- Overall RACER score per practice
- Relevance to identified relevant Procurement Scenarios

Main Characteristics

This consists of a set of characteristics that are of particular interest to have a quick indication of the item's context from both procurement and industry perspectives. These characteristics give insight to,

1. whether it is a procurement, ICT/DC industry, general based data indicator or practice;
2. the kind and level of maturity of the practice (only applicable to practices);
3. where it originates and where its regional focus is;
4. whether it has a qualitative / quantitative and/or a component/system focus and if it is performance based or not;
5. its life-cycle coverage (i.e. production, operation/use, end-of-life);
6. the type of business driver categories it addresses;
7. whether there is a certification / label opportunity attached (incl. expiry indication if applicable).

Technical Areas

Because the EURECA framework and tool primarily aims to operate where procurement and data centre related technology meet, the evaluation includes the main technical areas of a data centre for both the industry and procurement practices identified during research. This allows us to analyse the same technical areas from both perspectives. The areas selected are based on the most accepted method by leading bodies to identify the different (technical) levels of a data centre. These are,

1. Physical Building - The data centre's physical premises, this includes security, location and maintenance.
2. Mechanical & Electrical Plant - The selection, installation, configuration, maintenance and management of the mechanical and electrical plant.
3. Data Floor - The installation, configuration, maintenance and management of the main data floor where IT equipment is installed. This includes the floor (raised in some

cases), positioning of CRAC / CRAH units and basic layout of cabling systems (under floor or overhead).

4. Rack - The installation, configuration, maintenance and management of the racks into which rack mount IT equipment is installed.
5. IT Equipment - The selection, installation, configuration, maintenance and management over its life-cycle of the physical IT equipment.
6. O/S & Virtualisation - The selection, installation, configuration, maintenance and management of the Operating System and virtualisation (both client and hypervisor) software installed on the IT equipment. This includes monitoring clients, hardware management agents etc.
7. Software - The selection, installation, configuration, maintenance and management of the application software installed on the IT equipment.
8. Business Practices - The determination and communication of the business requirements for the data centre including the importance of systems, reliability availability and maintainability specifications and data management processes.

To indicate the focus of the practice the above technical areas are complemented by

9. DC product - Focus on DC system or physical components
10. DC service - Focus on services using data centre infrastructure (this may incl. coverage of data transfer and hardware at user)

Data Centre Operation Coverage

This set of characteristics addresses relevant areas of attention for good management / governance of a data centre. Since these are primarily relevant to industry and (although indirectly important) are underlying factors from a procurement perspective, only the industry practices are evaluated on this set of characteristics. These are,

1. Power Resilience - The data centre's power distribution system, transformers, switch gear, Uninterpretable Power Supply (UPS), back-up generators etc.
2. Connectivity & Cabling Resilience - The data centre communications systems, structured cabling, optical fibre etc.
3. Environmental Control Resilience - The data centre's mechanical systems, cooling equipment, chillers, condensers and Computer Room Air Conditioning units (CRAC's)
4. Operations and Maintenance Professionalism - Data Centre Infrastructure Management (DCIM) monitoring and control systems and human resources.
5. Site Access Security & Control - The data centre's physical protection against natural events, fire and criminal activity.
6. Data Centre Energy Efficiency - The data centre's strategy, performance indicators and processes for energy management.

Supported Areas

The selection of supported areas to evaluate the practices on are based on the initial description of what the EURECA framework and tool aims to address or provide (a EURECA

'functionality'). For this reason only the identified procurement practices are evaluated on this set of characteristics. It provides some insight whether the practice offers procurers any support (by means of useful information or tools) in these areas. The project identified the following 'supported areas':

1. Procurement Stages (PCP / PPI / RFI / RFP / ITT) - Which type of procurement or stages are addressed?
2. Benchmarking - Any information or tools available to identify relevant benchmark(s) for 'environmentally sound' procurement?
3. Maturity Model Framework - Does the practice help in assessing maturity level and /or means to raise an organisations' maturity to become more 'environmentally sound'?
4. Cost / Benefit & RFI Assessment - Are any means available that help assess possible cost/benefits during RFI stage?
5. Roadmap /signposting - Can it provide priority actions identification and improvement steps indicators to become more 'environmentally sound'?
6. Individual Assistance - Are there ways to get in touch with peers or practice experts for additional specific and individual support?
7. Market information - Does it provide any means or advice to explore and engage with the 'market' and ongoing developments?
8. ROI & Business Case information - Any information or tools to support business case construction, incl. risk tips, to help produce robust ROI?

RACER methodology

The European Commission has specified in its publication "Impact Assessment Guidelines" (European Commission, 2005[1]) that indicators should fulfil the so-called RACER criteria. RACER is an evaluation framework applied to assess the value of scientific tools for use in policy making. RACER stands for relevant, accepted, credible, easy and robust:

- Relevant – i.e. closely linked to the subject-matter and objectives to be reached
- Accepted – e.g. by staff and stakeholders
- Credible for non-experts, unambiguous and easy to interpret
- Easy to monitor (e.g. data collection should be possible at low cost)
- Robust – e.g. against manipulation

For the exercises relevant to D1.1, RACER focuses on:

- Evaluation and cataloguing framework applying RACER to Industry practices relevant for environmentally sound DC products and services in relation to Public Procurement scenarios.

[1] European Commission (2005): Impact Assessment Guidelines. SEC(2005) 791. 15 June 2005.

- Evaluation and cataloguing framework applying RACER to current procurement practices and procurement processes in relation to environmentally sound DC products and services.

Procurement Scenarios

In order to help support the procurers to select the right and best fit criteria and potentially relevant standards, guidelines, frameworks, specifications and KPI/metrics, each practice is evaluated to indicate its relevance to the set of procurement scenarios that have been identified by the project. These scenarios are indicative of the different kind of product or service (solution) that is (to be) procured which needs to meet the actual needs of the public sector body. This need can be triggered by a variety of situations arising. The identified scenarios are:

1. In-house New Build - A scenario where a new data centre is (to be) built where none existed before to better meet the needs and/or organisational targets.
2. Retrofit In-house M&E - A scenario where the mechanical and/or electrical components of an existing in-house data centre or server room is (to be) refurbished or replaced to better meet the needs and/or organisational targets.
3. Retrofit In-house Floor - A scenario where the data floor component of an existing in-house data centre or server room is (to be) refurbished or replaced to better meet the needs and/or organisational targets.
4. New In-house Equip - A scenario where the existing equipment is either (to be) replaced or expanded upon to better meet the needs and/or organisational targets.
5. New In-house Service - A scenario where an existing ICT service is replaced or a new ICT services is (to be) procured to better meet the needs and/or organisational targets.
6. Outsource Co-location - A scenario where an existing ICT environment is outsourced or an additional/new ICT environment is outsourced to a co-location provider but is managed by the public sector body.
7. Outsource Hosting - A scenario where an existing ICT environment is outsourced or an additional/new ICT environment is outsourced to a hosting provider who provides the services needed to run the organisation's core ICT-infrastructure and/or the additional application layer as a dedicated 'managed service'.
8. Outsource Cloud - A scenario where an existing ICT environment is outsourced or an additional/new ICT environment is outsourced to a Cloud service provider that provides the environment as a 'managed service' in a Cloud environment.

Underlying triggers

For context, the project has identified the following possible triggers, which range from strategy to operation level:

Strategic (business) drivers:

- Technology - Organisations may have the strategic aim to be a front-runner for innovative technology and will actively look to develop, pilot and/or adopt. Innovative market and technology developments in general can trigger the need to review / change their current technology environment to stay relevant.
- Social - Organisations may aim to enhance job creation, provide better or new (public) services that require or can be achieved through new or improved technology and thus initiate a change in their current use of technology infrastructure.
- Legal / policy compliance - New or changes in financial, health and safety, security (cloud, locations where data is stored, Patriot Act) regulations or (own) policies may trigger the need to change existing or adopt new technology. *In addition*, accountants may drive management to act via the so called 'management letters' in where the management of the organization is almost reprimanded for having neglected compliance issues, or where security risks are noted. Management is more or less forced to act upon remarks like these which are attached to the internal versions of the annual reports.
- Economic - Austerity programmes which result in cost cuts, budget cuts, staffing cuts or a voluntarily aim to make more effective use of their resources may trigger review of direct and indirect expenditures/costs that results in a need to change their (in-house or outsourced) ICT environment.
- Environment - Corporate and Public Social (and Sustainability) Responsibility initiatives may trigger initiatives related to data centre products and services to contribute to specific targets and ambitions for energy and material resource use (energy, water, land, materials etc.) and emission-related to GHG, Eutrophication, human toxicity, etc. or to other environmental aspects such as toxic / hazardous materials use, recycling etc. These may require improvement of or can be achieved through ICT technology changes.

Tactical:

Training, visiting seminars, magazine and papers, peer pressure, could raise awareness of new technology or new insights that, which may spark plans to change ICT / data centre performance and meet strategic drivers and/or address operational issues.

Operational:

Data Centre Failures

- Power
- Cooling
- Space Constraints
- Connectivity

Changes from IT Strategy / Business Alignment

- Virtualisation, Consolidation or Cloud transformation
- New (Cloud) applications

Operational costs

- Regular cost reviews

Contract Renewal

- Poor Service
- Price developments
- Political
- Mergers
- Contract End
- Automatic Contract renewal (End of Agreement)

Performance issues

- Limits of current ICT environment, space or connectivity
- Unsatisfactory performance

4.3 Industry Best Practices

Data centres are complex technical systems with many elements subject to standardisation that affect the efficiency and environmental impact of the facility. Our analysis looked at standards and best practices used within data centres that will form the basis for the EURECA tool.

From the already available expertise within the consortium, the supplemented desk-research and the engaged stakeholders from the Industry it can be concluded that there has been a lot of attention for the industry to become more sustainable. The area attracting most attention is the industry's energy use (primarily within data centres). Many of the standards, frameworks, guidelines and specification in relation to 'environmentally sound' that are developed and used within the industry are focused on energy efficiency, reduction and to some extend the use of renewable energy. This has resulted in significant efficiency gains and the development and adoption of new and alternative solutions, particularly relating to the cooling and power supply systems and the energy efficiency of IT hardware equipment (servers). For the most part these gains are visible in the private sector and large scale (shared) data centres.

There is, however, still much to gain in other areas, such as the in-house and smaller data centres, the increase of renewable energy generation and use, how software impacts the hardware's energy demand, robust life-cycle management for energy, electronic (and other material) waste etc. Within the industry the focus is widening beyond energy efficiency which results in increasing opportunities for the procurement of environmentally sound data centre products and services, particularly organisations participating in R&D and embarking on PCP and PPI.

The landscape is complex and fast changing with some areas more mature than others. However there is also some crossover of scope and duplication which has the potential to make the landscape even more difficult to navigate, especially for non-specialists. In an effort to help ease this situation, a Co-Ordination group has been established between the European standards organisations (CEN,CENELEC, ETSI) to monitor and document both the European and International "landscape" in an annually produced reference document and brochure. The reference document can be found here:

ftp://ftp.cencenelec.eu/EN/EuropeanStandardization/Fields/ICT/GreenDataCentres/StandardizationLandscapeEdition2.pdf

Goal of this research is to establish an understanding of the best practices in data centre (and ICT) Industry that are relevant to procurement of related products and services, which is followed by SWOT (Chapter 4.5), GAP (Chapter 4.6) and Benchmark recommendation approach (Chapter 5) that should or could be relevant to the EURECA framework and tool.

4.3.1 Data Centre Specific

The following list comprises a selection of the identified standards, frameworks, guidelines, specifications and other relevant practice initiatives that have been evaluated by the EURECA team:

EU Code of Conduct for Data Centres (Energy Efficiency): 2015 (EC)

This practice is based on an EU JRC document, originally created in 2008 by EU-JRC, BCS DCSG and Defra. It comprises 155 Best practices (2015) for energy efficiency within Data Centres, covering Management, IT Equipment, Cooling, Power Systems, Ancillary Systems, Design, and Monitoring.

Data Centres can apply to become a participant in the scheme, via the EU-JRC, applicants will be reviewed upon how many of the best practices have been or will be implemented over a 3 year timescale. Currently there are 229 endorsers (companies/operators/supply chain) and 107 participants representing 300+ Data Centres in the EMEA region.
EUCOC status is required by UK Government for all new services from 2014, this includes the G Cloud.

However knowledge of the scheme is limited (by the public sector) and although specified in G Cloud framework, is incorrectly referenced. EURECA can contribute to the increase in (correct) adoption of this Code of Conduct through the integration with the framework and tool.

Please note the comments in the section for *EN50600:2012 Parts 1-6 for further information on the EU Code of Conduct for Data Centres (Energy Efficiency): 2015*

Free Cooling Maps (Green Grid)

The free cooling maps for EMEA indicate that "free cooling" i.e. where dry-bulb temperatures are either equal to or below 35 degrees Centigrade and where dew-point is at or below 21 degrees Centigrade on an hourly basis are in excess of 8000 hours throughout the whole of the European Mainland and the UK and Ireland. This indicates that chilling, i.e. the reduction of white space temperatures to industry average of 18-21degrees Centigrade is not required, however hot air still needs to be dealt with in the white space, and this could be achieved through the use of extraction equipment. The input for these maps could be valuable source material for procurers to determine the best fit procurement scenario.

Data Centre Maturity Model & Annual Maintenance (Green Grid)

The Green Grid, Data Centre Maturity Model is an in-depth study of data centre infrastructure and its operational aspects, split into differing levels of maturity from Level 0 (No progress/minimal progress (i.e. the state-of-play today)) to Level 5 Visionary (5 Years away). Each stage is further defined below:

- Level 0 No Progress in implementing current best practices.
- Level 1 partial current best practices.

- Level 2 full implementation of current best practices.
- Levels 3 & 4, use of innovative ground-breaking concepts such as on-site renewable energy (between 5-35% of energy requirements , liquid cooling, active demand management, high utilisation levels 80% plus on IT equipment
- Level 5, use of renewable energy, enhanced management and operational aspects and sustainability.

The Maturity model covers Power, Cooling, Ancillary infrastructure, Management, Compute, Storage, Network and Other IT (Security/Fire/Leakage etc.).

This is currently under review by the Green Grid "DCMM" working group, we do not expect any significant changes to be published during this review phase, however the project team will continue to observe as the use and integration of a maturity model within EURECA is expected to be of valuable use to several of its perceived functionalities.

ASHRAE (American Society of refrigeration and air conditioning engineers)

Describes optimum temperature and humidity bands for various classes of IT and Telecommunications equipment in specific environmental conditions depending on geography, and maturity of the data centre. *Technical elements are included in the EUCOC.*
TC 9.9 Technical Report – Due for Revision.

Data Centre Alliance (DCA) Certification Scheme

During the PEDCA project (no 32013) Joint Action 6 specified a scheme to provide an industry led, affordable, independent governance of data centre standards and best practices. The DCA scheme addresses four "pillars" of the data centre reflecting end user demand, designed to assist buyers and end users of data centres in identifying and selecting data centres based on robust 3rd party verification of their stated credentials, the four pillars are:

- **The service availability and resilience of the overall data centre** utilising the classifications of EN50600-1:2012
- **The operational professionalism of the facility**, assessing, maintenance policies, staff and professional development
- **Access control and physical security**, assessing security processes and protection areas
- **Energy efficiency of the data centre** - verifying best practices commitments are met and maintained and that KPI's are correctly measured and reported.

The current requirements of the scheme are at Version 2.0 which are mapped directly to European & International Standards and best practices.

There are currently 50 requirements of the scheme which are must be complied with, data centres are re checked for compliance with the scheme every two years. The scheme is delivered in the field via a Global Network of Approved Firms including PTS Consulting, Keysource, Certios and Future-Tech SCI. The scheme has now successfully piloted and has now certified data centres in the UK with a growing interest and following.

Certified Energy Efficient Data Centre Award (CEEDA)

Developed by the British Computer Society, The Charted Institute for IT, and delivered by DataCenter Dynamics, this assessment certification is based upon 70-80% of the EU Code of Conduct for Data Centres (Energy Efficiency) best practices and covers management, IT equipment, cooling, power systems, data centre build design considerations and monitoring.

There are 3 award levels, bronze, silver and gold and 4 products, enterprise (owners and operators of a site, Co-location Provider (M&E aspects of co-location services) Co-location Tenant (IT Aspects of co-location services, must be assessed in conjunction with a Co-location Provider) and Design/Operate (for new data centres). It is possible for CEEDA award holders to seek assistance from the delivery partner to complete an EUCOC application.

EN50600:2012 Parts 1-6

European Normale Standard developed by CENELEC

- Part 1 – General Concepts
  This part deals with the approaches to design of a data centre. Clause 4 provides guidance to risk analysis and establishing the cost and impact of data centre downtime. Clause 6 offers a new classification systems for data centres for service availability (aggregated model), physical security and energy efficiency enablement, this aspect maps to soon to be standardised KPI's and describes the measuring points that are very often only possible to install at design phase of new builds and retro-fits.
- Part 2-1 Building Construction
  This part offers guidance for site selection for data centres including its assessment, the natural environment and geographical location and adjacency's. The standard also covers building construction and configuration, fire protection and quality construction measures this is described through six normative clauses.
- Part 2-2 Power Distribution
  This part provides recommendations and requirements for power distribution systems of data centres including power supplies to and within data centres, facilities for both normal and emergency lighting, equipotential for bonding and earthing, lightening protection and devices for measurement of power consumption. the standard offers more detail on the specific characteristics of service availability relating to the power distribution system.
- Part 2-3 Environmental Control
  This part covers control of temperature, humidity and fluid movement, floor layouts and equipment control, particulate control, vibration and energy saving practices relating to environmental control of a data centre. It also provides specific characteristics of service availability relating to environmental control systems.
- Part 2-4 Telecommunication Cabling
  This part specifies requirements and recommendations for cabling and network communications systems installations within data centres. It also provides specific characteristics of service availability relating to cabling and telecommunications systems.

- Part 2-5 Security Systems - is in preparation
- Part 2-6 Management & Operational - is in preparation

The research team are led to understand that the structure of EN50600 is under review by TC215 and is likely to be changed to a format as below:

- Part 1 - General Concepts
- Part 2 - Building Construction
- Part 3 - Management & Operations
- Part 4 - Reference Documents, Landscape Analysis (comparison with other international standards and other technical documentation.

We have been advised that the EU Code of Conduct for Data Centres (Energy Efficiency) has been used to provide the greater elements of a Technical Report (TR) that will be positioned into the EN50600 Part 4 series. The full title and other aspects to this report are outlined below:

CLC/TR 50600-99-1 "Part 99-1: Recommended practices for energy management

This draft Technical Report was prepared per decision of TC 215 by TC215/WG 3 in conjunction with the Directorate General Joint Research Council (DG JRC) of the European Commission (EC).

It replaces the Best Practices document of the Code of Conduct for Data Centre Energy Efficiency (CoC) scheme operated by the DG JRC and continues to be prepared both by TC215/WG 3 and the Participants and Endorsers of the Code of Conduct using their historic annual review process.

This draft contains the Practices of the V6.1.1 of the Best Practices document of the Code of Conduct but re-formatted and re-written in a conventional standards manner and with increased consistency in the use of terminology etc.

Comments from TC215 to Clauses 5 and 6 ("Expected" and "Optional or alternative" Practices of the Code of Conduct scheme) will be submitted to the meeting of Participants and Endorsers of the Code of Conduct on 6th October 2015 for their resolution.

Comments to other clauses (including those raised at the meeting of Participants and Endorsers) will be resolved by CLC/TC215/WG3.

All resolutions will be implemented by CLC/TC215/WG3 during the preparation of the final vote draft of the Technical Report.

ETSI TS 105 174-2-2

The present document details measures which may be taken to improve the energy efficiency within operator sites and data centres for broadband deployment.

- Clauses 2 and 3 contain references, definitions and abbreviations which relate to this part; similar information will be included in the corresponding clauses of the other parts, thus ensuring that each document can be used on a stand-alone basis.
- Clause 4 introduces data centre concepts including those specifically related to network operators;
- Clause 5 develops the concept of Key Performance Indicators (KPI), introduced in TS 105 174-1 [13], to enable consistent monitoring of energy efficiency;
- Clause 6 details the approaches that may be employed to improve energy efficiency within the information technology infrastructure;
- Clause 7 details the approaches that may be employed to improve energy efficiency within the environmental control systems;
- Clause 8 details the approaches that may be employed to improve energy efficiency via the physical
- infrastructure of the buildings;
- Clause 9 details the approaches that may be employed to improve energy efficiency within the power distribution system;
- Clause 10 provides a summary of energy efficiency approaches within existing data centres;
- Clause 11 provides a summary of energy efficiency approaches within new data centres and introduces wider issues concerning their location;
- Clause 12 contains the conformance mechanisms of the present document;
- Clause 13 contains the recommendations of the present document;
- Clause 14 introduces future opportunities for improvements of energy efficiency;
- ETSI Annex A provides indications of the first order effect of applying the approaches outlined in clauses 6, 7 and 9.

This will enable the proper implementation of services, applications and content on an energy efficient infrastructure, though it is not the goal of this multi-part deliverable to provide detailed standardized solutions for network architecture. The present document does focus on energy efficiency, but the CO2 footprint is not taken in account in. Two separate aspects of energy efficiency are considered:

1. actions to improve energy efficiency in existing data centres (short or medium term);
2. actions to improve energy efficiency in new data centres, (medium or long term).

The domains under study are:

- in the Information Technology (IT) infrastructure: all aspects of the technical infrastructure in the data centre, including servers, storage arrays, backup libraries and network equipment including routers, switches, etc.;
- in the IT operational strategy: all consolidation initiatives, such as virtualization, physical or logical consolidations, usage of specific software and processes;

- in the technical environment: all aspects concerning energy usage, cooling and, more generally, all disciplines involved in the technical environment of the data centre.

NPR 5313 'Computerruimten en data centre' (NL)

Now amalgamated into CENELEC 50600 series. NPR 5313 helps to specify, design, offer and commissioning of data centres. It is meant for refit-projects as well as new data centres builds. NPR 5313 primarily aims to facilitate larger organizations. NPR 5313 might be interesting for owners, managers of data centres, data centre designers and architects, consultants, procurers and public organizations. The contents of the norm is:

- General information; detailing the other norms involved
- Management, organization and operations; data centre requirements, commissioning protocol, maintenance
- Requirements and classification; classification models of requirements of
    - availability
    - security
    - sustainability
    - energy efficiency
- General design process; design of energy supply, climate control and cabling.

The remaining part of the norm contains checklists to guide improvements and design decision. By using the NPR 5313 generic knowledge will be applicable, and relevant publications and norms will be visible and enables procurers to compare offers of different vendors in a level playing field. Particularly the latter makes it a valuable practice for EURECA's framework and tool.

SMK Milieukeur DC standard (NL)

SMK has developed a certification scheme named: Milieukeur certification scheme data centre climate control. This certification scheme concerns Milieukeur climate control at data centres. It may possibly form part of a more holistic certification for data centres to be developed in the future, in which a broad range of sustainable measures are integrated. The current Climate control certification considers:

- climate control systems (refrigeration, ventilation, (de)humidification) tasked with providing the necessary conditioning in a data centre or in parts of it consisting of separate data rooms and to keep them within the tolerance of the ICT equipment and UPS.
- the installations that support the functioning of the climate control systems;
- the climate control of server rooms that are managed by a business, government organisation or educational establishment themselves for their own use.

The certification scheme has a clear measurement protocol for defining the $EUE_{climate}$, EUE_{total} and water consumption. Milieukeur is a reputable (eco-label) organisation in the Netherlands. Measurements and key figures utilised in this certification scheme coordinate with those of Blue Angel (Der Blaue Engel), the German environmental certification for data centres.

However, the product group to be certified under Blue Angel is a complete data centre, not only the data centre climate control, as is the case with Milieukeur.

Blue Angel (Blaue Engel) DC standard - (GER)

This standard was developed by the German Federal Ministry for the Environment, Nature Conservation, Building and Nuclear Safety, the Federal Environmental Agency (UBA).

The UBA has developed a Type I certification scheme named "Blue Angel for Energy Efficient Data Center Operation" that covers the complete data centre, except for evaluating the energy efficiency of memory systems and network components. The latest version is of February 2015. Aim of the Blue Angel, which is Germany's most widely used and best recognised environmental label, is to reflect the environmentally top 10% of products to be able to pass the evaluation criteria.

The Blue Angel certification scheme has a clear measurement protocol for defining the Energy Usage Effectiveness (EUE), Energy Efficiency Ratio (EER) of the cooling system, and load average of the IT equipment.

The requirements on DC's cover also during the period of the implementation of the contract e.g. energy management system, monitoring of the electrical energy and IT load, continued use of the IT inventory list, and taking into account life-cycle costs when making acquisitions. The requirements on the use-phase aspects is particularly high and there are currently no requirements on the hardware production related impacts. This is driven, according to the interview carried out in this context, to avoid that existing hardware s replaced too soon in order to "save energy" or "reduce environmental impact", what in Germany is apparently rather frequently the case, as it is believed that the production of the hardware contributes a high share to the life-cycle wide impacts. A study commissioned by the UBA in 2012 - however on a laptop - has found that well over 50% of the Climate change related impacts occur during the hardware production, accordingly less during use. Several other impacts are even more shifted towards the production phase. Such was less known so far, as published studies had often used simple engineering-level materials and not the high purity ones using in electronics. Also, the high environmental impact of clean room manufacturing and other specifics were not fully considered, according to the related interview. While the use pattern of laptop and DC hardware differ, this indicates nevertheless the relevance of the production stage.

Data centre establishment policy Amsterdam (NL)

The Mayor and Aldermen of the City of Amsterdam first established a data centre specific 'establishment' policy in 2001 and have approved an update of the policy in 2013. With Amsterdam being a long time ICT and data centre hot-spot, the industry has been working together with the City of Amsterdam and the Dutch government in the consortium Green IT Amsterdam Region on a green ICT sector, under the heading "Amsterdam Green Data Port". In this collaboration, saving energy is paramount, but there is also a focus on data centres as

local heat source, and the (joint) procurement of locally produced green energy. The municipality wants to facilitate the sector so that Amsterdam can develop further as a centre for data centres. Data centres are allowed anywhere provided there is room for businesses in the zoning plan. Furthermore, the data centre must be in compliance with the Building decree, the Wabo, the Environmental Management Act and the building regulations regarding external appearance. In addition to this, attention is also given to innovating forms of data storage (decentralized, small-scale) and efficiency in the ICT supply chain (lower cooling demands, efficient servers and software). Knowledge institutes in Amsterdam pioneer to achieve energy efficiency in the entire chain. Though there has been some criticism on the policy's focus on a EUE limit, this policy aims to stimulate such initiatives while leaving room for the data centre industry to flourish. See https://www.amsterdam.nl/gemeente/organisatie/ruimte-economie/ruimte-duurzaamheid/ruimte-duurzaamheid/making-amsterdam/publications/sustainability-0/data-centre-establis/

This is a practice for policy formulation that can be useful to other public sector bodies looking to do a similar exercise or to use (aspects of) it in reference to some of the EURECA procurement scenarios.

Green IT Best Practices – TU Berlin (GER)

Initiative launched in April 2009 (lead TU Technical University Berlin) that was financed until March 2015 by federal sources (re-structuring effort towards IT processes), includes a scoring tool for data centres (126 already in there) that is based on the PUE as main KPI. The initiative provides a list of partner organisations who have joined the initiatives, shares success stories and a variety of white papers e.g. Participants from data centres being scored include those from industry and public sector.

4.3.2 Non Data Centre Specific

The following list represents external standards, guidelines and frameworks that have an indirect impact on the construction of new data centres and the components that reside within.

DGNB - Deutsche Gesellschaft für Nachhaltiges Bauen (GER)

The DGNB assesses buildings and urban districts. The DGNB System covers all of the key aspects of sustainable building: environmental, economic, sociocultural and functional aspects, technology, processes and site. The first four quality sections have equal weight in the assessment. The assessments are always based on the entire life-cycle of a building. The focus is always also on the well-being of the user.

It is crucial that the DGNB does not assess individual measures but instead the overall performance of a building or urban district.

Buildings' overall performance in terms of sustainability is assessed on the basis of around 40 different criteria, e.g. thermal comfort, design for all and sound insulation. This can be useful

for new-build or retro-fitting of entire data centre procurement scenarios. The DGNB schemes for districts include a separate criteria set which addresses issues such as changing urban micro-climate, biodiversity and interlinking habitats, and the social and functional mix. For example for environmental quality, LCA is a tool to assess building performance and for economic quality, LCC is one of the tools.

Projects achieve a certificate/pre-certificate in gold, silver or bronze depending on the degree to which the relevant scheme criteria are met.

Building Research Establishment Environmental Assessment Method

BREEAM is the Building Research Establishment Environmental Assessment Method for buildings and large scale developments. It sets the standard for best practice in sustainable design and has become the de facto measure used to describe environmental performance of buildings and communities. BREEAM covers Management, Energy, Water, Health and Well-being, Transport, Materials, Waste, Pollution, Land Use and Ecology and Innovation. There are 5 levels as follows:

- Unclassified <30 Points,
- Pass >30,
- Good >45,
- Very Good >55,
- Excellent >70 and,
- Outstanding >85.

As with DGNB, this practice can be useful for new-build or retro-fitting of entire data centre procurement scenarios.

DIN V 18599 (GER)

The DIN standard series DIN V 18599 is a method to calculate the net primary energy demand for heating, cooling, ventilation, domestic hot water and lighting (energy balance) Building. It has been developed by DIN Normenausschüsse Bauwesen (NABau), Heiz- und Raumlufttechnik (NHRS) and Lichttechnik (FNL). It provides a method to assess the energy performance of buildings available, as referred to in Article 3 of Directive 2002/91 / EC of the European Parliament and Council Directive on the Energy Performance of Buildings (EPBD) from 2006. The current version is Dec 2011. The DIN V 18599 consists of 11 parts:

- Part 1: General balancing procedures, terms and definitions, zoning and evaluation of energy carriers
- Part 2: Net energy demand for heating and cooling of building
- Part 3: Net energy demand for energy air treatment
- Part 4: Net energy demand for lighting
- Part 5: Net energy demand of heating systems
- Part 6: Net energy demand of ventilation systems, Air heating systems and cooling systems for the residential construction

- Part 7: Net energy demand of ventilation and air conditioning - and air conditioning systems for non-residential construction
- Part 8: Net energy demand of domestic hot water systems
- Part 9: Net primary energy demand of electricity-producing plants
- Part 10: Boundary conditions use of,climatic data
- Part 11: Building automation

The standards have currently the status of 'pre-standard'. This indicates they are preliminary standards scheduled to be introduced in the European standardization process. The European Commission has the European Committee for Standardisation (CEN) to develop European standards for the most uniform possible implementation of the EU Directive.

ISO 50001:2011

This standard relates to the creation and use of an Energy Management System (EnMS) using the Deming (or PDCA) Cycle "Plan, Do, Check, Act to continually improve energy management, energy reduction, energy efficiency within an organisation, whilst the standard is not data centre specific, many data centre wholesale operators have embarked on the ISO 50001 journey. We believe that this is a direct result of the implementation of the Directive 2012/27 EU on Energy Efficient specifically Article 8. In the UK the interpretation of Article 8 is the Energy Savings Opportunities' Scheme (ESOS). ISO50001:2011 is included as an "optional" best practice in the EUCoC.

ISO 55000:2014

ISO 55000:2014 provides an overview of asset management, its principles and terminology, and the expected benefits from adopting asset management. This standard can be applied to all types of assets and by all types and sizes of organizations. ISO55000:2014 is included as an "optional" best practice within the EUCoC.

ISO 20000:2011

ISO/IEC 20000-1:2011 is a service management system (SMS) standard. It specifies requirements for the service provider to plan, establish, implement, operate, monitor, review, maintain and improve an SMS. The requirements include the design, transition, delivery and improvement of services to fulfil agreed service requirements. ISO/IEC 20000-1:2011 can be used by:

- An organization seeking services from service providers and requiring assurance that their service requirements will be fulfilled;
- An organization that requires a consistent approach by all its service providers, including those in a supply chain;
- A service provider that intends to demonstrate its capability for the design, transition, delivery and improvement of services that fulfil service requirements;
- A service provider to monitor, measure and review its service management processes and services;
- A service provider to improve the design, transition, delivery and improvement of services through the effective implementation and operation of the SMS;

- An assessor or auditor as the criteria for a conformity assessment of a service provider's SMS to the requirements in ISO/IEC 20000-1:2011.

Many Data Centre Co-location or Cloud customers may use ISO2000:2011 in their operations but it is unlikely that the data centre itself will be certified to this standard.

ISO 9001:2008 Revision due 2015

This standard sets out the criteria for a quality management system and is the only standard in the family that can be certified to (although this is not a requirement). It can be used by any organization, large or small, regardless of its field of activity. In fact ISO 9001:2008 is implemented by over one million companies and organizations in over 170 countries.
This standard is based on a number of quality management principles including a strong customer focus, the motivation and implication of top management, the process approach and continual improvement. Using ISO 9001:2008 helps ensure that customers get consistent, good quality products and services, which in turn brings many business benefits.

ISO 14001:2004 Revision due 2015

The ISO 14000 family of standards provides practical tools for companies and organizations of all kinds looking to manage their environmental responsibilities.
ISO 14001:2004 and its supporting standards such as ISO 14006:2011 focus on environmental systems to achieve this. The other standards in the family focus on specific approaches such as audits, communications, labelling and life-cycle analysis, as well as environmental challenges such as climate change.
Many data centre operators have certified to ISO14001 and it is a core requirement that an organisation operates either an ISO14001:2004 EMS or equivalent for all public sector tenders.

ISO 14644:1999

This standard relates to the classification of air cleanliness, Clean-rooms and associated controlled environments provide for the control of airborne particulate contamination to levels appropriate for accomplishing contamination-sensitive activities. Products and processes that benefit from the control of airborne contamination include those in such industries as aerospace, microelectronics, pharmaceuticals, medical devices, food, and health-care. Some data centres may operate to this standard but no evidence was found of certification to this standard in the EU data centre community.

EPEAT by Green Electronics Council (GEC)

The EPEAT (Electronic Product Environmental Assessment Tool) is an environmental label that integrates around 80 % of the criteria of EU Ecolabel, Blue Angel, Nordic Swan and TCO and meets the basic principles of ISO 14021. It is used for computer products to indicate environmentally preferable products. For example, all HP commercial PSG products are registered with EPEAT. Access to different levels of certification is conditional upon

compliance with a number of criteria covering the entire life-cycle of products. EPEAT's three current levels of certification, Bronze, Silver and Gold, are based on the IEEE 1680 family of Environmental Assessment Standards. This includes the "umbrella standard," which describes how products are registered by declaring their compliance to specific criteria, how they are rated based on the criteria they meet, how registration by country operates and how product declarations are verified. The related product standard 1680.1 contains the specific criteria for "PCs and PC Displays"

(EU) Energy Star (EC)

The EU Energy Star Programme follows an Agreement between the USA Government and the European Union on the co-ordination of voluntary energy labelling of office equipment, approved by the EU Council in April 2003. The programme has been implemented in the EU by "Council Decision 2006/1005/EC7" and by "Regulation (EC) No 106/2008 on a Community energy-efficiency labelling programme for office equipment" (recast). The management entity for Energy Star is the European Commission, Directorate General for Energy (DG ENERGY), advised by the Member States and stakeholders' experts in the European Community Energy Star Board (ECESB). In the USA, the U.S. EPA coordinates the programme and the labelling process.

The Energy Star Programme aims at optimising the energy consumption of office equipment. To achieve this goal the Energy Star requirements shall be of a dynamic nature, so that it follows both the market transformation consequences of the label and the fast technological evolution. It is therefore recommended that, when a new Energy Star criterion is issued, this should be set at a challenging level, so that it is met by only 20 to 25% of the equipment existing on the market at the date the eligibility criteria are set.

As the Energy Star criteria are originally developed in the U.S. and only adopted by the EU, little direct influence can be exerted on the criteria or the process; the EU Energy Star Board is involved in the development and stakeholder meetings in the U.S.

PCI-DSS

The Payment Card Industry Data Security Standard (PCI DSS) was developed to encourage and enhance cardholder data security and facilitate the broad adoption of consistent data security measures globally. PCI DSS provides a baseline of technical and operational requirements designed to protect account data. PCI DSS applies to all entities involved in payment card processing — including merchants, processors, acquirers, issuers, and service providers. PCI DSS also applies to all other entities that store, process or transmit cardholder data (CHD) and/or sensitive authentication data (SAD). The PCI DSS security requirements apply to all system components included in or connected to the cardholder data environment. The cardholder data environment (CDE) is comprised of people, processes and technologies that store, process, or transmit cardholder data or sensitive authentication data. "System components" include network devices, servers, computing devices, and applications. Examples of system components include but are not limited to the following:

- Systems that provide security services (for example, authentication servers), facilitate segmentation (for example, internal firewalls), or may impact the security of (for example, name resolution or web redirection servers) the CDE. Virtualization components such as virtual machines, virtual switches/routers, virtual appliances, virtual applications/desktops, and hypervisors.
- Network components including but not limited to firewalls, switches, routers, wireless access points, network appliances, and other security appliances.
- Server types including but not limited to web, application, database, authentication, mail, proxy, Network Time Protocol (NTP), and Domain Name System (DNS).
- Applications including all purchased and custom applications, including internal and external (for example, Internet) applications.
- Any other component or device located within or connected to the CDE.

Public sector organisations that accept credit cards for community services are required to follow the standard. EURECA needs to further examine potential PCI DSS compliance for the framework and tool.

4.3.3 Life Cycle Assessment, Environmental Management & Carbon Accounting

The following list of practices are examples of valuable standards, guidelines and frameworks that focus on Life-cycle Assessment, Life-cycle Costing, TCO and Environmental Management aspects such as Carbon Accounting and (Integrated / Sustainability) Reporting.

ISO 14044: Environmental Management: Life Cycle Assessment

ISO (the International Organization for Standardization) is a worldwide federation of national standards bodies (ISO member bodies). The work of preparing International Standards is normally carried out through ISO technical committees. Draft International Standards adopted by the technical committees are circulated to the member bodies (National level) for voting. Publication as an International Standard requires approval by at least 75 % of the member bodies casting a vote.

ISO 14044 was prepared by Technical Committee ISO/TC 207, Environmental management, Subcommittee SC 5, Life cycle assessment. This first edition of ISO 14044, together with ISO 14040:2006, cancels and replaces ISO 14040:1997, ISO 14041:1998, ISO 14042:2000 and ISO 14043:2000, which have been technically revised. ISO 14044:2006 specifies requirements and provides guidelines for life-cycle assessment (LCA) including: definition of the goal and scope of the LCA, the life-cycle inventory analysis (LCI) phase, the life-cycle impact assessment (LCIA) phase, the life-cycle interpretation phase, reporting and critical review of the LCA, limitations of the LCA, relationship between the LCA phases, and conditions for use of value choices and optional elements. ISO 14044:2006 covers life-cycle assessment (LCA) studies and life-cycle inventory (LCI) studies.

The ISO 14040 and 14044 are the common standard basis for all other environmental life-cycle standards, such as 14025, 14067 etc. Owned to its general position, ISO 14040/44 - although often the only reference for Life-Cycle Assessment studies - leaves a quite wide room

for interpretation by the implementer, limiting the achievable reproducibility of the study's results. This is one reason why many guides and handbooks have been developed outside the ISO domain, next to the need to have product-specific guidance to ease implementation.

ISO 14067: Carbon Footprint of Product

ISO 14067 is prepared by Technical Committee ISO/TC 207, Environmental management, Subcommittee SC 7, Greenhouse gas management and related activities. The ISO 14067 is used to calculate the greenhouse gas emissions from companies and their activities. This International Standard specifies principles and requirements for studies to quantify the carbon footprint of a product (CFP), based on life-cycle assessment (LCA) specified in ISO 14040 and ISO 14044. Requirements and guidance for the assessment of a partial carbon footprint (partial CF) are also provided. ISO 14067 is applicable to CFP studies and partial CF studies with or without the intention to be publicly available. This International Standard provides for the adoption of product category rules (PCR), where they have been developed in accordance with ISO 14025 and are consistent with ISO 14067.

This International Standard addresses the single impact category of climate change and does not assess other potential social, economic and environmental impacts arising from the provision of products. Product carbon footprints assessed in conformity with this International Standard do not provide an indicator of the overall environmental impact of products.

European Commission's International Reference Life Cycle Data System (ILCD)

In response to commitments in the IPP Communication of the European Commission, the International Reference Life Cycle Data System (ILCD) has been established by the European Commission's JRC-IES from 2005 to 2012 to help ensure consistent and reproducible life-cycle data and robust impact assessments. This system consists primarily of the ILCD Handbook and the ILCD Data Network, plus a range of supporting technical specifications including an interoperable data (exchange) format..

The Handbook is a series of technical guidance documents. It is developed through peer review and consultation and is in line with the ISO 14040 and 14044, while it provides further specified guidance for better reproducibility and more quality-assurance than the broader ISO framework can offer. The ILCD Handbook provides detailed provisions for product studies (situation A - micro-level and situation B - macro-level/consequential analysis) and corporate analysis/monitoring (situation C1).

To facilitate this development, links have been established with National LCA Database projects in all parts of the world via Memoranda of Understanding as well as with about 15 EU-level industry associations, as well as with the World Business Council for Sustainable Development and World Resources Institute (WBCSD/WRI) and the United Nations Environment Programme (UNEP).

European Commission's Product Environmental Footprint (PEF)

This PEF guide has been developed by the European Commission's Joint Research Centre (JRC). The process has started in January 2011, drawing on the International Reference Life Cycle

Data System (ILCD) Handbook as comprehensive, general handbook for Life Cycle Assessment. The work took into account new developments, but was also re-checking already published standards, in particular Draft ISO/DIS 14067(2012), ISO 14025(2006), ISO 14020(2000), the Ecological Footprint Standards, the Greenhouse Gas Protocol (WRI/ WBCSD), the general principles of France for an environmental communication on mass market products BPX 30-323-0 (ADEME), and the British specification for the assessment of the life-cycle greenhouse gas emissions of goods and services (PAS 2050, 2011). In fact, the emerging national developments were triggering the PEF development, in view of a common European market.

The scope of the EC PEF guide is to provide a comprehensive, scientific, robust method to evaluate the environmental burden associated with any product or service with the application/purpose of obtaining its environmental footprint for public communication. The method covers all currently addressed life-cycle impact categories, i.e. next to Climate change/Greenhouse gases, also Eutrophication, Human and Eco-toxicity, Resource depletion, water scarcity and so on. As this guide is applicable to any type of product, the development of specific requirements for specific product groups (e.g. ICT products in general or on more detailed level) is officially recommended. In this context and after having completed a first pilot phase on the PEF guide in 2012, the European Commission is currently field-testing the development of such product specific guides (PECFRs) on 24 product groups (plus 2 on organisational level), with several hundred members of the technical secretariats plus a total of about 3000 registered stakeholders. These are typically companies, associations, public bodies and green or consumer NGOs inside and outside Europe. This second pilot phase is expected to be completed by early 2017.

French BPX 30-323 (FR)

The repository of good practices, BPX30-323, was prepared under the French law called «Grenelle I», which establishes the prospect of regulatory communication of environmental information relating to product. This document was developed with over 300 organisations representing all the various relevant stakeholders, sectors, and NGOs gathered in the ADEME (Agency for Environment and Energy Management) / AFNOR (French Association of Normalization) platform.

BPX 30-323 is in line with ISO 14040 and ISO 14044 and can evolve following international or European community normative evolution. BPX 30-323 gives general principles for the environmental communication of products. The carbon footprint is required whatever the category of product. The environmental communication includes however other environmental impact indicators limited in number and specific to a category of product. These indicators take into account the main relevant impacts generated by the product.

BPX 30-323 defines main principles for drawing up methodological guides specific to product categories (PCR). These methodological guides are developed by relevant stakeholders of different sectors and are validated by the ADEME / AFNOR platform. 10 methodological guides (PCR) are already available.

PAS 2050 (UK)

The PAS 2050 is a "Publicly Available Standard", meaning that its development process and format is based on the British Standard model. However, unlike a 'full' British Standard, it does not require full consensus between all stakeholders on technical content. This also means a shorter timescale for the development of a PAS (Ibid).

The draft PAS 2050 specifies requirements for the assessment of the life-cycle GHG emissions associated with the life-cycle of goods and services ("products"), based on life-cycle assessment techniques and principles. Requirements are specified for identifying the system boundary, the sources of GHG emissions that fall inside the system boundary, the data requirements for carrying out the analysis, and the calculation of the results. It includes the six GHGs identified under the Kyoto protocol and covers the whole life-cycle of products, including the use phase and emissions from direct land-use changes that have taken place since 1990.

GHG emissions excluded from the assessment include those associated with: the production of capital goods, such as machinery, equipment and buildings used in the life-cycle of the product; the transport of employees to their workplace; human energy inputs; and animals providing transport services.

ITU-T L1410 Methodology for environmental impacts assessment of ICT goods, networks and services; version: February 2012

Recommendation ITU-T L.1410 deals with the assessment of the environmental impact of Information and communication technology (ICT) goods, networks and services. It has been developed by Study group 5 of ITU since 2010. It is organized in two parts:

1. ICT life-cycle assessment: framework and guidance
2. Comparative analysis between ICT and a reference product system (baseline scenario); framework and guidance".

It focuses on the assessment of energy consumption and greenhouse gas (GHG) emissions. The ITU-T L.1410 however does not reach a relevantly better methodological reproducibility than the ISO 14040/44, while it adds suitable information on ICT products.

ETSI TS 103 199

The European Telecommunications Standards Institute (ETSI) has developed the standardized methodology ETSI TS 103 199 "Life Cycle Assessment (LCA) of ICT equipment, networks and services: General methodology and common requirements". It is a dedicated LCA methodology for ICT equipment and services. It is aimed at the whole ICT supply chain for assessing the environmental impact of any ICT product or service, to evaluate the amount of greenhouse gas emissions and other environmental impact categories, as well as to estimate total primary energy usage. It provides a harmonized assessment and reporting methodology, which aims at increasing the quality of ICT related life-cycle assessments, facilitate their comparison, and improve their credibility.

This standard also forms part of the ICT industry's response to the call for reduced ICT greenhouse gas emissions in the European Commission's Digital Agenda for Europe.

Comparisons between environmental assessments of ICT products, which have been performed by different organizations are beyond the scope of this Recommendation. Comparisons are supported if they have been performed by the same staff and applying the same rules (either within the same study or subsequently).

ISO 14064

ISO 14064-1:2006 specifies principles and requirements at the organization level for quantification and reporting of greenhouse gas (GHG) emissions and removals. It includes requirements for the design, development, management, reporting and verification of an organization's GHG inventory.

ISO 14064-2:2006 specifies principles and requirements and provides guidance at the project level for quantification, monitoring and reporting of activities intended to cause greenhouse gas (GHG) emission reductions or removal enhancements. It includes requirements for planning a GHG project, identifying and selecting GHG sources, sinks and reservoirs relevant to the project and baseline scenario, monitoring, quantifying, documenting and reporting GHG project performance and managing data quality.

ISO 14064-3:2006 specifies principles and requirements and provides guidance for those conducting or managing the validation and/or verification of greenhouse gas (GHG) assertions. It can be applied to organizational or GHG project quantification, including GHG quantification, monitoring and reporting carried out in accordance with ISO 14064-1 or ISO 14064-2.

Global Reporting Initiative (GRI)

The Global Reporting Initiative (GRI) is a large multi-stakeholder network of experts worldwide, who participate in GRI's working groups and governance bodies, use the GRI Guidelines to report, access information in GRI-based reports, or contribute to develop the Reporting Framework. The GRI Reporting Framework sets out principles and performance indicators that organizations can use to measure and report their economic, environmental, and social sustainability performance.

GRI's Reporting Framework is developed through a consensus-seeking, multi-stakeholder process. Participants are drawn from global business, civil society, labour, academic and professional institutions.

CDP Water Disclosure Project

The Carbon Disclosure Project is an independent not-for-profit organization. The CDP Water guidance document is intended to support users in completing a questionnaire for corporate disclosure of water use, management and risk. Areas covered by the CDP Water Disclosure questionnaire include:

1. Water management and governance
2. The commercial risks and opportunities relating to water both in companies' own operations and in their supply chains. Particular attention is given to exposure to

water scarcity, flooding and pollution; regulation; reputational, product-related and infrastructure risk; and linkages between water-related and carbon-related risks and opportunities

3. Water accounting including withdrawals, discharges and water-intensity

GHG Protocol Reporting Framework

The World Resources Institute (WRI) and the World Business Council on Sustainable Development (WBCSD) started to develop its corporate standard in 1998 and its Product and Value Chain GHG Accounting and Reporting Standard in September 2008. The revised edition of the GHG Protocol Corporate Standard was published in 2004, a culmination of a two-year multi-stakeholder dialogue, designed to build on experience gained from using the first edition. It includes additional guidance, case studies, appendices, and a new chapter on setting a GHG target. The GHG Protocol Corporate Standard provides standards and guidance for companies and other types of organizations preparing a GHG emissions inventory. It covers the accounting and reporting of the six greenhouse gases covered by the Kyoto Protocol—carbon dioxide (CO2), methane (CH4), nitrous oxide (N2O), hydrofluorocarbons (HFCs), perfluorocarbons (PFCs), and sulphur hexafluoride (SF6).

The Corporate Value Chain (Scope 3) and Product Life Cycle Accounting and Reporting Standards were published in October of 2011 after a 3 year multi-stakeholder development process. These new standards include requirements and guidelines on both product life-cycle accounting and calculation and reporting of corporate "Scope 3" emissions – i.e. corporations' indirect emissions, other than those already counted under "Scope 2" emissions from the generation of purchased energy. These two new standards are based on the life-cycle approach. The Scope 3 standard is a supplement to the Corporate Standard, while the Product Standard builds upon the ISO 14040 series of standards.

GHG Protocol Product Accounting & Reporting Standard: ICT Sector Guidance: Telecommunications network services, Desktop managed services

This document has been developed and coordinated by the World Resources Institute (WRI), the Global e- Sustainability initiative (GeSI), the Carbon trust, and the World Business Council for Sustainable Development (WBCSD). The guide is published as a Sector Guidance to the GHG Protocol Product Accounting and Reporting Standard (referred to as "the Product Standard" throughout this document). The purpose of this document is to provide additional guidance to practitioners who are implementing the Product Standard for ICT products. This guidance follows a Life Cycle approach for the assessment of ICT products. The need for this Sector Guidance is due to the specific nature of ICT products.

French Bilan Carbone (FR)

Bilan Carbone is an organizational GHG accounting guidance document and tool produced in France by ADEME. The guidance provided is more comprehensive than most other corporate GHG accounting methodologies. Emphasis is placed on physical realism in GHG accountancy. All greenhouse gases are considered, rather than the six Kyoto Protocol GHGs considered in

most guides. Calculation templates that include emission factors and provide outputs relevant to reporting under several other schemes are provided.

Leaving energy and environment-related standards and guides we briefly address two main cost-related ones. Such will receive more attention in later deliverables, when coming to address cost/benefits.

Total Cost of Ownership (TCO)

Total Cost of Ownership is a philosophy used as practice, which is aimed at understanding the true cost of buying a particular product or service from a particular supplier, i.e. next to purchase cost, also the cost of operation and consumables, repair and maintenance up to any cost for end-of-life managing/disposal. From its origins in defence equipment procurement in the US in early 1960s, the use of TCO has been extended to other areas of the public and private sectors and is more and more combined with LCC.

Life Cycle Costing (LCC)

LCC should be used to refer to all costs associated with the product or system over its life-cycle, be it direct cost as in TCO or indirect (external) costs shared by society. That is, again starting from requirement analysis, design, production, operation and maintenance until disposal. In this context, environmental LCC also covers the "price" of externalities, f.e. the price society pays for emissions and related impacts, with different approaches in use to convert emission data - based on Life Cycle Assessment - into costs. Details will be addressed in later Deliverables.

The external costs caused by emissions and resource depletion that are invisibly shared by many actors and the society in general, are of special interest to governmental bodies, explaining why environmental sound Public Procurement is step-wise moving to use LCC instead of "only" TCO.

LCC and TCO are being used to assist in decision-making, budget planning, cost control, and range of other activities that occur over the life of complex technological equipment.

4.3.4 Industry KPI's/Metrics

Although KPI and metric are often used as synonymous with regard to measurements, there is a nuance difference. Where a metric is used for a desired measurement. A KPI is an indicator (of said metric) that will determine whether you are meeting your critical success factors (CSF). A simple but useful mnemonic aid is to use the following example:

We want to determine if a distance (measurement) from A to B is short, medium or long compared to other comparable situations. For this we will express the distance in meters (metric) and determine that 100 meters (KPI) can be considered medium.

Inventory and adoption in industry

Data Centre Key Performance Indicators (KPI's) have traditionally been focused on "uptime" and availability, and these have been considered adequate for the "industry". Uptime is

usually expressed in percentages and availability in hours, normally associated with the "Tier rating" of the site.

Within the last 10 years, performance metrics of varying complexity have been proposed and discarded. Some of these were discarded because they do not provide a single viable "number" that can be applied to any type of data centre to ascertain its level of performance.

The "performance" of a data centre is still very hard to quantify, as almost every data centre does something different for its operator, for instance, some data centres (telecommunications) merely switch data requests to other data centres thus the KPI would be the amount of switching requests inbound and outbound per energy used to provide the switching, this will depend on the time of day, year and activity of users which themselves could be variable. Other data centres, for instance in the public sector may be processing credit card payments, file and print requests, management data, and increasingly providing IoT/Smart City activities.

We must note however, that the above is not the only reason why some proposed metrics have been discarded (or not widely adopted throughout the Industry). Other underlying reasons may also be (partially) because current design or operations within data centres are (not yet) able to, or willing to, provide the required data. This may provide an opportunity for Public Sector procurement to drive changes through demand.

Annex 3 contains a number of data centre metrics we have inventoried as result of our analysis of industry and procurement practices. This inventory also includes the metrics that were identified by the projects collaborating in the EU projects 'Data Center Cluster'.

Most of those inventoried have been discarded (or not (yet) adopted) by the industry for the reasons mentioned above, but may still be viable for use, either by Public Sector entity themselves to meet the critical success factor for their business needs or perhaps integration in EURECA once framework and tool development progresses.

The following metrics are considered to be fairly widespread within the "industry"

- GHG emission calculations in terms of CO2 (or CO2eq) emissions
- CO2 savings: Percentage of savings in terms of CO2 (or CO2eq) emissions
- Energy savings / Energy consumption: Expressed in kWh / year
- PUE: Power Utilisation Effectiveness*
- EUE: Energy Utilisation Effectiveness*
- CEF: Carbon Emission Factor
- ERF: Energy Reuse Factor#
- GEC: Green Energy Coefficient
- REF: Renewable Energy use Factor
- WUE: Water Usage Effectiveness

*PUE/EUE are the same metric from two different bodies, the Green Grid and CEN/CENELEC/ETSI.

But it is unclear if these metrics are being calculated correctly in line with the requirements of the originating body due to the level of understanding and measurement equipment.

The following metrics are those that are in widespread use or have been proposed by various organisations and are in the final stages of being adopted by the ISO.

No other metrics are in widespread use, although some organisations may have hybrid metrics that meet some critical success factors that are specific to that organisation.

PUE: Power Utilisation Effectiveness

The principle global metric is Power Utilisation Effectiveness or PUE, this is a Green Grid metric which is in the final stages of becoming an International Standards Organisation standard ISO 30134-2.2.

PUE is meant to be calculated on an annual basis, however depending on the level of monitoring and measurement maturity (specifically, where the IT LOAD is measured) within an organisation, the PUE can be further calculated on a basic, intermediate or advanced level as follows:

Basic:	At UPS output
Intermediate:	At PDU
Advanced:	At IT Equipment Input

Further variants of PUE are defined as follows:

- Partial PUE - for subsets of equipment contained within the data centre i.e. cooling equipment.
- Designed PUE - predicted PUE for a site that is yet to come into operation or for a major change i.e. new cooling equipment or containment solutions
- Interim PUE - for measure of PUE on a less than annual basis, i.e. spot PUE on a daily or weekly basis.

PUE is accepted as a "de-facto" efficiency metric, however it cannot really be accepted as an efficiency metric as it is the ratio of energy provided to a building divided by the amount of energy used by IT equipment and expressed as a single number.

Some criticism on the use of PUE has also arisen. Though it has never been intended for comparing the performance of different data centres with it, it has somewhat been turned into a marketing tool. Also, by setting requirements for PUE as the only (or most important) factor to evaluate how 'green' a data centre is compared to another, can actually result in the selection of less environmentally sound products and services and therefore not meeting the objective.

PUE shall have a minimum value of 1,0, indicating that if 1,0 this means 100% of the total data centre energy demand is used to run the ICT equipment and for nothing else.

Data Centre Infrastructure Efficiency (DCiE)

This metric is the inverse of PUE and is expressed as a percentage, thus lower PUE's will be a higher percentage.

Relevance of Renewable Energy Factor (REF)

REF is defined as the ratio of renewable energy (RE) used in comparison with the total data centre energy used (EDC is the total data centre energy in kWh). The Renewable Energy Factor (REF) metric describes the percentage of renewable energy (RE) over the total data centre energy use. REF provides an assessment of the mitigation of carbon emission originated from energy consumption in a data centre. The REF metric is an effective tool with which to monitor the use of RE and to increase the diversity of energy dependence and improve the sustainability of a data centre by enhancing use of RE.

E_{REN} is the RE in kWh owned and controlled by a data centre (i.e. any energy for which the data centre owns the legal right to the environmental attributes of renewable generation) including

a. energy that was generated on site of the data centre and whose legal rights to the environmental attributes of RE are retired in a data centre (so that are no longer a commodity to be traded and are possessions of the last owner or the renewable certificate system administrator),
b. energy that was obtained by procurement of RE certificates and retired in the data centre,
c. the portion of utility electricity, defined as RE, provided the data centre has obtained documented written evidence from the source utility provider(s) that the energy supplied, for the reporting period in question.

NOTE: This excludes RE generated in a data centre site but whose legal rights to the environmental attributes of RE were sold to other parties or the market.

REF shall have a maximum value of 1,0, indicating 100% of the total data centre energy is RE. On site generation of RE beyond the need of the data centre shall not be accounted for REF. Therefore, a value greater than 1,0 is not possible.

Because the RE content of the KPI is based on legal ownership of the rights to the environmental benefits, it is important to clarify that the location of energy source does not change the calculation of the REF.

EXAMPLE: A data centre has a solar panel on its roof to generate power. If the data centre sells the RE certificates associated with this power, then the contribution of the solar panel is excluded as RE within the calculation of the REF.

Conversely, a data centre that receives electricity entirely from a coal-fired plant can purchase RE certificates to offset the entire electric use. These certificates are included as RE in the REF.

4.4 Public Sector Procurement State of Practice

The procurement of data centre products and services can be regarded as complex, particularly in the effort to select the solution that meets the (a Public Sector organisations') needs while addressing organisational (strategic) targets and ambitions. The large array of technical systems and solutions available with many elements subject to standardisation that affect the efficiency and environmental impact of the facility, it can be quite a feat for people for whom the DC/ICT industry is not their primary expertise. Our analysis looked at several kind of practices used by Public Sector organisations: general practices used; (best) practices with (some) relevance to data centre products and services; and practices related to innovation (PCP and PPI specifically).

Judging by the evidence and experienced gained, for example via the survey, various interviews and event visits such as the Public Sector Show (London), the general awareness level of standards and best practices within public sectors is low. In addition, despite the efforts of schemes such as the EU Joint Research Centres Code of Conduct for data centre energy efficiency, the take up and specification within tenders for benchmarks related to best practices is sporadic at best or at worse missing completely. An example of this was discovered during the London workshop where a common consumption baseline KPI (in this case Power Utilisation Effectiveness or PUE) was requested for all government sites under an umbrella outsourced contract. However the contractor refused to provide the information without a further significant charge, because the KPI was not specified as required within the contract.

There is also some confusion within the Crown Commercial Services in the UK which specifies the EU Code of Conduct for Data Centres in their G Cloud (4, 5, & 6) requirements, however the intention has been blunted by incorrect wording as they actually ask for (as a supplier statement) whether they operate "the EU Code of Conduct for Operations" which does not exist. This has been raised with them and it is hoped that the correct wording will be included in G Cloud 7 framework which is due to be released at the end of August.

Goal of this research is to establish an understanding of the current state of practice within the (Public Sector) procurement landscape, which is followed by SWOT (Chapter 4.5), GAP (Chapter 4.6) and Benchmark recommendations (Chapter 5) that should or could be relevant to the EURECA framework and tool.

4.4.1 PCP & PPI Practices

As part of our regional analysis of the current state-of-play for procurement we have come across and analysed several PCP and PPI [2] specific procurement practices. Those that stood out have been elaborated on below. All others can be found in the Cataloguing and Evaluation Framework (Annex 1).

Procurement of Innovation Platform (EC)

[2] Footnote: In the UK PPI is sometimes referred to as FCP, short for Forward Commitment Procurement

The Procurement of Innovation Platform is an online hub that aims to help public authorities, procurers, policy makers, researchers and other stakeholders to harness the power of PCP and PPI. The Platform is roughly divided into three main elements: website, Procurement Forum and Resource Centre.

- The **website** offers an introduction to PPI with information about why PPI is something to consider, related legal and policy information, related facts & figures, guidelines for implementation; relevant news updates; information of ongoing projects about PCP and/or PPI; information for relevant training opportunities and events and links to the Procurement Forum and databases part of the Resource Centre.
- The **Forum and Resource Centre**, currently at around 2000 members, offers its members a place to discuss, share knowledge and exchange resource information (f.e. practical case examples, valuable reports and tools etc.). Members can start groups dedicated to specific subjects or initiatives.

The Procurement of Innovation Platform is driven by several regional and European organisations dedicated to procurement, innovation and sustainability and was developed by ICLEI under the CIP-EIP programme by EC. The PIP Platform has also published their own PPI Guide.

DEEP Toolkit and Procura+ Manual (EC/ICLEI)

The DEEP Project was supported by the „Intelligent Energy – Europe" programme of the European Commission. DEEP describes Energy efficient procurement as being applicable to the design, construction and management of buildings, the procurement of energy using equipment, such as heating systems, vehicles and electrical equipment, and also to the direct purchase of energy, e.g. electricity. It includes practices such as life-cycle costing, the setting of minimum energy efficiency standards, use of energy efficient criteria in the tendering process, and measures to promote energy efficiency across organisations.

The *DEEP Toolkit* is a package of resources designed to help public authorities who would like to use purchasing power to improve their energy efficiency performance. The DEEP tools have been designed to help public authorities:

- develop an energy efficient procurement policy, and implement it across the organisation,
- establish Life-Cycle Costing and train procurement staff in its application, and
- to assess current performance and identify some basic and low-cost energy efficiency measures.

The Procura+ Manual publication has been produced as part of the DEEP project. This manual covers the following topics:

- simple and key (purchasing) guideline and criteria that can be used and further advice on developing environmental specifications,
- a simple Milestones process designed to help manage implementation of integrating sustainable procurement activities within a quality or environmental management

system effectively to help ensure objectives, targets and measurement procedures are established throughout an organisation.

Although DEEP is not specifically targeting ICT or data centre related products and services, both the toolkit and the manual are useful sources: The Toolkit provides advise on formulating, implementing and managing a policy for energy efficient procurement, tools for LCC, performing a self-assessment on energy consumption and use of criteria. The manual provides advise on embarking on 'sustainable procurement' and addresses several of the procurement building blocks including environmental criteria in tendering, calculating costs of sustainable procurement through LCC and a roadmap framework (milestones).

DEEP Project completed some time ago (2007) so some of the initially reported info can be dated, however the varying elements within the Toolkit and manual still provide useful information for EURECA. Also, the manual and toolkit are often referred to from the varying Procurement Platforms the project has come across.

Smart SPP - Innovation Through Sustainable Procurement

Driving energy efficient innovation through procurement - A practical guide for public authorities presents advice on how public authorities can make their procurement activities more innovation friendly. This advice is structured into six key activities which should be addressed within the procurement process. There is a specific focus on early market engagement, that is, how to get the best out of the market through effective dialogue with potential suppliers before tendering.

Guideline published useful for EURECA for PCP/PPI (in relation to the procurement scenarios). Outlines steps & tips with practical advice, environmental driver primary focus, but it is unclear if the LCC/CO2 costing tool has received any updating since 2011 with potential LCA / LCC developments and insights. The guide and the tool are however regularly referenced from other platforms

PPI Guide by KOINNO / BMWI (GER)

PPI guide published by German Government (KOINNO/BWMI – 'Impulse fur mehr innovationen im offentlichen beschaffungswesen') that supports decision makers and procurement officers with concrete advice on becoming more innovation-orientated. The White Paper style guide is considered to provide useful information how to (re)interprete the General Purchasing Rules regarding innovation targeted procurement (PPI). It provides general guidelines with example and cross references to general (German) purchasing rules like VOL/VOB/VSV-VGV.

Vergabe- und Vertragsordnung für Leistungen VOL/A: General Purchasing Framework Regulations for Services VOL/A.

Vergabe- und Vertragsordnung für Leistungen VOB/A: General Purchasing Framework Regulations for Buildings VOB/A

VSVgV Vergabeverordnung für Verteidigung und Sicherheit: Purchasing Regulations for Public bodies in sectors Police and Military

VGV - Verordnung über die Vergabe öffentlicher Aufträge §4, §6 VgV: General Guideline (law) for purchasing activities of the public body in Germany, §4 and 6 have been revised to reflect 2012/27/EU

AVV-EnEff (GER)

German law regarding purchase of energy efficient products and services. It was last update 2013 and is expected to be updated late 2016. This is relevant since these regulations describe in more detail the General Regulations VOL/VOB/VSV-gV and link a lot of standards (Blauer Engel) e.g. to the standards that are relevant for purchasing.

Innovation Toolkit (Innovatiekoffer) & Public Innovation Programme Urgent (NL)

The Innovation Toolkit is part of the Public Innovation Procurement Programme Urgent in the Netherlands which offers an online toolkit ('Innovatiekoffer') to help get started on innovation procurement. The toolkit offers several Action plans such as for market exploration, for setting up a 'Living Lab', for a market consultation, how to develop a prototype, calculation of TCO, engaging in competitive dialogue, performing a needs assessment, and to set up a risk management process for the procurement procedure. Each Action plan also provides information on relevant legal policies.

The programme also develops flagship projects, provides and online innovation market to close the gap between supply and demand, and organises regional events where entrepreneurs and authorities can meet and to show best practices (which are also provided through documentation). The programme's toolkit does not refer to these Innovation Procurement practices as being PCP or PPI. The programme focuses on themes as opposed to sectors and as such does not provide details of 'how to' for sector specific expertise.

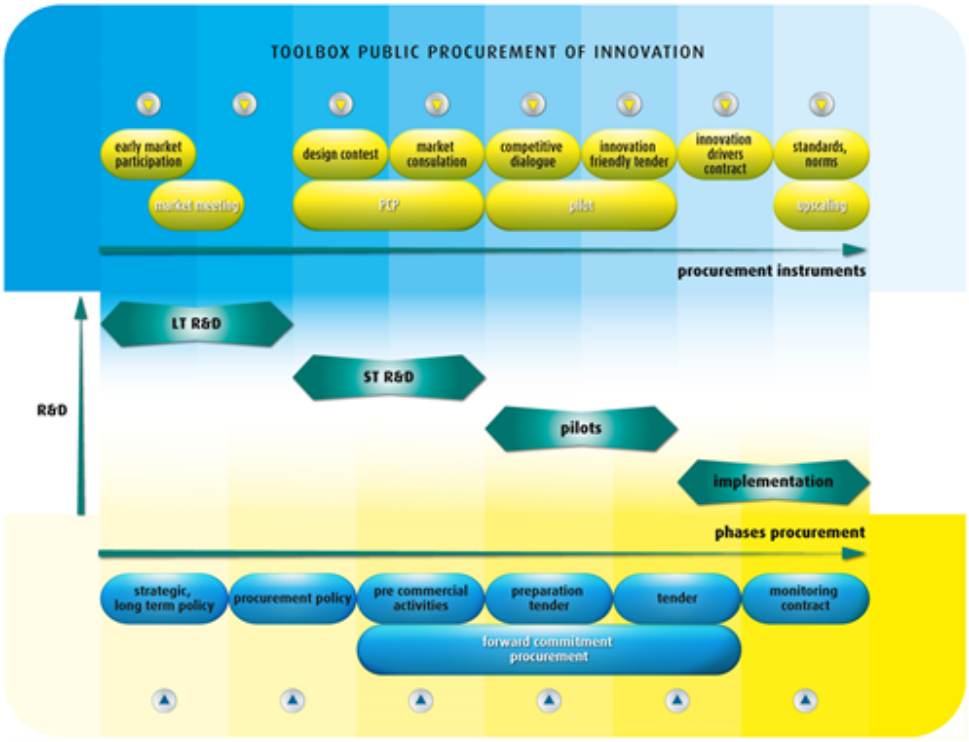

Figure 1 - Public procurement of Innovation Programme Toolbox - Source: Urgent

Policy for Innovation targeted procurement by Ministry Infrastructure & Environment (NL)

Rijkswaterstaat, the Ministry of infrastructure and the environment is responsible for the design, construction, management and maintenance of the main infrastructure facilities in the Netherlands. This includes the main road network, the main waterway network and water-systems. As with all Dutch ministries, Rijkswaterstaat has the obligation to devote 2,5% of the annual procurement budget to the procurement of "innovation", where innovation is defined as *The development and use of new products, technologies, processes and services*. The ambition of Rijkswaterstaat also states that:

Each innovation project should (in time) contribute to the Rijkswaterstaat goals of

- 30% less life-cycle costs
- 30% more functionality
- 30% more sustainable and safer

In order to facilitate this ambition, Rijkswaterstaat published its "Policy for Innovation targeted procurement". The policy document contains a decision support structure for innovation procurement and formulates the ambition for eliminating one of the major inhibitors for sustainability procurement, namely the budgetary divisions between acquisition and maintenance. As such, the policy document is a useful reference for EURECA as a use-case where a major governmental institution has realized what obstacles inhibit sustainability and is working on resolving the issue.

Infomil: Environmental legislation and policy in the Netherlands

Since January 2013 Rijkswaterstaat Environment is part of Rijkswaterstaat, the executive agency of the Dutch Ministry of Infrastructure and the Environment. In this capacity, Rijkswaterstaat is responsible for maintaining the Infomil website: http://rwsenvironment.eu/about-us/infomil/.

The Knowledge Centre InfoMil is the primary source of information and best practices in matters of environmental legislation and policy in the Netherlands. InfoMil is the place where information about environmental legislation and policy is documented, analysed and disseminated, providing up-to-date, unbiased and practical information to policymakers and to those who implement and execute policy, such as licensing officers and inspectors. They aim to operate as a central link between policy development and policy administration. Internationally, InfoMil uses its knowledge of European environmental policy to help organisations and countries find their way around European environmental legislation and policy. It aims to share their experience and documented knowledge to assist others wishing to implement European environmental policy. Ultimately, the goal is to strengthen relations between the Netherlands and its partners both inside and outside Europe. It is also a forum for the exchange of information and knowledge between policymakers from the Ministry of Infrastructure and the Environment and environmental authorities and services at provincial, regional and local levels. Information about environmental legislation and ICT procurement on this site is notably scarce. The only data centre associated KPI's that are mentioned on the website are:

PUE	DCiE	Score
>= 2	<= 50%	bad
1.8 - 2	50%- 55%	average
1.5 - 1.7	56% -66,6%	good
<1,5	> 66.6%	excellent

The site further features a very limited selection of recommendations that are all extensively covered by other more focused initiatives like the European CoC for data centres, the ASHREA TC9 recommendations and others. The overall impression of the quality of information on the particular subject of environmentally sound data centre (services) procurement is low, the amount of information is limited and the information itself aged.

The current state of information aside, the Infomil website is a respected authority on the subject of environmental policy and legislation and as such provides an excellent dissemination platform for EURECA information and tooling.

Practical Case examples:

Though PCP and PPI can certainly be applied to target specific innovation for data centre related products and services, most PCP and PPI related procurement initiatives have been

initiated from the perspective of a functional demand of smart solutions for societal, thematic, organisation specific issues, for instance related to transport and traffic, health-care, firefighting, food-waste etc.

There are, however, several practice examples of specific PCP & PPI focusing on data centre products and services.

The German Federal Ministry for Economic Affairs and Energy initiated a pre-commercial procurement (PCP) for high-temperature liquid cooling of data centre server components.

The PCP lays out a clear timetable for bidding, development and testing of a solution. Funding is available for the development of a prototype in the form of a government grant to cover up to 50 percent of the development costs.

Contracts for research and development are to be granted to a number of competing companies to encourage the development of a number of potential solutions. At the end of each phase, the companies with the best solutions will be chosen to carry on to the next stage. Bidders are asked to provide detailed explanations of their concept, calculations of time and money required to develop and test the solution and pricing if the resulting solution is chosen by the Federal Ministry for Economic Affairs and Energy. [German Ministry for Economic Affairs and Energy and German Centre for Air and Space travel (DLR)] Source: Innovation Procurement Forum (online) news archive.

The Cloud for Europe project tender for the joint pre-commercial procurement for research and development on Cloud computing services for public administrations.

The purpose of the tender is to research and demonstrate solutions to overcome obstacles for the adoption of cloud computing by the public sector. The Cloud for Europe PCP invited suppliers to bid for any or all of three services (lots), each of which provides a framework agreement for the realisation of research and development services. The lots comprise innovative solutions for federated certified service brokerage, secure legislation-aware storage and legislation execution. The work is to be carried out in three distinct competitive phases over 18 months. The process phases are related to the solution design (phase 1), prototype development (phase 2) and the original development of a limited number of first products or services in the form of a test series (phase 3). For each lot, several bids will be awarded a framework contract. After each phase, results will be evaluated and bids will compete with each other for assignments in the subsequent phase. - Sources: http://www.cloudforeurope.eu/home & http://www.agid.gov.it/cloudforeurope

4.4.2 RFI / RFP and ITT practices

Those examples elaborated on in this paragraph are primarily dedicated to standards, frameworks and guidelines associated with general stages of procurement practices, but may also include information on PCP and/or PPI aspects of procurement. Based on the project's research and analysis the examples mentioned here showcase noteworthy practices that are of added value to the EURECA framework and platform either as existing platforms to connect to or can provide valuable input for framework / tool content. All others can be found in the Cataloguing and Evaluation Framework (Annex 1).

Directive 2014/24/EU

The 2014 EU Procurement Directives came into force at EU level on 17 April 2014. EU member states now have 2 years to implement them in national legislation. This followed a successful lobbying campaign by the UK government and other EU partners to negotiate a simpler, more flexible regime of procurement rules.

The directives

- Public Sector: Directive 2014/24/EU of the European Parliament and of the Council of 26 February 2014 on public procurement and repealing Directive 2004/18/EC – view the EU Procurement Directive (Public Sector)
- Concessions: Directive 2014/23/EU of the European Parliament and of the Council of 26 February 2014 on the award of concession contracts – view the EU Procurement Directive (Concessions)
- Utilities: Directive 2014/25/EU of the European Parliament and of the Council of 26 February 2014 on procurement by entities operating in the water, energy, transport and postal services sectors and repealing Directive 2004/17/EC – view the EU Procurement Directive (Utilities)

We have identified clauses that can assist in the procurement of sustainable data centres and services, these are contained within Annex 2 [Directive 2014/24 Clause Analysis].

NEUPC ITS2002 NE PQQ

North Eastern Universities Purchasing Consortium Ltd (NEUPC) is one of six UK Higher Education purchasing consortia established to deliver and manage a wide range of collaborative framework agreements aimed to maximise third party expenditure within the higher education sector. It serves as a good example of joint procurement initiatives.

The framework covers many aspects of data centre design and construction, and includes the following scored criteria:

Statements of principal activity, Delivery & Quality Assurance, Health & Safety, Equality & diversity, Environmental Management, Sustainability, Capacity, Range of products and services, Staffing arrangements, Transport and logistics, Subcontractor management, Demand Management, Supply chain management, Case Studies, Supply partner references & Customer partner references.

GOVPROCTOOLBOX (OECD)

The Toolbox is an on-line resource that captures emerging good practice to enhance corruption prevention and good management in public procurement in OECD and non-OECD countries. The tools contained in this website have been compiled from practices which have been successfully tested in a number of countries. The tools are classified according to their use in the procurement cycle and also by theme according to the pillars underlying the OECD

Recommendation. The toolbox provides useful material and template suggestions that will help with corruption prevention and good management throughout a procurement / tender. Although this subject matter and the specific toolbox is somewhat removed from the scope of EURECA, it contains aspects that can be used next to or complementary to the EURECA framework / tool from the perspective of its contextual relation to 'Social Drivers'. It can be referenced to by EURECA as a useful guide for corruption prevention and good / ethical management of a tender process and as such providing some additional value to those users of EURECA who would like to explore the toolbox. Toolbox access: http://www.oecd.org/governance/procurement/toolbox/

PEPPOL

The OpenPEPPOL Association was established on 1st September 2012 as the result of the Pan-European Public Procurement Online (PEPPOL) project funded jointly by the European Commission and the PEPPOL Consortium members. OpenPEPPOL is a non-profit international association under Belgian law (Association Internationale Sans But Lucratif – AISBL) and consists of both public sector and private members. The OpenPEPPOL Association is responsible for the governance and maintenance of the PEPPOL specifications. Membership is open to public and private organisations interested in the adoption of standardised e-Procurement solutions and EU-wide connectivity.

PEPPOL focuses on the critical e-Procurement components to solve interoperability issues in Europe. PEPPOL is not an eProcurement platform but instead provides a set of technical specifications that can be implemented in existing eProcurement solutions and services to make them interoperable across Europe. It offers Business Interoperability Specifications for eCatalogues, eOrdering, eInvoicing, eAttestation (VCD) and eSignature validation; network specifications for open and secure documents exchange and network Governance through the PEPPOL Transport Infrastructure Agreements. Source: http://www.peppol.eu/

There is no direct link to the focus of EURECA, however, potential interoperability with its eProcurement functionalities may be worth further exploration to verify if it can provide added value for the Public Sector and vice versa.

PIANOo (NL)

The PIANOo organization (https://www.pianoo.nl/), is an initiative by the department of the Ministry of Economic Affairs. Pianoo is established to help understand the public procurement in the Netherlands, and to support vendors and procurement departments to improve the governmental procurement policies and practices. The methods the Dutch government is advocating are:

- **Best Value Procurement (BVP)**, where the vendor is in the lead in the proposal of the offered solution. Procurement used to describe every demand, leaving no initiative *for the vendor to introduce* a better solution. With BVP this has improved;
- **PIA procurement packages**, where PIANOo has defined a limited amount of procurement packages and added sustainability criteria to each of the packages. This comes close to an initiative to promote environmentally sound procurement. There is

no procurement package linked to data centres (yet), there is one for procuring energy (KWh);

- **Past Performance**, where several public bodies exchange their experiences with vendors and suppliers, in order to professionalize both procurement and suppliers, and make better procurement decisions;
- **Procurement diagnosis**, where regularly different organizations are being compared in what they bought, how much they spent, who bought from what supplier. It is a management method to improve the procurement process internally and has qualitative and quantitative information;
- **Tender boards**, where expertise is brought together on an ad hoc basis. The tender boards give expertise on all required levels: procurement legislation and standards, the product or service that needs to be procured, etc.

From experience with procurement departments in general, we also learn that most of the larger procuring public organizations have their own standards (rules, forms, responses, lead times, conditions) for procurement. PIANOo organization helps with the professionalizing and standardizing this public procurement that spends 60 B EUR annually.

TIKO - Sustainability rating system for data centres by Ministry of Transport and Communications (FIN)

TIKO is a sustainability rating system for new constructions of data centres. It is a weighted credit based system which acts as a systematic tool for designing, building, equipping, operating and managing data centres in an environmentally, socially and financially sustainable way. The TIKO-rating covers the data centre as an entirety, assessing the building, the IT and the operations as a whole acting as a check-list of sustainability issues that should be taken into consideration. TIKO emphasizes numeric metrics for communication and comparison of sustainability performance and sustainable planning, which takes into consideration the life-cycle of the data centre and bases on continuous improvement without strict rules or regulations allowing and encouraging innovation.

TIKO aims to guide and help assess for tender decision making in seven sustainability categories: *leadership, operational management, energy, sustainable site, water, waste and pollution*. The credit values reflect the importance of the factor in overall sustainability of a data centre and in relation to other points. TIKO is further separated into two other schemes:

- TIKO for existing data centre sustainable performance development and
- TIKO Guide for purchasing sustainable data centre services – for comparing DC service provides via the TIKO criteria.

It is the Finnish Ministry's intent is to first implement the produced sustainability rating system on pilot projects and continuously improve the content of the rating system to include new study results and feedback from projects implementing TIKO. TIKO aims to actively follow developments in the data centre area specifications including the work of The Green Grid, EU Code of Conduct etc. and use these developments as input for the TIKO tool and model. Due

to its integration with the aforementioned standardisation efforts and relatively robust and relevant rating system it can be a useful module to build upon with the EURECA framework and tool. However, there is little online information available besides the official publication by the Finnish Ministry of Transport and Communications. Source: http://www.lvm.fi/web/en/publications_series.

Practical Case examples:

PICSE – Procurement Innovation for Cloud Services in Europe

The PICSE project is an Initiative funded under H2020 focusing on the public procurement of Cloud services. The overarching objective of PICSE is to set up a European Procurers' Platform capable of raising the level of understanding of the issues surrounding procurement of cloud services, particularly regarding security and privacy. The platform will provide a repository of information, develop a procurement model for public national and international research organisations, best practices for implementing results, roadmap for cloud procurement, lay the foundations for future joint procurements to support the hybrid cloud model. PICSE aims to become a central point for the Public Sector PCP/PPI community. It has recently published a case studies analysis based on practical case examples within the Public Sector titled: Procuring cloud services today - Experiences and lessons learned from the public sector. The findings of these case studies will also be used as a preliminary for their roadmap. The focus of this platform can potentially provide added value to the scope of EURECA for Public Sector procurers when used in combination for Cloud procurement scenarios.

PrimeEnergyIT Case Studies Publication - Public Procurement of Energy Efficient Data Centres

The PrimeEnergyIT project aimed to support the market development for energy efficient central IT equipment, including server, data storage, network and facility equipment, as well as new power management technologies. It consisted of an international consortium of national agencies and research institutions in cooperation with a number of associate partners from industry. Its publication of their case studies analysis in 2012 concluded that public procurement of newly constructed data centres originates from efficient energy (i.e. a lower Power Usage Effectiveness (PUE) value), reduced operative and maintenance costs, and safer data storage through higher availability and improved redundancy, but used different (PCP/PPI) contracting methods and resulted in desired savings through innovative solutions. There are also significant challenges identified regarding access to internal technical skills, optimization of combining environmental and economic objectives, how to verify technical specifications and long-term performance monitoring solution, among others. The analysis conducted for EURECA indicates that, although some progress is made, the core of these conclusions are still valid.

KUBUS Project - IAAS procurement Higher Education

The KUBUS project is a joint venture between (currently) 5 Dutch universities of applied sciences to procure an IAAS platform using SURF as the procurement organisation. SURF is the collaborative ICT organisation for Dutch higher education and research. SURF offers students,

lecturers and scientists in the Netherlands access to the best possible internet and ICT facilities.

See https://www.surf.nl/en/about-surf and https://www.surf.nl/nieuws/2015/04/surf-cloudproject-kubus-naar-volgende-fase.html

Running the IAAS acquisition as a joint venture severs multiple purposes; firstly, the increased volume will attract more vendors and hopefully a more attractive pricing. Second, by operating jointly through SURF, the institutions save on the administrative burden of the procurement process. Thirdly and very important for the project, the institutions mean to lower both cost and environmental impact of this IAAS infrastructure through smart sharing of the infrastructure between the constituent organisations.

In order to quantify the environmental impact as well as to include sustainability metrics into the procurement process, the project ran a "current state inventory" (Dutch: 'nulmeting') which, amongst others, determined the average power draw per virtual machine associated to the current "in-house" infrastructure. This metric will be included in the upcoming RFP as a means of ranking potential suppliers on the energy efficiency of the proposed solutions.

The KUBUS project team and EURECA project team are currently in the process of drafting a letter of intent to formulate the standing intention for collaboration between the projects. In this collaboration, EURECA will supply information on relevant metrics and support KUBUS in monitoring the KUBUS infrastructure in order to record both the immediate and long term effects on energy efficiency of imposing sustainability criteria in the procurement process.

New data centre - Technical University of Eindhoven (NL)

In 2014 the data centre of the TU/e needed replacement. At the start the management decided to group together with the City of Eindhoven and the Summa Collage in Eindhoven. The first idea was to take some proven requirements, using the huge requirements of a tender of an earlier another data centre project. However reuse of requirements by just a copy-paste activity, appeared not to be a good idea at all.

The tender process improved when the consortium decided to share their (functional) wishes and ideas with potential data centre suppliers. In this way, new entrants felt themselves invited to use their creativity and knowledge to come up with an innovative data centre design, the consortium never dared to dream of: lower in cost, better in quality (first TIER IV data centre in the Netherlands) and very sustainable (negative CO_2 production) by actually heating a huge amount of offices.

The consortium and the data centre that won the bid all are very happy in the end. The decision to allow the vendor to enjoy some degrees of freedom how to address the functional requirements, in doing so respecting the expertise of the vendor, made this procurement consortium a success.

Data centre retrofit tender, Open University, Heerlen (NL)

The Open University (OU) of the Netherlands is an independent government-funded institute for distance learning at university level. The OU utilizes a twin data centre, both located in Heerlen (NL) to house its central ICT environment. The twin set is comprised of one location owned and operated by the OU and one owned and operated by the University of applied sciences Zuyd. The OU has recently started a project for retrofitting the OU owned DC facility with the explicit wish to create a highly efficient installation. For lack of knowledge about options and the current technology level of DC E&M equipment, they resorted to hiring an independent consultant to formulate the requirements and KPI's that will form the basis of the tender that is expected to come out later this year (2015).

EURECA's proposed tooling would have made a significant contribution to lowering the cost and expediting the start of this project, firstly by helping in coming to the decision to retrofit rather than opting for other options like outsourcing, secondly by providing the needed input for the KPI's defining DC E&M equipment complete with target values that represent the current efficiency of said equipment.

University of Hertfordshire (UK)

The University of Hertfordshire was the first European university to comply with the EU Code of Conduct for Data Centres, and was recognised in the Datacentre Leaders Awards 2010, the EAUC Green Gown Awards 2011 & the Uptime Institute GEIT Awards™ 2011.

The University is the UK's leading business-facing university and an exemplar in the sector. It is innovative and enterprising and challenges individuals and organisations to excel. The University of Hertfordshire is one of the region's largest employers with over 2,300 staff and a turnover of almost £231 million. With a student community of over 27,700 including more than 2,900 international students from over eighty-five different countries, the University has a global network of over 170,000 alumni.

As the University was considering some significant investments in its data centre and ICT infrastructure, the IT manager at the University attended a training course on the EU Code of Conduct which outlined a strategy for energy efficiency. The IT manager then managed to convince his peers and colleagues within stakeholder departments that this was the correct roadmap for the university to follow. The results can be found at:

http://www.goodcampus.org/uploads/DOCS/111-Case_1_Herts_Data_Centre_v5.pdf

and http://www.sustainabilityexchange.ac.uk/files/steve_dc.pdf

Crown Commercial Services (UK)

The Crown Commercial Service (CCS) brings together policy, advice and direct buying; providing commercial services to the public sector and saving money for the taxpayer. They've brought policy, advice and direct buying together in a single organisation to:

- make savings for customers in both central government and the wider public sector
- achieve maximum value from every commercial relationship

- improve the quality of service delivery for common goods and services across government

They work with over 1,400 organisations in the public sector and our services are provided by more than 2,600 suppliers. They are responsible for:

- managing the procurement of common goods and services, so public sector organisations with similar needs achieve value by buying as a single customer
- improving supplier and contract management across government
- increasing savings for the taxpayer by centralising buying requirements for common goods and services and bringing together smaller projects
- leading on procurement policy on behalf of the UK government

GDS' Digital Marketplace (UK)

This marketplace, is the UK Government's intended primary vehicle for ICT procurement across the entire public sector in the UK, there are some 27,000 organisations that can use the framework to purchase SaaS, IaaS, PaaS and Specialist Cloud Solutions (such as EUCOC assistance).

Public sector organisations can use the Digital Marketplace to access services from 3 frameworks:

- the G-Cloud framework, which includes cloud technology and support (e.g. web hosting or IT health checks)
- the Digital Services framework, which includes specialists for work on specific digital projects (e.g. technical architects and user researchers)
- the Crown Hosting Data Centres framework, which provides access to physical data centre space for legacy systems

Zero Waste Scotland – Tender for 10 Scottish public sector bodies.

The Scottish public sector data hosting and data centre strategy sets the vision that Scotland's public sector data hosting will be cost-effective, carbon neutral and makes appropriate use of cloud technology, for the delivery of efficient and highly available Information and Communications Technology (ICT) services. It describes the principles on how organisations can meet the vision and provides guidance on how they can be consistently implemented. The decision roadmap for organisations when considering investment and change for the delivery or hosting of services to meet efficiencies and flexibilities requires organisations to fully understand the cost of their existing facilities and the services they deliver and possible options that may be available. This tender was launched with the request to provide a tool that will allow specific Scottish public sector bodies to calculate the TCO for data centre services with a view to considering the use of co-lo/Cloud services provided by external bodies. Since the tender's objectives closely match with part of the envisioned functionalities of the EURECA framework and tool, the project is currently establishing contact with both ZWS and the successful bidder to open dialogue.

4.4.3 Use of KPI's / Metrics

Using KPI's and metrics to ensure the solutions selected contribute to the targets and ambitions set proof to be a challenge for procurers all round, and it is no different for those participating in Public Sector procurement initiatives. In the context of EURECA, there are several additional contributing factors:

- ICT and data centre related technology is a complex and wildly diverse industry, particularly for non-experts;
- the concept of sustainability, where the topics of resource efficiency and 'environmentally sound' are based, is also a complex and wildly diverse expertise;
- resource efficiency, particularly in the context of 'environmentally sound' data centre products and services is a relative new and emerging area;
- Innovation driven procurement is for many involved a 'road less travelled' and each innovation driven procurement initiative is almost by definition something unfamiliar.

Research has shown that within (Public) procurement there is still a lack of awareness of reliable KPI's/metrics and how to effectively use them in procurement. This results in a hesitancy to move beyond what is already known.

Moreover, improvements and advanced insights on what is already known have often not yet found their way into procurement practices. For example: we have found there are several leading platforms in public procurement that give only PUE as a measurable KPI for data centres, but the associated values (e.g. < 1,5 being excellent) are outdated.

However, it is reaching the stage where more KPI's, metrics and other useful measurement standards are establishing themselves and a maturity growth is ongoing. This provides more opportunities to create a foothold that can be used for procurement initiatives.

Over the last few years there is also an increasing amount of attention for related topics such as sustainability, energy efficiency, smart city concepts, circular economy and innovation in general which has found their way to the Public Sector formulating strategic objectives, ambitions and policies to stimulate this. We are seeing an increase in procurement initiatives that are exploring these areas and are testing the waters in the use of related KPI's, metrics and other measurement methods. It must be noted however, that these strategic objectives, ambitions and policies do not always result in (correct) translation for correlating procurement targets.

We have found the following (relevant) KPI's and metrics used by procurement initiatives, particularly by those that can be considered the 'innovators and early adopters' of Rogers bell curve in 'adoption life-cycle':

- GHG emission calculations in terms of CO2 (or CO2eq) emissions
- CO2 savings: Percentage of savings in terms of CO2 (or CO2eq) emissions
- Energy savings / Energy consumption: Expressed in kWh / year
- PUE: Power Usage Effectiveness
- EUE: Energy Utilization Effectiveness

- CEF: Carbon Emission Factor
- ERF: Energy Reuse Factor
- GEC: Green Energy Coefficient
- REF: Renewable Energy use Factor
- WUE: Water Usage Effectiveness

Of the above mentioned, the GHG emissions calculations, CO2 savings, Energy savings/consumption, the PUE are most common and accepted.

In addition to the above, there are other performance based measurements used and applied for the purpose of Life-cycle assessments and Life-cycle costing. Although these individual measurements should not be referenced to as KPI's or metrics as stand-alone measurements (since in their individual context they give no information of 'performance'), they are considered to be highly valuable for assessments, cost-benefit analysis, ROI & business cases for evaluation purposes.

It is however the existing level of maturity and the targeted ambition level of the organisation using any KPI, metric or other combinations of measurements, and most importantly how they are used, that determines how effective their use is. For this purpose the EURECA consortium will need to further examine during the next stages of the project where and how the different measurements can be best applied in the EURECA framework and tool.

4.4.4 Use of Scenarios

Current procurement platforms and related tools offering support often do make distinctions between innovation targeted procurement and general procurement practices and provide support in the form of checklists, templates, case examples or an interactive forum. Many offer the opportunity to search a database of different resources through filtering possibilities on different categories such as sectors, themes and regions to narrow down the search. However, throughout the practices and accompanying tools none appear to make clear distinctions in procurement scenarios, i.e. the different kind of solution avenues of product or service that can be procured to address the actual organisational needs and ambitions.

From the perspective of the Public Sector, the procurement officer(s) responsible for procuring data centre related products or services are in most cases faced with a predetermined procurement scenario. In other words, it has already been decided what needs to be procured, be it a new build data centre / server room, an expansion of the infrastructure (additional equipment) or to outsource to a (Cloud) application environment etc.

This decision is most likely made by someone from ICT (management), based on the valid argument they are likely to have a higher level of expertise on the subject-matter. However, the decision is most often formulated by a best effort assessment that purely focused on what triggered that specific procurement desire. From the research and interviews the project has carried out it appears that in the majority of cases neither the ICT department nor the procurement department (is able to) perform(s) an evaluation exercise to verify whether this is indeed the best procurement scenario to select, by offsetting the needs assessment triggering the procurement desire against the existing ICT environment.

4.5 SWOT Analysis (T1.2)

This SWOT analysis was carried out for the purpose of identifying the (perceived) Strengths, Weaknesses, Opportunities and Threats related to current (Public Sector) procurement practices.

The SWOT analysis particularly focuses on those practices related to data centre products and services in combination with efforts towards resource efficiency, including the use of (industry or procurement) standards, frameworks, guidelines or KPI/metrics to do so (or if not, to identify possible barriers or weaknesses in the procurement practices that prevented this).

Figure 2 - SWOT Matrix

4.5.1 Methodology

SWOT usually consists of a two steps of analysis, which are conducted separately. The first step addresses the local (or internal) factors, which contains discussions of Strengths and Weaknesses as per the aims of the SWOT. The second step, in which external (or global) factors are analysed, contains the discussion of relevant Opportunities and Threats. Both steps are summarized in Figure 2.

Strengths and Weaknesses

The analysis of the internal factors was conducted based on a number of brainstorming and discussion sessions involving stakeholders from the data centre industry, interviews with Public Sector staff and representatives, and workshops and events. In addition, information from the survey conducted under Task 1.1 was also used. The analysis was also based on reviewing published Public Sector tenders for data centre products and services and comparing them to an "ideal".

Opportunities and Threats

The analysis of external factors opens the wider field of trends, development options and possibilities. Here it was especially important to take into account only such factors that were relevant for the topic of the SWOT. Data obtained from reviewing the activities of Standards development organisations. Example aspects considered included: Political, Economic, Social, Technological, Legal and Environmental.

Value of SWOT analysis

SWOT analysis is not a tool of strategy development by itself. However, the information reported in this document will feed into WP2 where the EURECA Framework and Tool are developed. Some of the ways this information can be used here are:

- Recognizing valuable practices to learn from and incorporate (Strengths + Opportunities)
- Avoiding risks that have been pointed out in current practices (Strengths + Threats)
- Potential to address identified current practice weak points (Weaknesses + Opportunities)
- Identifying potential pitfalls (Weaknesses + Threats)

4.5.2 SWOT Analysis Conclusions

Strengths: Conclusions

Table 2 - SWOT Strengths Conclusions

Strengths	Explanation	Rationale
Procurement policies mainly centres around ISO 14001	Broad "sustainability" goals of Public Sector do not clearly translate to actions relating to the data centre.	For example: interviewee stated that estates department focus on a great deal on other areas such as transport, recycling and buildings but mostly "miss" the data centre as an energy/carbon reduction "target".
Some referencing of best practices and KPI's although limited	Case studies highlighted by University of Hertfordshire show the value and beneficial impact of adopting best practices and KPI's correctly.	The case study can show others how much energy, carbon reduction and money can be saved.
Embryonic recognition of EU schemes for procurement - e.g. EU Code of Conduct	As above, policy docs e.g. Scottish Government, state the need for compliance, but it remains to be exploited.	Interviewee described this as a "tick box" exercise, but lack the knowledge to verify or question if compliance is actually met.
EU Directive 2014/24 on Public Procurement strengthens guidance for environmental aspects and scope for Eco-Innovation	The revised Directive makes it easier and stronger and requires to include environmental aspects into procurement. E.g. is it now possible to refer for products to specific standards, e.g. that they must have the German Blue Angel for DC, as one interviewee explained.	So far, this was not possible, but only the specific criteria could be listed, making it less efficient and much harder for evaluation/review.
The German self-commitment of federal bodies to annually report on ICT-related energy consumption and that the values of 2013 cannot be exceeded Germany-wide, despite of increasing demand.	DC developers and DC-service providers have to report the annual data for the products or services delivered to the respective public body; this is contractually fixed, as one interviewee reported.	DC developers and Dc service providers are forced to measure their own on-site energy consumption, including of energy reuse. These are important inventory data that will help EURECA to come to more accurate life-cycle wide environmental footprint results and hence allow for more reliable comparison of future DC /DC-service procurement

		calls via the EURECA tool that will build on life-cycle data.
German experience showed that consolidation of data centres achieved successful results in reducing overall energy consumption in public sector	This is most likely due to combining multiple smaller data centres that are no longer suitable locations into a larger more modern energy efficient facility where new efficient technologies and methodologies can be deployed together with better economies of scale and utilisation of energy.	a target was set for -40%, achievement by 2014 was -47% as reported in face to face interview.

Weaknesses: Conclusions

Table 3 - SWOT Weakness Conclusions

Weaknesses	Explanation	Rationale
Low awareness of relationship of best practices to KPI's and environmental performance	Although best practices provide a comprehensive overview of what should be done to make a data centre more energy efficient, specialist knowledge is needed to turn this into procurement actions and KPI benchmarks	A case was highlighted where an important KPI for measuring energy consumption was not specified in an outsourcing contract, which severely restricted the Public Sector organization's ability to address energy efficiency.
Reference models for innovative high performance energy solutions are generally missing from best practices	Innovative solutions such as liquid cooled devices, waste heat reuse and other innovative solutions are not covered extensively in standards/best practice guides	For example, surveys reported that waste heat reuse in public sector data centres had not yet been considered.
Little scope for verification of energy efficiency credentials	Service provider credentials on energy efficiency performance in not clearly governed	Feedback from workshop reported a general mistrust of sales proposals making energy savings claims
Energy efficiency metrics not clearly understood	KPI's such as PUE are often misunderstood as an efficiency metric or even as suitable for comparisons of different DCs	Feedback by several interviewees showed that public sector organisations could be missing large amounts of energy wastage by over –relying on the value of PUE
General failure to recognise a problem exists	Because of the technical and complex nature of data centres – and their role in enabling energy saving IT services, there appears a general lack of recognition of the need to address energy consumption of data centres.	Workshop feedback showed that participants remain convinced that a problem exists. At the same time analysis of some public sector tenders put a selection criteria weighting of only 10% against energy efficiency performance.

Maturity Model not aligned to EU best practices	The Green Grid Maturity model was originally designed to be aligned with European practice but this has slipped.	Options will need to be considered by the EURECA team to find a solution to address this.
No one "go to" person exists in most Public Sector organisations	There is wide ranging diversity in job titles, roles and areas of responsibility. For example the data centre or IT manager's role often does not include reducing energy or monitoring energy consumption.	Feedback from PS Show, workshops and interviews show that the responsibilities are distributed across multiple Public Sector Departments with differing objectives
Interpretation of "sustainable" and "green" varies across different sub-sectors of the Public Sector leading to different guidelines, and develop new insights quickly.	This makes it more difficult for vendors to provide the right answers to tenders, and more difficult for procurers to formulate the right requirements.	Example: recently, Netherlands based research institute HIVOS presented additional categories of 'green' power for data centres[3]. Insights how to become sustainable attention make things shift; long time focus of the (research) industry and goals was expressed in KWh (PUE), CO_2 reduction, emphasis nowadays is also on wastage of water, Green House Gasses, toxic wastes and life-cycle analysis and adds space for interpretation, discussion and complexity.
Little knowledge and awareness available in organization levels that could drive change to procurement (e.g. C-level)	In successful cases, the driver for change has come from an "enlightened" individual.	Evidence gathered on successful cases e.g. University of Hertfordshire showed that no clear directives or policy had been received from senior levels.
Procurement policies mainly centres around ISO 14001	Broad "sustainability" goals of Public Sector do not clearly translate to actions relating to the data centre.	For example: interviewee stated that estates department focus on a great deal on other areas such as transport, recycling and buildings but mostly "miss" the data centre as an energy/carbon reduction "target".

Opportunities: Conclusions

[3] 'Gebruik type energieproduct commerciele data centres inventarisatie 2015', Hivos, The Netherlands, 2015

Table 4 - SWOT Opportunities Conclusions

Opportunities	Explanation	Rationale
Existing EU Scheme for best practices	The scheme for energy efficiency is mature and widely recognised by industry	Although under-exploited by the public sector, many aspects of the scheme can help underpin the EURECA tool's impact and objectives
Many new standards, Commission developments, metrics and KPI's	Concentrated efforts at International and European standards bodies as well as FP7 research projects are either just releasing or will be releasing results during the timeline of the EURECA project. Provide exploitable content for EURECA. More important even, ongoing developments of Product Environmental Footprint guides by the European Commission, including for Data Centre relevant product groups such as UPS and HDD provide more specific guidance for efficient life-cycle modelling, as well as some useful data (e.g. BOM). The same applies to the preparatory studies on enterprise servers are just being concluded these months.	These results may provide additional exploitable content for EURECA.
The German self-commitment of federal bodies to annually report on ICT-related energy consumption and that the values of 2013 cannot be exceeded Germany-wide, despite of increasing demand. This item is already listed as "Strength", but is also an opportunity, in connect with the PEF and the German Blue Angel.	In view of the introduction of life-cycle based guides in Commission developments, particularly under the Product Environmental Footprint, but also further development of the German Blue Angel to include the computational performance at some point, it will be a small step to ask DC hardware and service providers to provide the limited amount of additional data that is needed to come to reasonably robust life-cycle wide environmental impact estimations on a regular basis of procurement.	The effort to collect and report electricity and energy reuse data - in relationship to the provided services - is a key part that is effectively working in practice in Germany. Using the reporting mechanism that is already implemented in Germany for this purpose, makes this an evolution, rather than a revolution.
Market for innovative solutions is wide ranging	The range of innovative products coming to market is substantial	As witnessed at Data Centre World 2015, the ingredients for innovation i.e. changes in standards (e.g. ASHREA) and strong growth has stimulated many innovative products and solutions
Maturity Model developed by Green Grid (updated 2015)	The maturity model specifies 5 levels, which are ideally suited for the objectives of EURECA	As reviewed as part of the framework this can be exploited to

		define improvement roadmaps for Public sector data centres
EU is facilitating projects and raising awareness it is also illustrating new governance and possible new regulation	is facilitating projects like PEDCA and EURECA provides opportunities for wholesale change of attitudes	N/A
A general pressure from society to improve the sustainability (e.g. president Obama's recent directives[4]), illustrated also by the consumers switch to organic foods[5,6].	Society is demanding more responsibility from industry to become more sustainable. The negative reactions to several environmental scandals may illustrate this. Governmental/Political powers are following.	There is more concern how to sustain a world where the population is growing and the resources are limited[7].
The data centre industry is organizing itself (e.g. DCA, Dutch Datacentre Association)	this will make it easier to address sustainability	EG Training and Certification schemes

Threats: Conclusions

Table 5 - SWOT Threats Conclusions

Threats	Explanation	Rationale
Under resourcing	Many Public Sector organisations are facing cuts in resourcing	Interviewee stated that finding an "enlightened" individual in either IT, FM/estates or Procurement is essential to driving change, gaining the time and resources of an individual may become more difficult
Technical complexity	The technical knowledge required to implement energy and environmentally efficient solutions may be a bottleneck	The scientific approaches and resource intensity needed to measure energy performance and environmental impact may impact ability to adopt
Limited environmental data provided by vendors	Not able or unwilling to collect, measure and communicate (transparency) data needed.	Potential investments needed to collect, measure and communicate data. Also a persistent (but sometimes unjustified) fear of disclosing (perceived) sensitive or IP related data.
Resistance to change, widely understood (or at least known) KPIs	The PUE is the single most well known KPI of the DC industry. However, it is not suitable for	During interviews and KS1 it was indicated that resisting attitudes within the group (involvement)

[4] https://www.whitehouse.gov/sustainability-challenge

[5] http://www.earthfuture.com/earth/Organic%20-%2010%20Reasons.pdf
[6] http://orgprints.org/28706/1/willer-schaack-2015-europe.pdf
[7] http://www.humansandnature.org/sustainability--well-being--and-economic-growth-article-116.php

	comparisons, has its value exclusively for the improvement of an existing DC, internally, still with some caveats and gaps. The threat is that given the several years of efforts across the DC industry - resulting in close to 100 more or less different KPI's/metrics most of which are labelled as not suitable for different reasons (see chapter Industry KPI/metrics)	during the procurement process had a negative or limiting impact on adoption of new aspects outside the 'known playing-field'.
The procurement associations nor the accountants have shown much interest in the data centre industry.	The perceived complexity and maybe even natural obscurity of data centres might be a reason.	Interviewing public organizations in the past indicates that the energy cost specifications of public organizations (research by Dr. D. Harryvan) - that accountants work for -, close to 'never' specify data centre energy costs (up to 50% of their energy use) in their quarterly/annual reports.
General idea that sustainability is expensive.	Also this misconception exists in the private sector also, lack of trusted information, e.g. case studies and awareness of the link with cost of energy is likely cause.	This remark is often made in dealing with customers. The first thought when hearing 'green', is that investments need to be made. There are also supporting stories that go viral on the internet[8], trying to discredit green investments.

[8] http://www.thecarconnection.com/tips-article/1010861_prius-versus-hummer-exploding-the-myth

4.6 GAP Analysis (T1.3)

A gap analysis is a method of assessing the differences in performance. It analyses whether requirements are being met and, if not, what steps should be taken to ensure they are met successfully. GAP refers to the space between "where we are" (the present state) and "where we want to be" (the target state). A gap analysis may also be referred to as a needs analysis, needs assessment or need-gap analysis. It is s a way to determine the next course of action.

4.6.1 Methodology

In essence all GAP analyses have the following methodology in common.

1. Identify the objectives
2. Identify current standings and, in doing so, the actual known and potential gaps
3. Create a plan for action to close the gaps
4. Execute the plan to close the gaps.

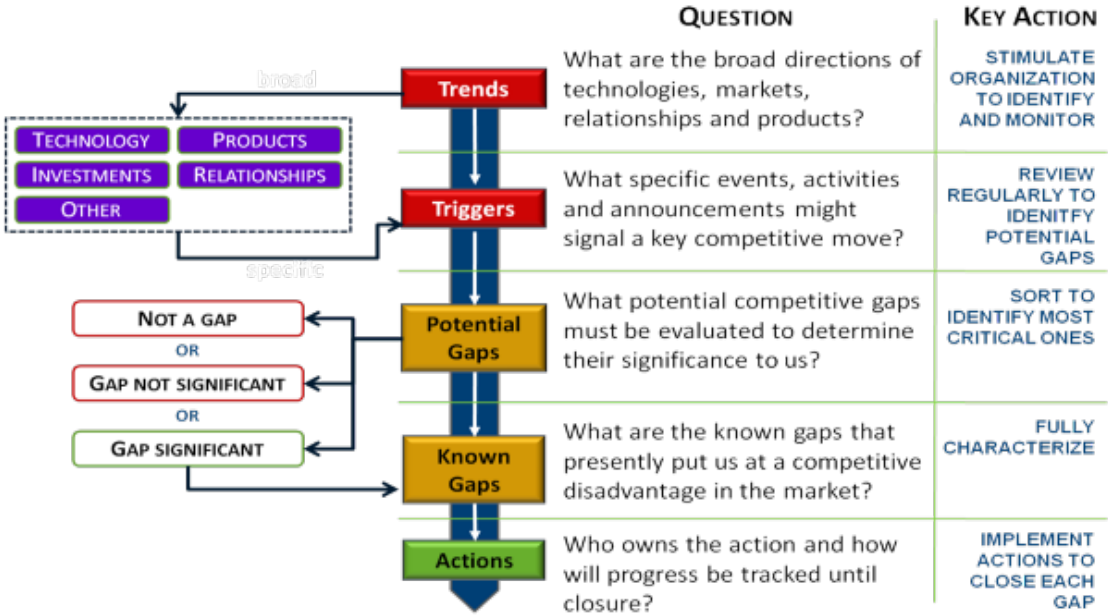

Figure 3 - 4 steps GAP Analysis methodology

4.6.2 GAP Analysis Conclusion

The gaps that may be addressed and are within the reach of a project like EURECA to start with, are mostly to be found in the W of the SWOT; the Weaknesses. Strengths should be even further strengthened, opportunities may be stimulated and threads may be softened but weaknesses are close-by, internal, and could be addressed first and most effectively. What the ideal situation will look like, and how EURECA could identify the distance from where we are now to that ideal situation, will offer us the gaps and the potential areas of improvement.

Between existing procurement and environmentally sound procurement vs current state of practice against the current best industry practice + where further advanced methods and indicators for environmentally sound data centres can be employed, highlighting the gaps and the potential areas of improvement.

Simultaneously, these gaps and bottlenecks provide the main opportunities to address and improve via procurement support via EURECA framework and tool.

Gaps and key bottlenecks:

- No or ineffective 'trickle down' translation from drivers and targets/ambitions on a strategic level to the right procurement criteria.
- Insufficient or ineffective dynamics in Group involvement for procurement to identify a public body's real need / requirements and/or providing the tools to be able to create an effective group involvement.
- Continued maturity growth regarding sustainability in relation to conventional economic and societal processes.
- High pace of new (technological) solutions becoming available on the market coupled with;
- Lack of sufficient understanding / awareness of DC industry best practices, standards, metrics etc., the importance of including data centres related aspects in procuring ICT services and how these relate to the public body's strategic drivers.
- Lack of an approach to bring the various metrics and data/information on DCs and DC services into a common framework, resulting in indicators that would allow comparisons of DCs and DC services based on her environmental performance, in life-cycle perspective.
- The lack of awareness within the decision making ("C-")levels of the necessity and impact it will make to procure data centre products and services in an environmentally sound way. Hesitance and/or insufficient confidence in understanding by the public sector (specifically those elements that influence procurement) on how to approach PCP and PPI well and how to relate this to conventional tender awarding processes.

This section also identifies both the needs but also the principle options to go beyond current best practice in procurement of environmentally sound DCs and DC services:

As to the metrics and KPIs in use: While in some cases relatively comprehensive data and KPI requirements have been established, such as in form of the German Blue Angel Type I Ecolabel for DCs, also this advanced label does not yet include two important elements: the computational performance of the DC (i.e. how much environmental impact and primary energy consumption it causes per provided data or computation service) AND the impacts and embedded energy of the production of the building and ICT hardware. These two elements are addressed so far only indirectly.

At the same time it needs to be argued that the computational performance is the only suitable basis for an effective environmental assessment - otherwise the environmental advantage of a DC is easily overcompensated by a lack of computational performance and in total the overall environmental impact and energy consumption will be even higher. Regarding the production of the building and ICT hardware, it has been shown that these contribute typically substantially and at least relevantly to the overall impacts and energy consumption. Hence, production cannot be neglected neither.

The principle options to consider these two items in procurement context are however given: the DCeP is a KPI that captures the "useful work" of the DC, i.e. can be considered to represent

the computational performance, and while it needs to be still better defined and its measurement made operational. Other approaches would relate to the overall amount of data stored in the DC and transmitted with the final user as functional unit of the DC and hence the relevant computational performance of the DC.

The production of the DC building and the hardware would need to draw on life-cycle data, which is also possible to an initially satisfying extent, given that data availability has largely increased in both quantity and quality (incl. better documentation) over the past 5 to 10 years. Efforts by the European Commission, among others on the Energy-related Products Directive and the Product Environmental Footprint (and preceding efforts such as the development of the ELCD database, jointly with EU industry), have substantially contributed to the situation. Particularly for buildings, industry-driven Environmental Product Declaration schemes have been crucial.

Still, in cases where for a given procurement situation, the available vendors do not have (yet) the necessary data/information available for a calculation of sufficiently accurate life-cycle wide impacts, working with the more qualitative conventional DC KPIs and metrics in combination with default values can act as a stand-in that allows to in most cases provide an approximated life-cycle wide impact result that is better suitable for comparisons of offers than the current indicators are. Such approximated results would complement best practices such as the Blue Angel for DCs but also the Maturity levels of DC's.

Bringing it together: Current best practice still lacks moreover a better integration of expertise at the public body into the work-flow towards a successful procurement. The lack of awareness and knowledge outside the direct ICT department makes it difficult to assess whether the request for procurement from within the organisation is the best fit choice.

This is an important reason of why alignment between the people with various (departmental) expertise on subjects related to technology, sustainability and other (organisational) drivers is difficult to establish. Such includes next to the procurement officer also the facility manager, which will be a key person for energy management during DC use. Several elements that may help improve this when brought together into the EURECA framework and tool are,

- the structuring of different (data centre products and services) technology into procurement scenarios;
- assessment of the current environment and organisational needs and ambitions; and
- relating metrics, data/information and selected KPIs as measurement and evaluation tools.

The interaction between these elements lies at the foundation of the to-be-developed EURECA framework and tool and the manner in which they will be integrated within EURECA will determine the extent to which EURECA can help facilitate and support the market transformation towards the procurement of more environmentally sound (data centre related) products and services by the Public Sector.

With current practices it is moreover difficult to assess if the procurement request/ wish matches the actual procurement need. Both ICT/DC and procurement officers can be helped by providing a tool/mechanism to assess the right match before initiating an actual procurement process or large scale tender. Integrating the use of procurement scenarios (structuring the different solution areas to give procurement direction) in such an assessment will contribute to guide procurement towards the best fit choice.

5 Summary conclusions in EURECA framework and tool context

5.1 Related to main EURECA functionalities

Below is an analysis summary of the set of practices in relation to the possible EURECA functionalities.

Stages addressed (PCP / PPI / RFI / RFP / ITT)

Many current practices for providing support aimed at the public sector via procurement platforms appear to either have a focus on PCP and PPI specifically or focus on general tender stages such as RFI, RFP and TTI. Of the latter, some do also provide some guideline information for embarking on PCP and PPI. The project consortium considers it to be of added value to be able to 'cater' to both the innovative procurement initiatives and the 'general' procurement initiatives that look for proven technology and services since efforts to increase and stimulate resource efficiency can be incorporated in both. By facilitating both kinds of procurement initiatives the EURECA framework and tool can act as a one-stop shop in this respect.

Benchmarking

Providing benchmark information is a crucial element when researching market developments. Many current practices for providing support aimed at the public sector via procurement platforms provide a database of (practical) case examples of tenders that can be used as a benchmark. These examples are often situational specific and as such provide good ideas of what 'has been done', but often provide little or no context of the specific or detailed needs, targets and standards used and associated with the case. If the EURECA framework and tool can provide such benchmark information of previous tenders it can help make insights more concrete for newly initiated tenders and market explorations.

Maturity Model Framework

There are several supporting procurement platforms that provide general information to improving energy / resource efficiency and provide references for using methods and measures that can potentially be used to measure improvements. During the project's research we have not come across procurement practices (guideline, framework or practical case studies) that provide a comprehensive maturity model framework that will allow an organisation to establish its current baseline, identify its potential improvement steps and help align / map these with the (procurement) needs indicated by the public sector body's organisation. In other words, integrating a Maturity Model (with a primary focus on resource efficient data centre products and services) with actions taken throughout a tender / procurement initiative, EURECA has the ability to become something that can be of continuous use for various stakeholders within the Public Sector bodies such as DC/ICT management, Procurement officers and general management. This is expected to be one of the more complex endeavours for the EURECA framework and tool and is likely to be undergoing its own levels of maturity as it is developed and continuously improved.

Cost / Benefit RFI Assessment

Initial thoughts within the project consortium have been that it would be of value for procurers to be able to make a general assessment of costs and benefits at a relative early stage (during the RFI stage) of the procurement process. As with many situations there is not always just 'one way to Rome', as they say. This would make it possible to compare either several solution avenues within a procurement scenario or possibly provide a cost-benefit comparison between differing procurement scenario options that may fit the Public Sector's underlying needs. In earlier stages it is quite possible that differing avenues or even differing procurement scenarios altogether seem viable options, but they may vary in other areas resulting in different cost-benefit results.

Roadmap / signposting

Roadmapping can help establish a (organisation wide) shared vision and an understanding of the key steps needed to realise that vision, presented in a way that is accessible where needed. So far, from the projects research activities it appears that the possibility of integrating roadmaps developed within organisations within procurement processes (and the frameworks, guidelines, tools etc. used) is either not done or limited to a strategic objective. In case of EURECA these roadmaps and related signposts need to be made available for the stakeholders involved with responsibilities (that can result) in procurement initiatives at any point in time, not just when something triggers a procurement request. For purpose of continuous improvement and staying relevant, it should be adjustable if the (functional or technical) needs or targets / ambitions within a public sector body changes. In addition, the perceived Self-Assessment and cost-benefit/RFI assessment may provide a summary of priority areas to address that the user may want to integrated (i.e. translate) into the roadmap signposting steps. If the EURECA framework and tool is able to facilitate this, it will provide significant benefits to the user.

Individual Assistance

In researching and evaluating the current procurement practices and the available supporting standards, frameworks and tools etc. the project team also looked at the forms in which (if any) personal assistance is offered. Depending on the type of practice this can be something as simple as a contact person/point or a platform support desk. The level of such assistance varies, of course, and during the course of the research it was difficult to assess per practice how significantly any offered personal assistance channel contributes to the success of procurement initiatives. For EURECA the concept of added Personal Assistance, next to the framework and tool, is aimed at the Public Sector Special Interest Group Community where it aims to facilitate 'twinning programmes'. The project team considers this to be of potential added value for procurers to engage with peers and share specific experiences on a more in-depth level than a case study report.

Market information

During the research activities of the project, we have come across multiple (online) platforms where the Public Sector and (DC/ICT) industry can 'meet'. For instance:

- Supply and Demand online marketplaces
- Multiple Public Sector and (DC/ICT) Industry events that cater for stakeholder groups on both ends.
- Procurement platforms also often provide 'news' sections and (other) resource databases that contain information on recent (industry) market developments.
- (Online) magazines that also cater for stakeholder groups on both ends.

Feedback from several stakeholders have indicated the importance of engaging with (DC/ICT) industry on market developments, particularly in the early stages of any procurement initiative and most specifically for those targeting PCP and PPI. The challenges in doing so is to decide in which form(s) to instigate this, how to move beyond the 'sales-pitch' and how to provide (DC/ICT) representatives with the right parameters in such early stages.

ROI & Business Case information

Traditionally ROI and Business Case information is focused on monetary return and is quite often calculated per the boundaries of each separate initiative. The underlying reasons for this are of course that these boundaries provide easier ways to calculate and to evaluate whether to return is worth the investment. Recent trends have shown that ROI and Business Case calculations are more and more including valuable benefits that are more difficult to translate into monetary values, such as social and natural capital (e.g. value of ecosystem services), 'externality' costs (e.g. GHG/CO2 emissions and other forms of pollution). In addition, there are developments in calculating ROI's and Business Cases in combination with other initiatives, i.e. adopting a 'cumulative' approach to ROI and Business Cases using increasingly comprehensive approaches of LCC and TCO, for example. This requires the integration of and collaboration with other areas of expertise and can be quite challenging. There is however a growing number of resources of standards, reports and guidelines to provide an increasing amount of support. The level in which the development of the EURECA framework and tool can assimilate the core practices associated with this, can provide significant value to both the Public Sector and the DC/ICT industry.

5.2 Related to relevant topics

Below is an analysis summary of the set of practices related to relevant topics for EURECA.

Energy efficiency

The topic of energy efficiency (and energy reduction and renewable energy) has enjoyed the most attention in recent years. This can be explained for the large part by the attention on Climate Change and the reduction targets for GHG emissions. Efforts on energy efficiency are still primarily triggered and driven by cost reduction targets, however, strategic objectives related to sustainability and CSR have gained. Those (DC/ICT) Industry KPI's that have been most accepted both Industry and Public (Procurement) by are focused on energy efficiency.

Other resources

In terms of resource efficiency, energy is not the only significant resource related to data centre products and services. More often water usage, most significantly drinking water, is receiving additional attention particularly in relation to cooling methods used. Material use, whether hazardous, toxic or not, is also gaining attention, now partially driven by the increasing attention to Circular Economy as a concept, as organisations are looking for ways to reduce their waste and investigate opportunities to reuse, recycle using LCA, LCC and TCO to gain more insights. Procurement initiatives in this area can most likely be considered to be part of PCP or PPI.

LCA, LCC and TCO

Underpinning to the other topics mentioned here, the level of detail and depth of LCA, LCC and TCO impacts the maturity in which the other topics are addressed. There are performance based measurements used and applied for the purpose of Life-cycle assessments and Life-cycle costing considered to be valuable for assessments, cost-benefit analysis, ROI & business cases etc. It is however the existing level of maturity of the organisation and level of depth the LCA and LCC's are applied, that determines how effective their use is.

Carbon Accounting / Integrated Reporting

Whether it is on a voluntary or mandatory bases, the increase in applying carbon accounting (and/or perform integrated reporting) has resulted, amongst other things, in an increasing awareness and understanding that 'sustainability' and other business drivers can go hand in hand, and quite often provide added benefits and complement each other. It is however, a long(er) term and sometimes steep learning curve and can require a mature level of group involvement (including with external parties) and understanding of the supply chain and environment the organisation operates in ('integrated thinking').

6 Benchmark recommended procurement scenarios approach

Benchmarking is the process of comparing a product, an organisation (or practice, projects, tools etc.) to those considered to be the best in industry from other products, organisations, etc. Dimensions typically measured are quality, time and cost. In the process of best practice benchmarking, management identifies the best in their industry, or in another industry where similar processes exist, and compares the results of those studied to one's own. In this way, it can be assessed how well the targeted element can perform and why it should (or might not) be successful.

6.1 EURECA context

In the context of EURECA the project researched and evaluated the practices from both (data centre and ICT) industry and the Public (procurement) Sector, supplemented by several additional practices outside these sectors the project has come across or were pointed out by stakeholders, in order to determine

- which elements of the initially envisioned framework and tool are indeed expected to successfully contribute to the project's goals and
- which (newly discovered or confirmed) aspects the project needs to take into account in the development of EURECA's framework and tool.

This allows the project to formulate the 'Benchmark recommended procurement scenarios approach' that will form the foundation on which the initial requirements and concept design for the project's WP2 will be based. Further analysis within WP1 on the procurement needs and ambitions within the industry and Public Sector, and the method to assess the potential (environmental and economic) impact of using the EURECA framework and tool will be used for further development and enhancement throughout the project. Understanding the current needs and ambitions coupled with the understanding of the effects of making new procurement choices and their impact on social, environmental, legal and economic aspects will lead to the development of cost/benefit data that would help create business cases and also baseline economic life-cycle data for WP5.

The practices that have been highlighted in previous chapters of this Deliverable have been earmarked by the project as particularly noteworthy. They are either leading practices in themselves or contain elements EURECA can learn from or build upon.

As a first look ahead to WP2 for the development of the EURECA framework and tool a first sketch is included below

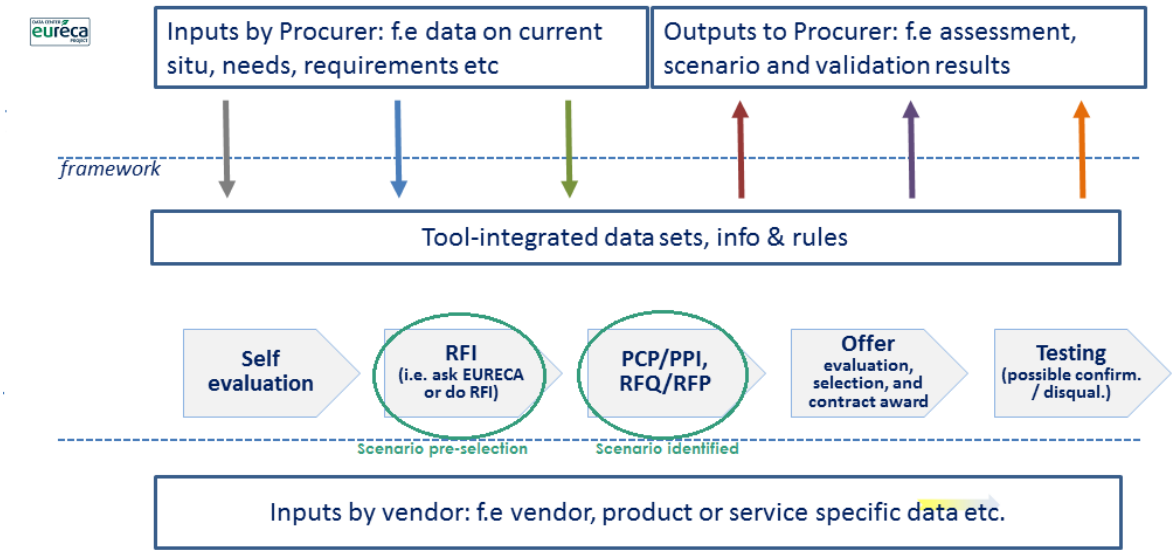

Figure 4 – First sketch towards framework and tool visual

6.2 Approach outline

To provide Public Sector organisations, that include people with varying subject matter expertise, with quantifiable information on the environmental impact of data centres and related procurement choices, a comprehensive and harmonized (set of) approach(es) is needed.

The overarching approach is to create a framework that allows Public Sector organisations to assess their current position regarding their existing ICT (and more specifically) their data centre environment and to set a target of where they want to go. From this the organisation can determine which procurement scenario is the best fit, what route to take and which available tools and methods can be used to get there.

This requires several (sub)approaches for which several related activities are needed. For these activities we have identified certain tools practices or functionalities that are required or considered highly useful. Table 6 provides an overview.

Please note that these '(sub) approach(es)' and 'activities' are not necessarily performed in the order structured below as there are many interactions and inter-dependencies between them. This table of approaches is therefore not meant to be used in and of itself as a step-by-step roadmap for each possible procurement scenario.

Table 6 - Approaches & Activities in procurement scenario selection

(sub) Approach(es)	Related Activities	Tools, practice or functionalities

Self-evaluation	• Determine the *current* maturity of both the procurement organisation and the ICT/DC environment • Identify and formulate objectives (from strategic targets and ambitions). • Select the *desired* maturity of both the procurement organisation and the ICT/DC environment.	• Key Performance Indicators and/or metrics relevant to organisational drivers. • Relevant Industry Standards, Guidelines and Frameworks • Maturity Framework • Maturity Assessment • Group Involvement
Scenario selection	• Determine / update the actual functional and technical needs of the organisation the ICT/DC environment needs to support. • Identify already registered or ongoing procurement requests and flag possible upcoming procurement triggers	• Key Performance Indicators and/or metrics relevant to organisational drivers. • Key Performance Indicators and/or metrics relevant to functional and technical performance. • Group Involvement • Needs assessment • Risk assessment • Translate / update business needs to technical requirements.
	• Establish an understanding of what the existing ICT / data centre environment can still offer • Offset functional & technical needs against potential of current environment. • Identify constraints and parameters (legal or otherwise)	• Group Involvement • Relevant Key Performance Indicators and/or metrics. • Scan to identify 'low-hanging' fruit and additional improvement opportunities.
Market Developments exploration	• Formulate a Request for Information that includes relevant objectives and possible specific targets and ambitions. • Research via industry development outlets and channels • Engage with industry players about (innovative) approaches to organisational or societal challenges • Engage with other Public Sector professionals to either identify fitting practical examples or joint ambitions.	• Group Involvement • (Cross) sector knowledge sharing initiatives • Internal knowledge sharing • Relevant Key Performance Indicators and/or metrics. • Relevant Industry Standards, Guidelines and Frameworks • Practical Case-studies • Needs assessment • Risk assessment • Business case & Cost-Benefit analysis
RFI/ RFQ / RFP/ ITT (also for PCP, PPI)	• Explore for Joint procurement opportunities • Formulate objectives and criteria and ask for contract formats that allow for mid-contract improvements, also consider constraints and parameters of such improvements, from both customer and supplier side.	• Engage fellow public sector professionals • Relevant Key Performance Indicators and/or metrics. • Product / Service performance assessments (that possibly includes a rating system) • Maturity Framework • Maturity Assessment

		• Recurring improvement evaluation
Intermediate route checks	• Verify initial objectives are still valid and adjust where necessary in collaboration with internal and external stakeholders • Verify initial criteria are still valid and adjust where necessary in collaboration with internal and external stakeholders	• Relevant Key Performance Indicators and/or metrics. • Relevant Industry Standards, Guidelines and Frameworks • Maturity Framework • Maturity Assessment • Group Involvement • Concept, use-case, demo and/or pilot testing
Training and Knowledge sharing	• Stimulate cross-expertise awareness • Communicate organisational objectives, targets and ambitions • Stimulate knowledge development for effective translation of organisational objectives (etc.) to procurement criteria.	• Relevant Key Performance Indicators and/or metrics. • Relevant Industry Standards, Guidelines and Frameworks • Subject-matter webinars • Group Involvement

The above table provides a basis to further work out the intricate details within this benchmark recommended approach which can then be used for the design of the processes within the EURECA framework and tool. Figure 5 can be seen as a high-level approach of steps in which the above (sub) approaches, related activities and tools / practices / functionalities are incorporated.

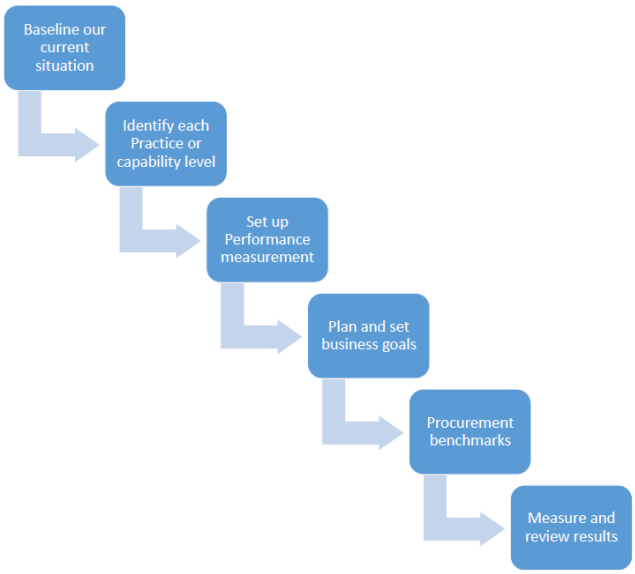

Figure 5 - First sketch EURECA processes design

7 Appendices

7.1 Annex 1 - Cataloguing & Evaluation Framework

Framework of researched and evaluated practices found during research activities. Due to its extensive nature and size this Annex is provided separately (D1.1. Annex 1 - Evaluation Framework v1.0).

7.2 Annex 2 - Directive 2014/24 Clause Analysis

EU Directive 2014/24/EU

Clause 40

Control of the observance of the environmental, social and labour law provisions should be performed at the relevant stages of the procurement procedure, when applying the general principles governing the choice of participants and the award of contracts, when applying the exclusion criteria and when applying the provisions concerning abnormally low tenders. The necessary verification for that purpose should be carried out in accordance with the relevant provisions of this Directive, in particular those governing means of proof and self-declarations.

Clause 41

Nothing in this Directive should prevent the imposition or enforcement of measures necessary to protect public policy, public morality, public security, health, human and animal life, the preservation of plant life or other environmental measures, in particular with a view to sustainable development, provided that those measures are in conformity with the TFEU.

Clause 43

For works contracts, such situations include works that are not standard buildings or where works includes design or innovative solutions. For services or supplies that require adaptation or design efforts, the use of a competitive procedure with negotiation or competitive dialogue is likely to be of value. Such adaptation or design efforts are particularly necessary in the case of complex purchases such as sophisticated products, intellectual services, for example some consultancy services, architectural services or engineering services, or major information and communications technology (ICT) projects. In those cases, negotiations may be necessary to guarantee that the supply or service in question corresponds to the needs of the contracting authority. In respect of off-the-shelf services or supplies that can be provided by many different operators on the market, the competitive procedure with negotiation and competitive dialogue should not be used.

Clause 47

Research and innovation, including eco-innovation and social innovation, are among the main drivers of future growth and have been put at the centre of the Europe 2020 strategy for smart, sustainable and inclusive growth. Public authorities should make the best strategic use of public procurement to spur innovation. Buying innovative products, works and services plays a key role in improving the efficiency and quality of public services while addressing major societal challenges. It contributes to achieving best value for public money as well as wider economic, environmental and societal benefits in terms of generating new ideas, translating them into innovative products and services and thus promoting sustainable economic growth.

It should be recalled that a series of procurement models have been outlined in the Commission Communication of 14 December 2007 entitled 'Pre-commercial Procurement: Driving innovation to ensure sustainable high quality public services in Europe', which deals with the procurement of those R&D services not falling within the scope of this Directive. Those models would continue to be available, but this Directive should also contribute to facilitating public procurement of innovation and help Member States in achieving the Innovation Union targets.

Clause 48

Because of the importance of innovation, contracting authorities should be encouraged to allow variants as often as possible. The attention of those authorities should consequently be drawn to the need to define the minimum requirements to be met by variants before indicating that variants may be submitted.

Clause 49

Where a need for the development of an innovative product or service or innovative works and the subsequent purchase of the resulting supplies, services or works cannot be met by solutions already available on the market, contracting authorities should have access to a specific procurement procedure in respect of contracts falling within the scope of this Directive. This specific procedure should allow contracting authorities to establish a long-term innovation partnership for the development and subsequent purchase of a new, innovative product, service or works provided that such innovative product or service or innovative works can be delivered to agreed performance levels and costs, without the need for a separate procurement procedure for the purchase. The innovation partnership should be based on the procedural rules that apply to the competitive procedure with negotiation and contracts should be awarded on the sole basis of the best price- quality ratio, which is most suitable for comparing tenders for innovative solutions. Whether in respect of very large projects or smaller innovative projects, the innovation partnership should be structured in such a way

that it can provide the necessary 'market-pull', incentivising the development of an innovative solution without foreclosing the market.

Contracting authorities should therefore not use innovation partnerships in such a way as to prevent, restrict or distort competition. In certain cases, setting up innovation partnerships with several partners could contribute to avoiding such effects.

Clause 60

The instrument of framework agreements has been widely used and is considered as an efficient procurement technique throughout Europe. It should therefore be maintained largely as it is. However, certain aspects need to be clarified, in particular that framework agreements should not be used by contracting authorities which are not identified in them. For that purpose, the contracting authorities that are parties to a specific framework agreement from the outset should be clearly indicated, either by name or by other means, such as a reference to a given category of contracting authorities within a clearly delimited geographical area, so that the contracting authorities concerned can be easily and unequivocally identified. Likewise, a framework agreement should not be open to entry of new economic operators once it has been concluded. This implies for instance that where a central purchasing body uses an overall register of the contracting authorities or categories thereof, such as the local authorities in a given geographical area, that are entitled to have recourse to framework agreements it concludes, that central purchasing body should do so in a way that makes it possible to verify not only the identity of the contracting authority concerned but also the date from which it acquires the right to have recourse to the framework agreement concluded by the central purchasing body as that date determines which specific framework agreements that contracting authority should be allowed to use.

Clause 61

The objective conditions for determining which of the economic operators' party to the framework agreement should perform a given task, such as supplies or services intended for use by natural persons, may, in the context of framework agreements setting out all the terms, include the needs or the choice of the natural persons concerned.

Contracting authorities should be given additional flexibility when procuring under framework agreements, which are concluded with more than one economic operator and which set out all the terms.

In such cases, contracting authorities should be allowed to obtain specific works, supplies or services, that are covered by the framework agreement, either by requiring them from one of the economic operators, determined in accordance with objective criteria and on the terms

already set out, or by awarding a specific contract for the works, supplies or services concerned following a mini-competition among the economic operators parties to the framework agreement. To ensure transparency and equal treatment, contracting authorities should indicate in the procurement documents for the framework agreement the objective criteria that will govern the choice between those two methods of performing the framework agreement. Such criteria could for instance relate to the quantity, value or characteristics of the works, supplies or services concerned, including the need for a higher degree of service or an increased security level, or to developments in price levels compared to a predetermined price index. Framework agreements should not be used improperly or in such a way as to prevent, restrict or distort competition. Contracting authorities should not be obliged pursuant to this Directive to procure works, supplies or services that are covered by a framework agreement, under that framework agreement. EN 28.3.2014 Official Journal of the European Union L 94/75.

Clause 95

It is of utmost importance to fully exploit the potential of public procurement to achieve the objectives of the Europe 2020 strategy for smart, sustainable and inclusive growth. In this context, it should be recalled that public procurement is crucial to driving innovation, which is of great importance for future growth in Europe. In view of the important differences between individual sectors and markets, it would however not be appropriate to set general mandatory requirements for environmental, social and innovation procurement.

The Union legislature has already set mandatory procurement requirements for obtaining specific goals in the sectors of road transport vehicles (Directive 2009/33/EC of the European Parliament and the Council (1)) and office equipment (Regulation (EC) No 106/2008 of the European Parliament and the Council (2)). In addition, the definition of common methodologies for life cycle costing has significantly advanced.

It therefore appears appropriate to continue on that path, leaving it to sector-specific legislation to set mandatory objectives and targets in function of the particular policies and conditions prevailing in the relevant sector and to promote the development and use of European approaches to life-cycle costing as a further underpinning for the use of public procurement in support of sustainable growth.

Section 2 Article 4 Thresholds

This Directive shall apply to procurements with a value net of value-added tax (VAT) estimated to be equal to or greater than the following thresholds:

(a) EUR 5 186 000 for public works contracts;

(b) EUR 134 000 for public supply and service contracts awarded by central government authorities and design contests organised by such authorities; where public supply contracts are awarded by contracting authorities operating in the field of defence, that threshold shall apply only to contracts concerning products covered by EU Directive Annex III;

(c) EUR 207 000 for public supply and service contracts awarded by sub-central contracting authorities and design contests organised by such authorities; that threshold shall also apply to public supply contracts awarded by central government authorities that operate in the field of defence, where those contracts involve products not covered by EU Directive Annex III;

(d) EUR 750 000 for public service contracts for social and other specific services listed in EU Directive Annex XIV

Section 2 Article 6

Revision of the thresholds and of the list of central government authorities

1. Every two years from 30 June 2013, the Commission shall verify that the thresholds set out in points (a), (b) and (c) of Article 4 correspond to the thresholds established in the World Trade Organisation Agreement on Government Procurement (GPA) and shall, where necessary, revise them in accordance with this Article.

In accordance with the calculation method set out in the GPA, the Commission shall calculate the value of these thresholds on the basis of the average daily value of the euro in terms of the special drawing rights (SDRs), over a period of 24 months terminating on 31 August preceding the revision with effect from 1 January. The value of the thresholds thus revised shall, where necessary, be rounded down to the nearest thousand euros so as to ensure that the thresholds in force provided for by the GPA, expressed in SDRs, are observed.

Article 8

Specific exclusions in the field of electronic communications

This Directive shall not apply to public contracts and design contests for the principal purpose of permitting the contracting authorities to provide or exploit public communications networks or to provide to the public one or more electronic communications services.

For the purposes of this Article, 'public communications network' and 'electronic communications service' shall have the same meaning as in Directive 2002/21/EC of the European Parliament and of the Council (1).

Article 31

Innovation partnership

1. In innovation partnerships, any economic operator may submit a request to participate in response to a contract notice by providing the information for qualitative selection that is requested by the contracting authority.

In the procurement documents, the contracting authority shall identify the need for an innovative product, service or works that cannot be met by purchasing products, services or works already available on the market. It shall indicate which elements of this description define the minimum requirements to be met by all tenders. The information provided shall be sufficiently precise to enable economic operators to identify the nature and scope of the required solution and decide whether to request to participate in the procedure.

The contracting authority may decide to set up the innovation partnership with one partner or with several partners conducting separate research and development activities.

The minimum time limit for receipt of requests to participate shall be 30 days from the date on which the contract notice is sent. Only those economic operators invited by the contracting authority following the assessment of the information provided may participate in the procedure. Contracting authorities may limit the number of suitable candidates to be invited to participate in the procedure in accordance with Article 65. The contracts shall be awarded on the sole basis of the award criterion of the best price-quality ratio in accordance with Article 67.

2. The innovation partnership shall aim at the development of an innovative product, service or works and the subsequent purchase of the resulting supplies, services or works, provided that they correspond to the performance levels and maximum costs agreed between the contracting authorities and the participants.

The innovation partnership shall be structured in successive phases following the sequence of steps in the research and innovation process, which may include the manufacturing of the products, the provision of the services or the completion of the works. The innovation partnership shall set intermediate targets to be attained by the partners and provide for payment of the remuneration in appropriate instalments.

Based on those targets, the contracting authority may decide after each phase to terminate the innovation partnership or, in the case of an innovation partnership with several partners, to reduce the number of partners by terminating individual contracts, provided that the contracting authority has indicated in the procurement documents those possibilities and the conditions for their use.

Article 62

Quality assurance standards and environmental management standards

1. Contracting authorities shall, where they require the production of certificates drawn up by independent bodies attesting that the economic operator complies with certain quality assurance standards, including on accessibility for disabled persons, refer to quality assurance systems based on the relevant European standards series certified by accredited bodies. They shall recognise equivalent certificates from bodies established in other Member States. They shall also accept other evidence of equivalent quality assurance measures where the economic operator concerned had no possibility of obtaining such certificates within the relevant time limits for reasons that are not attributable to that economic operator provided that the economic operator proves that the proposed quality assurance measures comply with the required quality assurance standards.

2. Where contracting authorities require the production of certificates drawn up by independent bodies attesting that the economic operator complies with certain environmental management systems or standards, they shall refer to the Eco- Management and Audit Scheme (EMAS) of the Union or to other environmental management systems as recognised in accordance with Article 45 of Regulation (EC) No 1221/2009 or other environmental management standards based on the relevant European or international standards by accredited bodies. They shall recognise equivalent certificates from bodies established in other Member States.

Where an economic operator had demonstrably no access to such certificates, or no possibility of obtaining them within the relevant time limits for reasons that are not attributable to that economic operator, the contracting authority shall also accept other evidence of environmental management measures, provided that the economic operator proves that these measures are equivalent to those required under the applicable environmental management system or standard.

3. Upon request, Member States shall make available to other Member States, in accordance with Article 86, any information relating to the documents produced as evidence of compliance with quality and environmental standards referred to in paragraphs 1 and 2.

Article 68

Life-cycle costing

1. Life-cycle costing shall to the extent relevant cover parts or all of the following costs over the life cycle of a product, service or works:

(a) costs, borne by the contracting authority or other users, such as:

- (i) costs relating to acquisition,
- (ii) costs of use, such as consumption of energy and other resources,
- (iii) maintenance costs,
- (iv) end of life costs, such as collection and recycling costs.

(b) costs imputed to environmental externalities linked to the product, service or works during its life cycle, provided their monetary value can be determined and verified; such costs may include the cost of emissions of greenhouse gases and of other pollutant emissions and other climate change mitigation costs.

2. Where contracting authorities assess the costs using a life- cycle costing approach, they shall indicate in the procurement documents the data to be provided by the tenderers and the method which the contracting authority will use to determine the life-cycle costs on the basis of those data. EN L 94/134 Official Journal of the European Union 28.3.20 The method used for the assessment of costs imputed to environmental externalities shall fulfil all of the following conditions:

(a) it is based on objectively verifiable and non-discriminatory criteria. In particular, where it has not been established for repeated or continuous application, it shall not unduly favour or disadvantage certain economic operators;

(b) it is accessible to all interested parties;

(c) the data required can be provided with reasonable effort by normally diligent economic operators, including economic operators from third countries party to the GPA or other international agreements by which the Union is bound.

3. Whenever a common method for the calculation of life- cycle costs has been made mandatory by a legislative act of the Union, that common method shall be applied for the assessment of life-cycle costs.

A list of such legislative acts, and where necessary the delegated acts supplementing them, is set out in EU Directive Annex XIII. The Commission shall be empowered to adopt delegated

acts in accordance with Article 87 concerning the update of that list, when an update of the list is necessary due to the adoption of new legislation making a common method mandatory or the repeal or modification of existing legal acts.

7.3 Annex 3 - Inventory Industry Metric, KPI's, and LCAI's

Industry metric/KPI's

The following table provides an overview of the main DC-related metrics and KPI's under discussion. A further evaluation in WP 2 will help to filter out the suitable candidates as fall-back options for the environmental performance evaluation, for all cases where the life cycle inventory data is not or only partly available.

Table 7 - Industry Metrics/KPI's

AEU	Air Economizer Utilization - The extent to which air-side economizer system is being used in one year of continuous load. Overall airflow efficiency in terms of the total fan power required per unit of airflow. This metric provides an overall measure of how efficiently air is moved through the data centre.
APC	Adaptability Power Curve: Provides an evaluation of the capability of a DC to adapt to a predefined DC energy consumption curve.
APCren	Adaptability Power Curve at Renewable Energies: Provides an evaluation of the capability of a data centre to adapt to the production curve of the renewable energy sources available to the data centre in hand.
Building Heat Loss	Total heat loss of a building hosting a data centre
CADE	Corporate Average Data Centre Efficiency - Overall energy efficiency of an organization's data centres (organization energy footprint)
Carbon Credit	The offset credits that are bought and sold to offset carbon dioxide emissions (similar to paying a fine for noncompliance). The price varies for every country and its regulations.
CEF	Carbon Emission Factor - The level of CO2 emissions for a data centre site
CER	Cooling Effectiveness Rate
CIUD	Carbon Intensity per Unit of Data - The carbon emissions related to data centre services activity of transporting data
CO2 savings	The percentage of savings in terms of CO2 emissions generated by a data centre, once improvements have taken place with regard to its energetic, economic, or environmental management. Note: GHG also calculated to CO2eq for carbon accounting.
COP	Coefficient of Performance of the Ensemble - The ratio of total heat load to the power consumed by the cooling infrastructure
CPE	Compute Power Efficiency - Indicator of the efficiency of a data centre. Usually not all electrical power delivered to the IT Equipment it is used by that equipment for useful work

CSE	Data Centre Cooling System Efficiency - The overall efficiency of the cooling system (including chillers, pumps, and cooling towers) in terms of energy input per unit of cooling output.
CSS	Cooling System Sizing - The installed cooling capacity efficiency.
CUE	Carbon Usage Effectiveness: Total carbon dioxide emission equivalents (CO2eq) from the energy consumption of the facility divided by the total IT energy consumption, for data centres with electricity as the only energy source this is mathematically equivalent to multiplying the PUE by the data centre's carbon emission factor (CEF). The units of the CUE metric are kilograms of carbon dioxide (kgCO2eq) per kilowatt-hour (kWh).
DCA	Data Centre Adapt: Provides an evaluation of the capability of a DC to change its energy consumption behaviour, compared to its respective behaviour before the application of a certain set of optimisation actions
DCcE	Data Centre Compute Efficiency - The efficiency of compute resources, which allows to identify areas of inefficiency.
DCeP	Data Centre energy Productivity - Overall work product of a data centre per unit of energy expended to produce this work
DCIE	Datacentre Infrastructure Efficiency: is the ration of Total ICT Equipment Power divided by Datacentre Facility Power
DCPD	Data Centre Power Density - Operating power density of a data centre
DH-UE	Deployed Hardware Utilization Efficiency - The power efficiency of operating servers and storage systems
DH-UR	Deployed Hardware Utilization Ratio - The power drained by the idle servers or amount of power waste
DPPE	Data centre Performance Per Energy
EES	Energy Expenses: A measure of how much the energy related expenses have changed in comparison to a baseline scenario, after having performed actions to upgrade the energetic, economic or environmental behaviour of a data centre.
Energy consumption	Expressed in kWh / year
Energy savings	Expressed in kWh / year
ERE	Energy Reuse Effectiveness - The energy efficiency in data centres that re-use waste energy from their own data centre. Or measures the (potential) benefit of reusing any recovered energy from the data centre.
ERF	Energy Reuse Factor: Portion of energy that is exported for reuse outside of the data centre. ERF is computed as reuse energy divided by total energy consumed by the data centre.

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 649972.

EUE	EUE, Energy Utilization Effectiveness, is a similar metric to the PUE, but there are some differences. EUE is based on (source) energy rather than power. It is calculated by dividing total source energy by total UPS energy (Total facility Energy consumption / Exchange equipment Energy consumption). It takes into account the source energy instead of site energy to be able to represent the variety of fuel types a facility can use. By including source energy it can also account for losses during transport of energy to the site.
FLOPS per Watt	FLOPS per watt is energy efficiency measure. Like the FLOPS (Floating Point Operations Per Second) it is based on, the metric is usually applied to scientific computing and simulations involving many floating point calculations. Expressed in no. of FLOWS, MFLOPS or GFLOPS per Watt of electricity used by a HPC.
GEC	Green Energy Coefficient: GEC is computed as the green energy consumed by the data centre (kWh) divided by total energy consumed by the data centre (kWh). For the purposes of GEC, Green energy is defined as any form of renewable energy for which the data centre owns the rights to the green energy certificate or renewable energy certificate, as defined by a local/regional authority.
GHG emission	Expressed in equivalent tons of carbon dioxide (CO2) = Tons CO2eq.
GPUE	Green Power Usage Effectiveness - Amount of CO2 to be emitted by DC use of dirty or clean energy
GUF	Grid Utilization Factor: Percentage of time that the local power generation does not cover the building demand, and thus how often energy must be supplied by the grid.
H-POM	IT Hardware Power Overhead Multiplier - How much of the power input to a data centre is wasted in power supply conversion losses or diverted to fans rather than making it to the useful computing components.
HVAC Effectiveness	Measures the overall efficiency potential for HVAC systems. A higher value of this metric means higher potential to reduce HVAC energy use.
ITEE	IT Equipment Efficiency - This metric consists of the quotient between the total rated capacity of work of IT equipment and the total rated power of IT equipment.
ITEU	IT Equipment Utilization (Server Utilization / Hardware Utilization / Network Utilization) - How efficient the server CPU, the storage and the network is used.
PAR4	Measures energy efficiency of data centres servers - The measurement is made at 100% CPU load, and the power draw is measured at the server plug

Performance per Watt	Measure of the energy efficiency of a particular computer architecture or computer hardware. Literally, it measures the rate of computation that can be delivered by a computer for every watt of power consumed.
Primary Energy Savings	PE Savings and CO2 avoided emissions: The percentage of savings in terms of primary energy consumed by a data centre, once improvements have taken place with regard to its energetic, economic, or environmental management
PUE	Power Usage Effectiveness: is the ratio of total amount of energy used by a computer data centre facility to the energy delivered to computing equipment.
RCI	Rack Cooling Index - How effectively equipment racks are cooled and maintained within industry thermal guidelines and standards. There are two RCI metrics for measuring the equipment room health at the high (HI) end and at the low (LO) end of the temperature range.
REF	Renewable Energy Use factor
RHD	Relative Humidity Difference - The difference of the return and supply air relative humidity in the data centre. Small relative humidity difference range suggests opportunities to reduce energy use.
RoGI	Return of Green Investment - The period of time in which the investments (money, human resources etc.) made in green solutions are recuperated
RWH	Reuse of Waste Heat
ScE	Server Compute Efficiency - Percentage of servers doing "useful work" meaning the servers having active primary services
SI-POM	Site Infrastructure Power Overhead Multiplier - Measures the energy efficiency of facilities components such as transformers, UPS systems, cooling etc.
SWaP	Space, Watts and Performance - Indicator for a server's overall efficiency
TCO	True cost of buying a particular product or service from a particular supplier, i.e. next to purchase cost, also the cost of operation and consumables, repair and maintenance up to any cost for end-of-life managing/disposal.
THD	Total harmonic distortion - Characterize the power quality of electric power systems. The higher the percentage, the more distortion is present on the mains signal.
TPS/Watt	Transactions per second per Watt - Efficiency in terms of work done over power consumption

UPS Load Factor	UPS system over-sizing and redundancy factor
UPS System Efficiency	Measures UPS efficiency
VM/server	No. of virtual servers per of physical servers
WEU	Water Economizer Utilization - The extent to which the water economizer system is being used in one year of continuous load.
WUE	Water Usage Effectiveness - The units of the WUE metric are litres per kilowatt-hour (kWh).

LCI data, main cost components

The following data/metrics below, are a draft list of the key input information required to perform a quantitative environmental performance estimation based on life cycle assessment as well as a life cycle costing and cost-benefit analysis. This work will be advanced in the dedicated work of WP 2.1.

Table 8 - LCAI - Life-cycle indicators

Net electricity consumption	Expressed in kWh/a. This should be calculated on a daily basis to determine peaks and troughs over the calendar year.
Electricity source	Either the specific provider (with the mix of energy sources being provided and EC-recognised certified green energy is identified), OR the country mix, AND/OR on-site generation if on-site. For on-site: fuel types and amounts consumed on net annual basis (consider on-site storage stock-changes), technology used for conversion. Optional: provide in addition an emission profile or standard met for on-site generation.
Cooling type share	Cooling technology type(s) with share (capacity). Optional: actual cooling share
Refrigerant consumption	Annual overall net refrigerant consumption (i.e. losses) per type of refrigerant expressed in kg or m3 per year.
m2 building	Expressed in m2 for total building. Optionally per area use: server room use, cooling use, office use, storage use, parking use, energy generation (re)use, other
Building height	In number of stories or m.
Construction type	Type. Optional: year of construction.
Estimated building lifespan	Expressed in no. of years as by design or intended lifespan
Building age	Expressed in no. of years since construction
Heat reuse for internal office heating	Expressed in kWh per year
Heat reuse for internal warm tap water	Expressed in kWh per year

Heat reuse for 3rd party heating	Expressed in kWh per year
Heat reuse for 3rd party warm tap water	Expressed in kWh per year
IT infrastructure components	Expressed in type, model, capacity, purchase year, and no.'s of each of the following: servers, switches, UPS.
Cooling method used	Indicator for efficiency and effectiveness of cooling method used when compared to other aspects of the DC facility
Nominal max power uptake servers	Expressed in kW for total no. of servers (control value).
SPECpower result	For the servers: Suite of tests that details power and performance in a single number. It takes an average of the workload tests and divides it by the average of watts used at each level. The resulting number is the final benchmark result.
Energy Star rating per server	Indicator for which and how many servers are certified for this label benchmark
Type I ecolabel per server OR DC	Indicator for which and how many servers are certified for this label benchmark. OR for the DC as a whole (German Blue Angel for DC; version of Blue Angel used).
Average lifetime per infrastructure component type	Expressed in no. of months/years between placement and removal per type of component, i.e. server, router, network cable, UPS etc. Based on actual replacement rate, or, for new facilities planned replacements rate.
End-of-life treatment	Indicated per shares going to landfill, incineration, material recycling, 2nd life reuse, expressed in kg per material or per type and model. For all quantitatively relevant contributions of IT equipment (particularly server, switches, UPS), building construction materials, packaging materials, office interior materials.
Amount of data storage	Expressed in TB total and per unique user per type of storage as linear average over the year.
Amount of data transferred to and from final user, and to and from other DCs (for backup, etc.)	Expressed in TB total or per unique user as linear average over the year.
End user requirements for availability	User defined but can be 24/7/365 or 99%, 99.9%, 99.99%, 99.999%, the last 3 roughly correspond to the Uptime Institute's Tier levels 2, 3, and 4.
End user requirements for security	User defined, and can be split into physical and cyber security, physical security would be perimeter fencing, security cameras, biometric access controls, turnstiles etc., preventing access the "white space" or data halls. Additional internal security measures

	would include card access to rooms, locked data cabinets and racks, and the removal of keyboards, mice and monitors. Cyber security would include firewalls, intrusion detection, cyber architecture, DMZ zones and other software designed to prevent unauthorised access. Usernames/Passwords and Security tokens are elements of an IT security infrastructure but outside of the EURECA project scope, but maybe required by the PS. There is an energy cost to the extent of security systems but it is negligible in terms of the cost of the Data Centre as a whole.
End user (functional) requirements	Varies
No. Employee/time	Expressed in FTE per year.
Energy price	Pence/cents per kWh, can vary depending on whether organisation has entered into a fixed price term agreement (this fixes kWh costs for a period normally 5 years. This can result in a massive increase when renegotiation of the cost occurs after the term ends
Water/ coolant price	Fixed Cost based on building OR variable cost if metered, options such as district heating schemes may reduce cost or provide an income if heat rejection is achieved via heat network