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1 EXECUTIVE SUMMARY

1.1 EURECA and the role of this deliverable

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 detail the EURECA framework and specification as basis for the subsequent development of the EUREA tool.

1.2 EURECA framework overview

On a general level, the EURECA framework is combining case-specific data and information (e.g. DCMM analysis and key characteristics during use of the current data centre) with market and other external data, a mapping to best practices (from the EUCoC) as well as common background data (e.g., the life cycle data) via dedicated combination and calculation rules (e.g., the DC knowledge system, the LCA and LCC calculation rules) to provide case-specific support to the public body, for comprehensive decision support for all relevant stages during procurement.

The initial step however sets on before any possible procurement would be triggered: a status quo analysis of the existing data centre / server room situation, to evaluate the maturity, the options for improvements and the potential savings, but via procurements and via other measures, such as better management of the existing installations.

By referencing available solutions on the market today (as evidenced in the EURECA products, services and providers directory), case studies, procurement examples and other supporting materials, the best possible and – importantly – context-specific support is provided to the public procurer.

Procurement of Innovation (PPI) and also Pre-Competitive Procurement (PCP) receive special attention, in line with the project call and the need to increase the uptake of such solutions in public bodies. Links and characterisations of the related innovation achievements of the various FP7 DC Cluster Projects, facilitate their use in upcoming procurements, and strengthen their legacy beyond those projects.

2 Introduction

2.1 Purpose of this document

This document is to detail the EURECA framework and specification. According to the DoW "*The framework will guide procurers in making economic and environmental cost/benefit analysis, decision making, and provide guidance on developing business cases, maturity and capability assessment, etc. in relation to procuring 'green' (i.e. energy-efficient and better environmentally performing) data centre products, services and buildings.*"

2.2 Objectives

The DoW (Description of Work, see the Definition of Terms in Section 3) specifies the following activities to be performed for this D2.1 within work package 2:

- To develop a comprehensive framework for procurers use in RFI and RFP, helping them to differentiate data centre and related offerings by their energy-efficiency and environmental performance
- Integrate quantitative environmental and costing life cycle information towards a cost/benefit analysis, considering among other the computational performance
- Make best practices from the EU Code of Conduct available jointly with a maturity and capability model to identify the status and for benchmarking.

This D2.1 will be implemented in WP2.2 and resulting in the EURECA tool D2.2.

2.3 Deliverable scope and structure

This deliverable and its annexes provide the concept, the logical flow, the calculation instructions, and the format specifications for the EURECA framework and its various components.

Chapter 4 presents the framework itself, i.e. how the EURECA components are interacting and how the information and data flow is foreseen from the start of a procurement intention all the way towards awarding contracts (for PPI and PCP including following up their implementation and verifying achievements) or towards implementing recommended measures, where a procurement is not taking place but the existing data centre / server room is improved by other measures.

Chapter 5 describes the Data Centre Maturity Model and the EU Code-of-Conduct of Best Practices components that are key to the status analysis of the data centre /server room and for making initial recommendations for technically suitable improvements.

Chapter 6 details how the procurements or changes in the data centre's consumption of electricity and water and amount of hardware under operation are transformed to life cycle wide savings of primary energy and a range of environmental impacts such as Climate change, Particulate emissions, Water depletion, and some others. It also specifies how the life cycle cost calculations will be done.

Chapter 7 describes and illustrates the Award criteria schemes for tenders, for all key data centre procurement scenarios, from single hardware to complete data services (e.g., hosting).

Chapter 8 characterises the rage of components in the EURECA Directory, such as Best practices, Standards and Guides, Products, Services and Vendors, Innovative solutions, Business cases, Legal aspects and Service Level Agreements, Terms and Acronyms, FAQs

Chapter 9 briefly sketches the foreseen structure of a special interest group (EURECA consortium) with a secretariat to maintain and update the EURECA framework and tool beyond the project duration.

A large set of comprehensive **Appendices** – referenced from the individual chapters and subchapters – provides the specific details of the Directory formats, data and other information used for the life cycle calculations and the award schemes, and others, including a brief introduction to Life Cycle Assessment.

3 Definition of Terms and Acronyms

1U is the height metric of rack servers

C3IT stands for the EURECA partner Carbon3IT Ltd

CBA stands for Cost Benefit Analysis

CG stands for the EURECA partner Certios B.V.

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

D2.1 means the Deliverable identified as number D2.1 within Work Package 2 of the EURECA project

D2.2 means the Deliverable identified as number D2.2within Work Package 2 of the EURECA project

D5.1 means the Deliverable identified as number D5.1 within Work Package 5 of the EURECA project

DC means data centre

DCMM means the data centre maturity model of The Green Grid.

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

EC means the European Commission

eLCC stands for environmental (or external) life cycle costing

Energy Usage Effectiveness = Annual Energy Consumption Data Centre [kWh] / Annual Energy Consumption IT-Equipment [kWh]

ETSI means European Telecommunications Standards Institute

EUCoC means European Code of Conduct for energy efficient data centres

EUE means Energy Usage Effectiveness

EURECA means the Data centre EURECA Project

Environmentally Sound stands for "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.

GITA stands for the EURECA partner Green IT Amsterdam

Green stands for: see 'Environmentally Sound'

GHG stands for Greenhouse 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

eLCC stands for (environmental) Life Cycle Costing

LCA stands for Life Cycle Assessment

maki stands for the EURECA partner maki Consulting GmbH

PCP stand for Pre-Commercial Procurement or Pre-Competitive Procurement

PPI stands for Public Procurement of Innovative solutions

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

PU means Public dissemination level

PUE means Power Usage Effectiveness, (Total facility Power [kW] / IT-Equipment Power [kW])

RFI stands for Request for Information

RFQ stands for Request for Quotation

RFT stands for Request for Tender (Invitation to tender, **ITT**)

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.

Task 2.1 stands for the first task as described in the EURECA project's DOW under WP2, consisting of comprehensive framework that can guide procurers in the process

of production of RFI's and RFP's, and help them differentiate data centre and related service offerings by their energy-efficiency and environmental performance.

Task 2.2 stands for the second task as described in the EURECA project's DOW under WP2, consisting of sound and robust software tool based on the requirements identified under Task 2.1.

Task 5.1 stands for the first task as described in the EURECA project's DOW under WP5

TCIT stands for the EURECA partner TeleCity

TCO stands for Total Cost of Ownership

UEL stands for the EURECA partner University of East London

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

Work Package 2 (or WP2) of the EURECA project covers 'Procurement framework and Tool'

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

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

4 EURECA Framework

4.1 Framework overview

The EURECA framework and specification is a core development of EURECA. In form of the online software that will implement it (D2.2), it will advise public procurers and DC experts in making better procurement decisions of SC products and data services, as well as implement improvement measures in their data centres and server rooms.

The EURECA framework comprises knowledge-system type components, directory-type components, data, calculation rules, as well as questionnaires and text templates, and others. They interact in specific ways to provide four main kinds of decision support in public procurement context, the first two of which are:

- Self-evaluation of the public body's current data centre situation and identification of the most recommendable options for improvement (chapter 4.5)
- Recommendations for exclusion and award criteria and other elements of procurement tenders of different types and for different procurement scenarios (chapter 4.6)

In combined way, the flow of these first two components can be depicted as shown in Figure 1.

The initial step is a "Basic check" that draws on and adjusts/expands the basic set of questions from the DCMM. E.g. asking for the size of the data centre, the PUE value and annual electricity consumptions, and few other elements. If there is key information missing or the result is that the data centre is very low performing, the advice will be to directly get a consultant or major training ("Get help / workshop", to the left in Figure 1). At that stage it simply would make no sense to make a detailed analysis.

If the basic check reveals already that the (small) size of the data centre /server room or existence of many disconnected sites or rooms directly points to go to the (government, private or public) cloud or to check for a data centre consolidation, that option will be recommended, leading to cloud procurement or consolidation experts information and contacts in the EURECA Directory ("Cloud/Consolidate", middle in Figure 1).

If the basic check shows a data centre with sufficient information and basic performance, so that a detailed analysis for improvement options is suitable, such is

then recommended, leading directly to the comprehensive self-evaluation interface along a EURECA-modified Data Centre Maturity Model (DCMM-based status quo analysis).

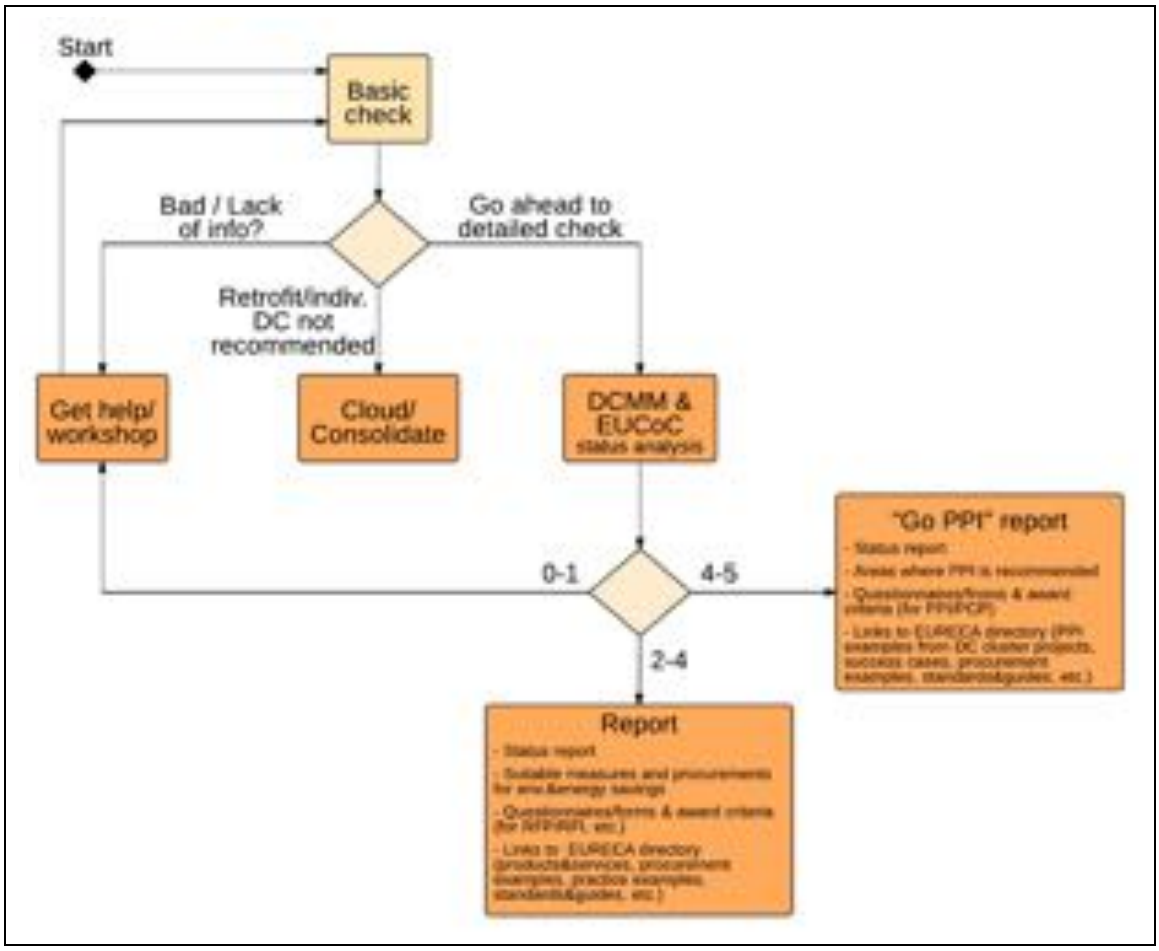

Figure 1 Flow of the first two and main components of the EURECA framework, i.e. the Status analysis based on DCMM, EUCoC best practices and additional questions, and the Procurement support with Award criteria and questionnaires/forms for procurement.

The DCMM is combined with the EU Code-of-Conduct (EUCoC) best practices, i.e. identifies principally suitable measures for each of the DCMM elements, i.e. what can be done to improve the situation.

Bringing in additional questions on technical, political or other restrictions, via the EURECA knowledge system, narrows down the choices. Initial estimates on the related potential of primary and environmental savings of the measures will help to prioritise the most promising ones.

However, also at this stage and depending on the maturity level of the analysed data centre or server room, three principally distinct options are identified:

If the data centre or server room now turns out to have a very low maturity level (0 – 1) it will again be recommended to "Get help /workshop" for a more thorough analysis, as likely a complete retrofit, new build or external cloud/hosting or co-location solution will be advisable.

Should the result show an interim maturity (2-4), a report will summarise the status, list suitable measures including procurements as well as quantify the related potential primary energy and environmental savings. Drawing on the EURECA Directory section on "procurement support", this report will also already contain the relevant award criteria sets for any listed procurement option and provide hyperlinks to the relevant subsections of the EURECA Directory, so the procurer can directly check on what the market offers, see relevant procurement examples, as well as standards & guides, and case study practice examples.

Should the analysed data centre show already a high maturity level (4 – 5), the report will again show status and options, but now focus on Procurement of Innovation (PPI) and Precompetitive Procurement (PCP), as this is where relevant improvement can be expected.

The subsequent, second set of decision support components, read in the questionnaires/forms received from tenderers and contractors, to support calculating award points and assess the performance of developments:

- Support in the tender evaluation, by transforming the information provided by the tenderers via the forms into the award points (chapter 4.7)
- Support to evaluating the test results of PCP and PPI developments in terms of environmental, energetic and cost performance (chapter 4.8)

Figure 2 shows in a simplified way the overall structure of the EURECA framework with the four decision support components:

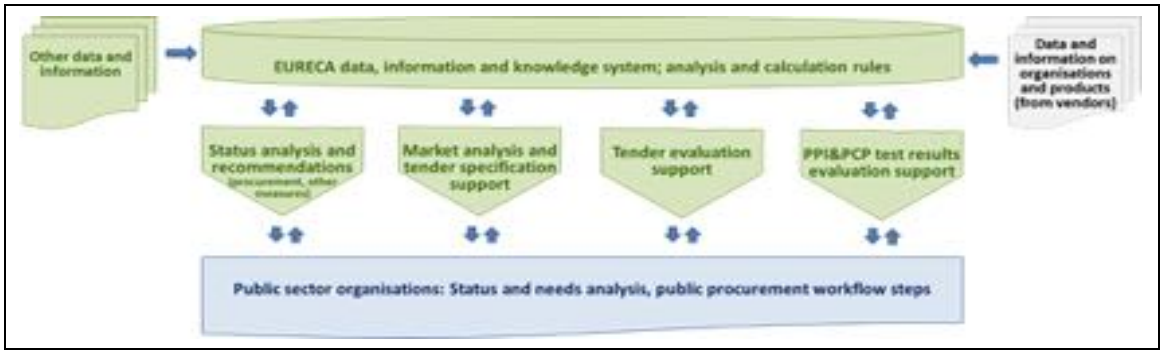

Figure 2 Schematic, simplified overview of the four decision support components that the EURECA framework (green) provides to public procurement of DC solutions (blue); in grey the direct input by third-parties into the EURECA directory via self-declaration is indicated.

4.2 High-level measures and procurement scenario outcomes of EURECA framework

In a nutshell, the following ones are the possible high-level outcomes of the EURECA framework, in addition to suggesting specific measures (such as increasing air inlet temperature etc.). Note that the Output "Hardware/equipment" is to be further differentiated along the detailed list provided in chapter 8.2.2, i.e. into "Servers", "Storage", UPS", etc., similarly for "Software optimization/virtualization".

Table 1 Possible high-level outcomes of the EURECA framework and main references to the EURECA Directory sections. Note that on micro-level, also individual measures of improvement are recommended as result of the DCMM and EUCoC best practices analysis.

Output	Output details	Connects to Directory entries on …
Retrofit	A generic retrofit of M&E Systems is advised, EURECA suggests to support your pre-planning via questionnaire/form documents for the relevant M&E elements	Appropriate questionnaire/form
Retrofit	A generic retrofit of M&E Systems is advised, EURECA suggests to support your pre-planning via a workshop. Please contact your nearest EURECA training partner	List of training partners
Retrofit	Since a generic retrofit of M&E Systems is requested, EURECA supports your pre-planning by giving you access to a database of potential suppliers	Service providers
New built	Since a new build project is requested, EURECA suggests to support your pre-planning via a workshop. Please contact your nearest EURECA training partner	List of training partners/DC consultants
New built	Since a new build project is requested, EURECA supports your pre-planning by giving you access to a database of potential suppliers	Service providers

Workshop	The level of information available does request a basic workshop completed upfront of any advice from the EURECA tool. Please contact your nearest EURECA training partner.	List of training partners
Public Cloud	Unless policies not mentioned here advise differently, EURECA suggests to consider using a public cloud solution for the public sector. EURECA supports your pre-planning by giving you access to a database of potential suppliers	Service providers
Private Cloud/Hosting	Since a private cloud/dedicated hosting solution is requested. EURECA supports your purchase process via questionnaire/form documents for the relevant elements of a private cloud/dedicated hosting solution.	Appropriate questionnaire/form
Private Cloud/Hosting	Unless policies not mentioned here advise differently, EURECA suggests to consider using either a private cloud solution or a dedicated hosting solution. EURECA supports your pre-planning by giving you access to a database of potential suppliers	Service providers
Colocation	Given the frame of policies and cost effectiveness described EURECA suggests to consider a colocation solution. EURECA supports your purchase process by giving you access to a database of potential suppliers	Service providers
Colocation	Since a colocation solution is requested. EURECA supports your purchase process via questionnaire/form documents for the relevant elements of a colocation solution.	Appropriate questionnaire/form
Hardware / Equipment	The energy efficiency of the Hardware used can be enhanced by consolidation/replacement of Hardware. EURECA suggests to support your pre-planning via questionnaire/form documents for purchase of hardware.	Appropriate questionnaire/form
Hardware / Equipment	The energy efficiency of the Hardware used can be enhanced by consolidation/replacement of Hardware. EURECA supports your purchase process by giving you access to a database of potential system integrators.	Products

Software Optimization/Virtualisation	The energy efficiency of the IT Infrastructure used can be enhanced by a basic reconfiguration/replacement of Software. EURECA supports your purchase process by giving you access to a database of potential system integrators.	Products
Software Optimization/Virtualisation	The energy efficiency of the IT Infrastructure used can be enhanced by a basic reconfiguration/replacement of Software. EURECA suggests to support your pre-planning via questionnaire/form documents for software optimization.	Appropriate questionnaire/form
Best Practices	The achieved level of energy efficiency can be enhanced by implementing several best practices. EURECA suggests an in-depth onsite check of the practices and procedures that should result in a generation of a list of best practices and an advise how upon their implementation. Pease contact your nearest EURECA training partner	List of training partners/consultant
PPI	Significant enhancement of the level of energy efficiency and environmental impact can be achieved via an innovation procurement solution. EURECA can support this by bringing together the relevant PPI parties, please contact your nearest EURECA training partner	List of training partners/consultant
PCP	Significant enhancement of the level of energy efficiency and environmental impact can be achieved via an PCP exercise. EURECA has collected a variety of PCP exercises/showcases that your exercise may benefit from.	Practice examples
PCP	If the PCP project call is above a few hundred thousand EUR, it is recommended to request the tenderer to foresee steering their development via Life Cycle Assessment in line with the Commissions ILCD Handbook.	Service providers

Moreover, for all of the cases listed in Table 1, internal hyperlinks will point to the suitable procurement examples, FAQs, and Terms & Acronyms in the EURECA Directory.

4.3 Detailed flow of EURECA framework and connection to the EURECA components

Figure 3 provides a more detailed overview of the EURECA framework, as well as its embedding into the main procurement steps for the main procurement types, ranging from conventional ITT (i.e. RFP and RFQ) to PPI and PCP. The corresponding chapter numbers are shown for each component in the figure.

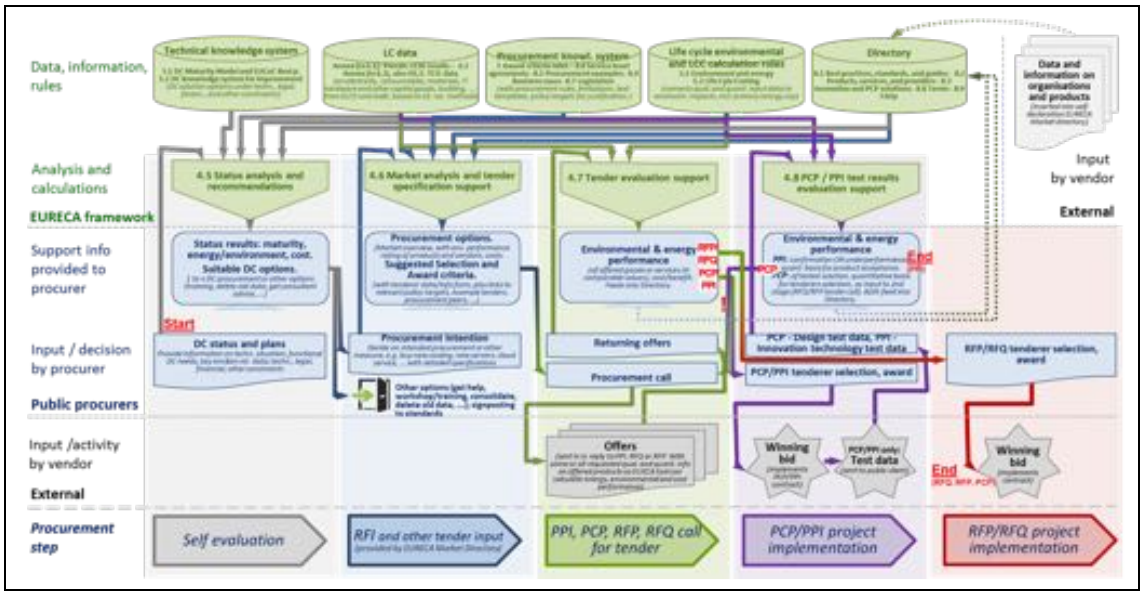

Figure 3 Overview of the EURECA framework, as well as its embedding into the main procurement steps. Details see preceding and following text. Some of the framework's components have a more complex inner working, which is graphically shown and described in the respective sub-chapters 4.1, as well as 4.5 to 4.8.

The above-mentioned four kinds of decision support are represented in the graphic from left to right by the grey, the blue and the green and purple shaded areas. The details of how these four kinds of decision support are provided are worked out in the dedicated sub-chapters 4.1 as well as 4.5, 4.6, 4.7, and 4.8, respectively. The other chapters of the report explain and specify (typically in annexes) the other framework components.

Procurement workflow

The workflow from procurement perspective in Figure 3 is from left to right, with "Start" in red indicating the initiation. "End" indicates where the final product/project is being delivered to the public body: Note that there are necessarily two "End", one for ITT / RFQ and RFP (as well as for PCP via the subsequent RFQ or RFP), at the right

bottom. And one for PPI upon acceptance or rejection, whether or not the test results of the installation of the innovative technology achieve the offered performance.

Depending on the procurement type, some steps may be skipped, e.g. if a standard RFQ or RFP procurement is recommended in the specific situation, the elements that are relevant exclusively for PCP and PPI (the purple area in the figure) are not applicable.

Particularly for PCP, please note the path back to the RFQ or RFP procurement step which should follow the PCP step (indicated with a red exclamation mark in the figure.)

Irrespective of the full workflow, it will of course also be possible for procurers to directly access the main components, particularly, the different Directory components, e.g. to browse or search and filter offerings per product group, etc.

Data and other content

Next to data and information that is specific for the public sector procurement and IT exerts that are using the EURECA framework or tool, a range of other data and information will be provided.

Parts of the data in the Directory will be compiled and inserted by the EURECA partners in the further course of the project. This will include the already compiled innovative technologies from the DC Cluster projects, the life cycle footprint background data, the procurement examples and business cases, as well as legislative and procurement support such as ward criteria sets, and so on.

Other data will be inserted by vendors on the market that want to offer their products and services to public procurers via the EURECA framework and tool (see top-right element in Figure 3).

4.4 Principles of the framework

The EURECA framework has been conceived following a set of high-level principles (i.e. Relevance, Easiness, Credibility, Robustness, Acceptance) that have been translated into more operational ones.

Relevance:

Relevance in context of the EURECA project aims means: Focus on public procurement, capturing the actual energy and environmental benefits without

shifting of burdens or weak proxies, market coverage, and focus on relevant primary energy and environmental impact contributions to DC products and services.

Focus on public procurement

An essential principle is to meet the needs and boundary conditions of public procurers, which are typically stronger bound to procurement rules, but also have a less high level of DC-specific expertise, both compared to private companies. To better meet the needs of public procurers, the available DC-related instruments, such as the DCMM and EUCoC are enhanced by public procurement specifics. For the specific procurement support in form of award criteria, the latest 2014 Procurement Directive (European Commission 2014) is fully observed.

Capturing the actual energy and environmental benefits without shifting of burdens

While in many other product categories, reliable labels and criteria sets are available to integrate energy and environmental criteria into procurement, for data centres and data centre-related products this is not the case (with few exceptions, such as the Blue Angel for data centres, in Germany).

On data centre level, the industry is widely using practically only one KPI, the Power Usage Effectiveness (PUE), which is however per design and intention unsuitable for comparisons across data centres and can also not capture the computational performance of the IT equipment. It is hence a very weak proxy to alone capture the data centre's energy and environmental performance (Wolf 2014; see also D1.2). At the same time, the PUE is a useful measure for improving a single data centres effective use of energy, i.e. for IT, not for cooling or as M&E energy losses. The PUE is hence used in EURECA for this purpose.

Ecodesign criteria under the Ecodesign Directive are under development for enterprise servers, although these will not allow to differentiate differently well-performing servers that are on the market, only to exclude the worst ones from the EU market. For UPS, HDD and batteries, type III label Product Environmental Footprint Category Rules are under development at the Commission, expected for end 2016/early 2017; these capture moreover all relevant environmental impacts, next to primary energy, and cover all relevant parts of the products' life cycles.

Moreover, in Germany a Type I Ecolabel (Blue Angel of data centres) has been developed and recently updated that captures many important aspects of DC products' and services' environmental performance.

These three developments will be core to build upon a life cycle based composite indicator of the different DC products and DC services' energy and environmental performance.

In view of the special focus of the project on PPI and PCP, such more explorative developments with less predefined ways to capture the performance of the products or other measures need a somewhat more flexible approach, while also here the core will be to capture the net changes in data centres overall capital goods and operational energy use and transform this information into the mentioned life cycle based composite indicators.

Market coverage

We consider the EURECA market directory to be one core component and very valuable support to public procurers that essentially can replace the RFI step in procurement, as it provides a well-structured overview of the market offerings, for all relevant DC service and product types. That is, if for each of these it provides a sufficiently broad and "complete" overview of the market. Special attention is hence placed on making the market directory attractive to vendors to insert information about their offerings. Experience from similar platforms will be employed to this end.

Focus on relevant primary energy and environmental impact contributions to DC products and services

While a data centre is composed of thousands of products, the main innovation towards more energy and environmentally efficient data centres lays not in the "nuts and bolts", but in the main IT and M&E components, as well as their integration and operation. We will therefore focus the guidance on these main components, namely servers, storage, UPS, cooling, etc. and their energy efficiency and environmental performance, as well as the building itself as largest capital good. Moreover, will the electricity mixes and sources for operating the data centre receive special attention, to be able to appropriately capture a shift to more renewable energy (while observing that not all renewable energy carriers are equally beneficial for the environment). Finally, the data transmission network will be considered, as it is both a relevant contributor and a principle difference between in-house server rooms and any externally located data service.

Easiness:

Easiness means that it has to be easy to use for three groups of actors: firstly, procurers, secondly providers, and thirdly those that are to maintain and update the

framework and tool. This principle has been translated into the practical principles "Modularity of components", "Flexibility", "Maintainability".

Modularity of components

The different components behind this framework will also be available a single component for flexible, targeted use. E.g., the market directory to obtain an overview of the market and its products and services and their technical, environmental and energy performance as well as Total Cost of Ownership, eliminating or reducing the need for an RFI.

Flexibility

Flexibility is a further key characteristic required here: data centres are highly complex products and decisions on changes have to consider all kinds of specific aspects of technical, organisational, strategic, financial and legal nature, as well as timing. This means that the DC knowledge system that brings the DCMM into procurement context in principle can never capture all these aspects and can hence "only" help to get the right information and data in a structured way and filter down the most promising options from the EUCoC Best practices. It cannot, however, replace specialist consultant services, at least not in complex decision support situations.

This means that there are two flexibilities built into the framework: one that allows the procurer or public DC specialist to options and aspects from the analysis. Secondly, the system will always point out where a consultant should be involved to work out the details e.g. of a PPI or PCP call or to help detailing the technical specifications of a RFQ or RFP tender, that is, unless off-the shelf single components will be procured (e.g. replacement servers).

Maintainability

Since the data centre industry and the technologies are rapidly further developing, special attention was put on updatability and expandability of the framework. This is reflected in a strict separation of the "containers" of the framework's components and the actual content. For example, does the framework specify the information that is requested from vendors that want to insert their offerings into the market directory. The actual content is filled in separately into these containers and can always be updated or removed. Another example are the internal references to the market directory entries; these will not directly point to an entry, but to all entries of a certain set of characteristics, e.g. to all hardware providers that provide 2U servers, i.e. via filters. These referenced sets of criteria are specified as part of the framework,

and any update of e.g., the DCMM that is anticipated for mid-2016, can then equally receive a new set of criteria sets, e.g., via DSL, while such software-specifics will be worked out in D2.2. Important is that the specification has the right level of being generic and modular to ease such software-based measures for better updatability.

Credibility and Robustness:

Credibility and robustness means that public sector organisations can rely on the results and recommendations and that manipulation and "engineering" of results is sufficiently avoided. An example of "engineering" is to optimise products to perform well in tests, while they are less good under real use conditions. This is reflected in the EURECA framework by using the SPEC CPU or SPEC SERT benchmark for server performance, rather than the SPEC_ssj_power (SPECpower Committee 2012, SPECpower Committee 2015).

The high-level principles of Credibility and Robustness have been translated into the following operational principles: Building on European Commission guidance and harmonised standards wherever available, avoiding subjectivity in the market directory and ensuring vendor neutrality, personal data protection, and solving potential legal responsibility issues.

Building on European Commission guidance and harmonised standards

Building on the standards and guides that were compiled and classified/characterised in D1.1 and giving preference to any harmonised standard and Commission-led guides is argued to be a good and necessary prerequisite for credibility of the EURECA framework. Next to the already mentioned Ecodesign Directive, and the Product Environmental Footprint, the EC-led EUCoC, and other developments such as the ILCD and ELCD, and European Harmonized Standards will be used in preference. Where however only relevant international standards and guides are available, e.g. for server performance via the SPEC, or the Green Grid Maturity Model (DCMM), such are integrated as suitable.

Vendor neutrality, personal data, legal responsibility

Several aspects are important in respect to third-party data insertion: vendor-neutrality is to be ensured as well as misuse for unfounded marketing claims and the legal responsibility for entries has to rest outside the Commission and the EURECA consortium. This will use the same mechanism that has been used for the "LCA Resources Directory" for third-party offerings of LCA services, data and tools on the Commission's JRC website: The data and information that can be provided for each offering is highly pre-structured, does not contain any personal data, and after

registration - that is open to any vendor and free of charge - the vendor is directly technically responsible and legally tangible for maintaining its entries up to date and accurate. The named LCA Resources Directory, that has been specified and coordinated by a EURECA partner staff, is now online for close to 10 years and worldwide widely used, up-to-date online-directory in this domain. A few learnings from that experience will be used to improve the EURECA directory (e.g. deleting entries after automatically sent update/confirmation requests stay unanswered for a certain period of time).

Acceptance:

The last of the high-level principles is "Acceptance". In practice however, the acceptance will largely be determined by meeting the other principles of relevance, easiness, credibility and robustness.

4.5 Framework component 1: Status analysis and recommendations

The first step before any potential procurement process and also in the EURECA framework is the analysis of the status quo. In case of data centre related decisions, this is the status of how the current data needs are being served. This was already sketched in chapter 4.1, here below further details are provided:

4.5.1 Basic questions

As shown already in the overview graphic in Figure 1, the more detailed status analysis is preceded by a more basic one. This one comprises the following questions:

1. Data centre name
2. What country is your data centre located
3. Building classification (list of mixed and pure DC uses)
4. What type of data centre is your site (list of types such as Database transactions, Infrastructure support, Directory/Email services, mixed)
5. What vertical sector is your data centre in (list such as public admin, hospital, educational institution, …)
6. What is the class of your data centre (1 to 4)
7. What is the age of your data centre (built or last major refurbishment, in years)
8. Size total and IT space (m^2 and m^2)

9. How many unconnected server rooms or data centres do you have (1 … many)
10. Annual average PUE
11. Annual total and IT electricity consumption (kWh)
12. Current measured UPS output (% of usable UPS draw, IT load only)
13. Number of Servers (expressed in U for rack servers, number of blades for blade servers)
14. Age of Servers
15. Do you use water for cooling/chilling, if so how much (m^3)

The answers to these basic questions will determine the next step – "Get help / workshop", "Cloud or Consolidation", or "Detailed DCMM analysis".

The former two possible outcomes will directly refer to the respective service and product sections of the EURECA Directory. The last one, the detailed DCMM analysis, will provide to what is detailed in chapter 5, i.e. a thorough analysis of the Status of the Data Centre or Server room.

4.5.2 Detailed analysis - DCMM and EUCoC best practices

The output of the DCMM analysis again can lead to three possible next steps:

1) If the maturity level is low (0-1), it will be recommended to get advice or a workshop/training to work out a detailed retrofit or a new built solution.
2) If the maturity is intermediate (2-4), a report will be generated and provide the public body with all necessary information and references e.g., to best practices, procurement examples and the respective sections in the EURECA products and services Directory to decide about the most suitable way forward. Hence a situation-specific list of EUCoC derived measures and procurement scenarios will be provided that are technically, legally, and economically feasible and environmentally recommendable, and the to-be-expected energetic, environmental and cost benefit will be estimated. These results will help procurement officers and decision makers at the public body to decide on the principal way forward, which can range from M&E retrofit to hosting or colocation, training of in-house data centre staff and other measures and procurements – suitable for the given case. Once the public body has decided on the actually preferred way forward (which may e.g. select or combine from the EURECA recommendations), the next step will be the second decision support component of EURECA, the "Market analysis and tender specification support" (see chapter 4.6)

3) If the maturity is high (4-5), major gains will come with procurement of innovative solutions, hence PPI or PCP will be recommended, with the report being tailored to the specific area where PPI or PCP is recommended (e.g. cooling). Also in this case, the next step is the second decision support component of EURECA, the "Market analysis and tender specification support".

4.5.3 How triggers and drivers influence decision making on what to do for improving a data centre

Taking one step back, it is important to understand that this status analysis, respectively the intention for procurement or other improvement measures, will be triggered at the public sector organisation by a range of different elements, the most frequent ones listed here below:

- **Scalability**, i.e. the need for more processing or more storage
- **End of life**, i.e. the upcoming end of useful life of relevant equipment (e.g. servers, batteries of UPS, …)
- **External compliance and/or internal policy drivers**, e.g. fading out of certain coolants, the organisation's carbon reduction targets, DC energy saving targets on national level
- **Restructuring plans**, e.g. the consolidation of several separate server rooms across the organisation or cooperating entities (e.g. local administrations of a region) into one data centre
- **Innovation interests**, e.g. to showcase leadership, to promote innovation, or to take the next step in environmental performant DC services for the citizen

Often, there will be not the single one element that matters, but several of these will at least influence the focus of the analysis. For example, where the hardware may be outdated and not able to anymore meet the demand, energy costs or environmental considerations and related national or organisational targets would be considered, beyond the purely technical need.

In addition, other legal, political, strategic, and economic aspects will influence the later course of measures. For example, if data must be kept within the country, a public cloud is not a solution. Or, if the available budget for investment is very limited, it might be more likely to purchase a data hosting service or to implement a more limited retrofit of the existing own facilities, instead of a new built.

These elements and aspects and their relevance will hence determine the ambition of the measures to be taken later on, but always in view of the results of the self-analysis. This means particularly that the improvement measures or procurements that the DCMM and EUCoC identifies as technically advisable and environmentally preferable, may not be fully suitable for the specific situation and drivers of the public body. This insight also leads to separating the "Market analysis and tender specification support" as a distinct component from the "Status analysis and recommendations": the public procurer will decide about the way forward and needs then subsequently dedicated advice on the chosen way.

4.5.4 Better support to procurers by filtering recommendations through questions on constraints and life cycle benefit calculations

These insights translate into the high-level layout of this first component of the EURECA framework, the "Status analysis and recommendations":

- First step of this component is a self-analysis of the different parts of the own data centre(s) or server room(s) or other existing solution (e.g. co-location). This will use as core instrument an up-to-date data centre maturity model built on the Green Grid DCMM with the more recent EUCoC guidance. This status-quo technical analysis will be complemented by asking for the public body's ambition levels for each of the data centre elements. Details of this component are found in chapter 5.1.
- This will be enhanced by a set of additional questions on relevant legal, strategic, economic and other aspects that bring the DCMM closer to a procurement context and adds information that will allow, as sketched above, to filter down the otherwise recommendable options to those that respect the named political, economic and other constraints. Details of this component are found in chapter 5.2.
- As third element and to allow prioritising the economically and environmentally as well as energetically most beneficial potential measures, life cycle costing information and life cycle assessment data will be "injected" into the analysis. These will draw on data and information provided in the market directory, to have a first "reality-check" of which levels of energetic and environmental performance the market can currently provide. Next to existing solutions, procurement of innovative solutions will be motivated to the possible degree as

well as pre competitive procurement options. The latter will draw on insights from other DC Cluster projects and insights into the limitations that conventional procurement can have. Details of this component are found in chapters 6.1 and 6.2.

Figure 4 provides a schematic view on the "Status analysis and recommendations" component.

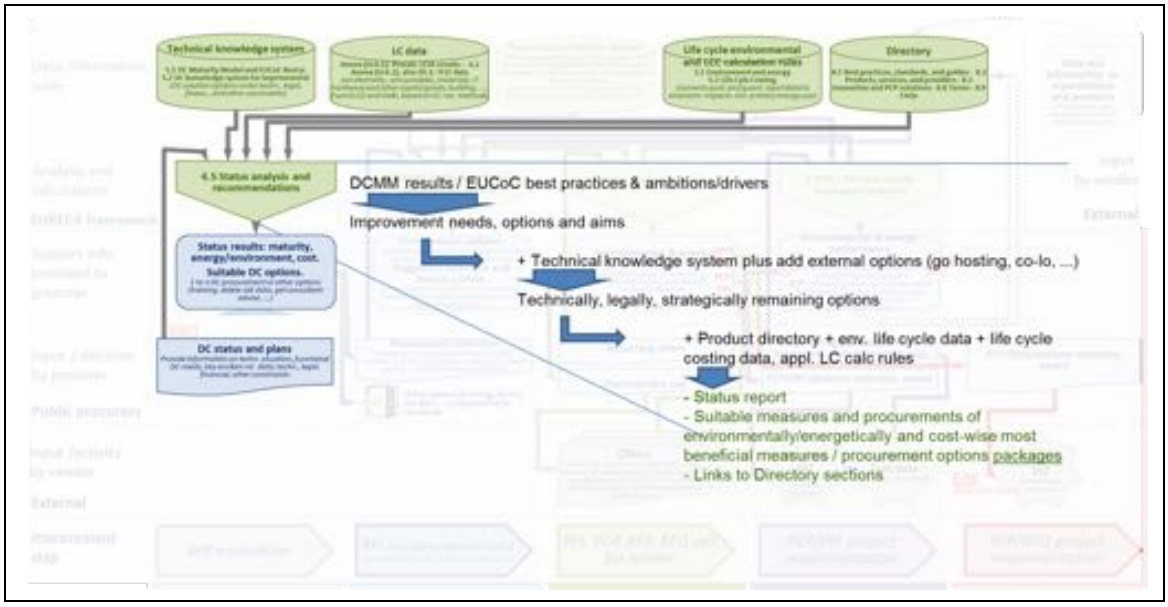

Figure 4 "Status analysis and recommendations" component of the EURECA framework, leading to the environmentally/energetically and cost-wise most beneficial measures / procurement options (green font on bottom), plus feeding back information to the directory.

4.5.5 Further aspects considered for the "Status analysis and recommendations" component, and the report

The following aspects have been considered in the exact design of the rules:

- Ambitions in DCMM is set by public body, determines relevance (lower level and/or higher ambition and/or higher to-be-expected energy and environmental savings result in higher priority)
- User can select options that were removed by EURECA analysis and de-select those selected by EURECA
- Less certain options and the need to get specific expert/consultant advice are listed

- Results are often packages (e.g. combination of several technical measures and procurement of hardware for in-house server-room).
- If the number of recommendations is very high, a whole retrofit or new-built or procuring data services will be advised.
- Results of self-evaluation based recommended measures / procurements are presented with a summary on the selection/exclusion logic:
    - Current DCMM level and ambition (future level)
    - Knowledge system based exclusions – for excluded options only
    - Quantitative results of estimated potential net environmental and energy savings per year in life cycle perspective
    - Key economic figures (i.e. costs for investment total and annualised, operation, EoL)

Note: environmental/energy and cost data are given either as absolute figures for each option, OR as net data compared to "no action" and/or to baseline solution (which they can select).

Figure 5 and Figure 6 illustrate the filtering down of options and the reports provided at the end of the process:

Figure 5 DCMM (columns) plus EUCoC best practice recommendations (stars) results, stepwise filtered out from top to bottom by using additional questions and analysis of the achievable environmental and energetic savings (white-out, and the EUCoC best practices removed), towards a set of remaining measures and procurement options (on bottom, blue) that are recommended for further consideration.

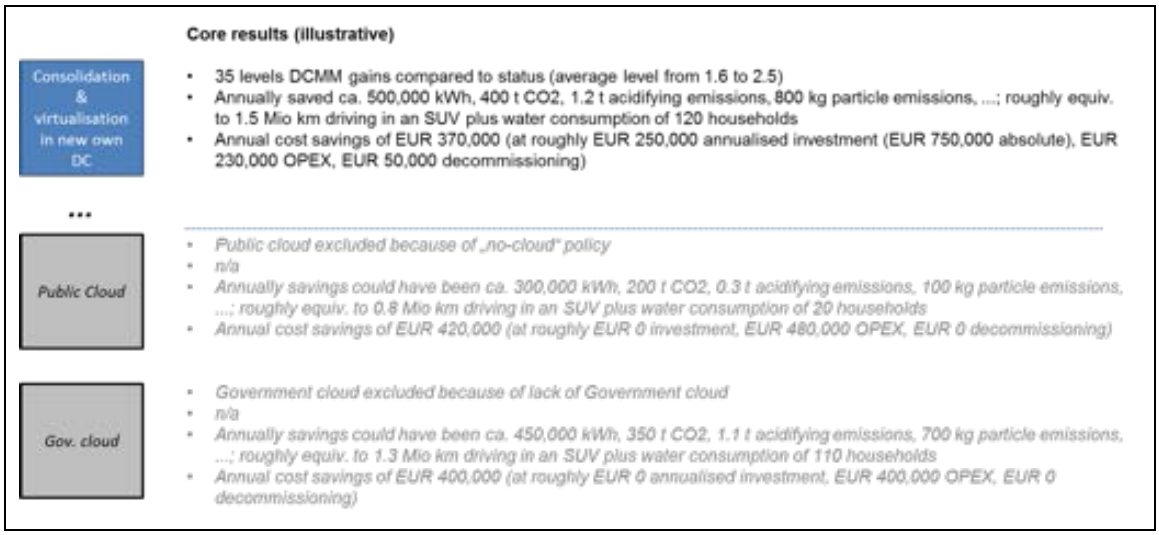

Figure 6 Illustrative example how top-level overview results (extract) for one of the recommended options could be provided to the procurer in the report (blue, top) and on which information and data basis other options have been excluded by EURECA (grey, below), in an illustrative, assumed case.

By working with the DCMM levels and bringing in quantitative life cycle cost, energy and environmental data of different options - always related to meet the same technical need – a high reliability will be achieved and subsequent effort will be more focussed and efficient. This will considerably help in getting a structured overview of the situation and options, and which options deserve a more detailed analysis. Since the recommendations already consider what the market can provide, the public procurers can shortcut directly to the decisions on measures and procurements without the need of a time consuming market analysis.

It is anticipated that in many cases the next step - i.e. the decision which measure(s) and/or procurements to initiate - will nevertheless be supported by dedicated specialist, either in-house data centre experts if available, or external consultants that can then already focus on the most suitable options. This is expected to be necessary, as many specific aspects may need to be considered that cannot all be encoded into the EURECA knowledge system and framework and also as for PPI and PCP in any case a more comprehensive and differentiated analysis, including creative elements, will be required. The extent of dependency on external consultants and

their individual preferences will however be considerably reduced, as only options that actually make sense will have to be looked into.

Beyond the decision support, the report will also contain EURECA-internal hyperlinks from each of the DCMM elements to the various components of the EURECA Directory, such as the products and services (including the innovation part), the example procurement cases, the business cases, and so on. Hence, if for example "purchase of new servers" would be a promising option, specific links will allow jumping to the relevant entries in the directory. Similar, for "consolidation" or "hosting", but also for "staff training", "installation of electricity consumption measuring devices" and any other improvement measures or procurement scenarios.

It is believed that this highly structured access to relevant information is in itself very valuable in a pre-procurement situation. It is important to highlight that the entries in the directory sections will not be merely of a descriptive form, but the products and services as well as service providers will be characterised in a structured, searchable and comparable way. The directory is hence also accessible to public procurers outside the decision support components of EURECA for browsing, filtering and searching its contents. Details are found in chapter 8.2.

4.6 Framework component 2: Market analysis and tender specification support

4.6.1 Overview

The public procurer – usually with preceding support by EURECA's "Status analysis and recommendations" component and often in addition by an in-house or external consultant – decides on the procurement scenario. This can be both an in-house improvement by purchasing e.g., a (new) cooling system, virtualisation software and new servers, etc. or an external data hosting, co-location service, etc. This includes of course PPI and PCP procurement plans, as described.

The second decision support component of EURECA is dedicated to support this step of tendering, should this be the option that the public procurer would have decided to follow. Figure 7 presents this component schematically:

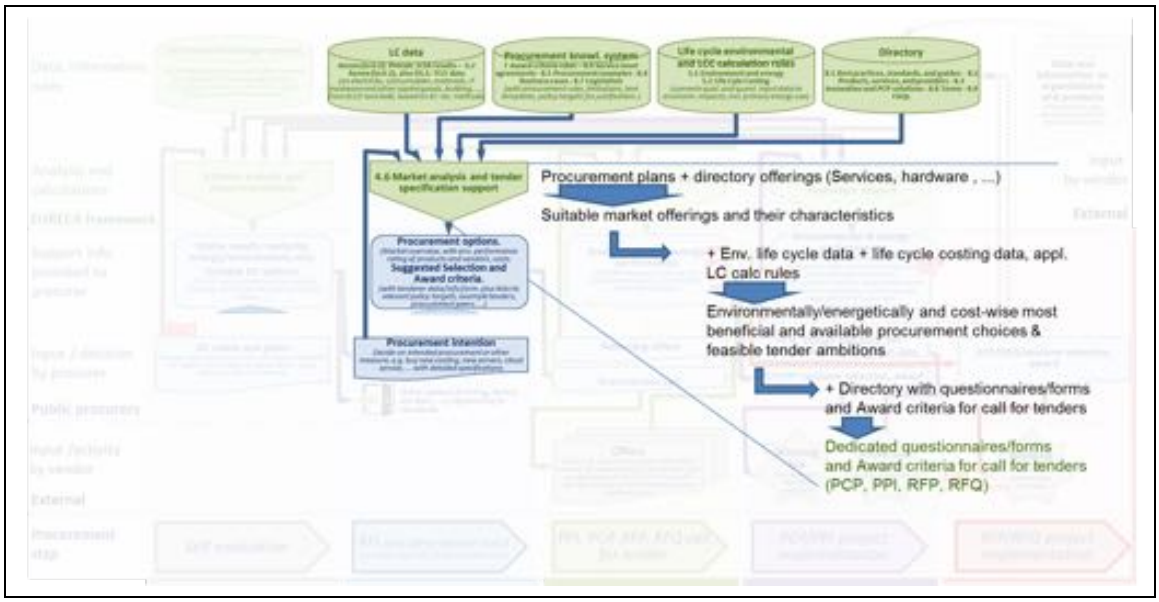

Figure 7 "Market analysis and tender specification support" component of the EURECA framework, schematic flow of main steps

Based on the individual products and DC services characteristics as documented in the market directory, and in combination with LCC and LCA data, the cost and environmental & energetic performances of the market offerings are calculated/estimated; details see chapter 6. Technically, these calculations are the same calculations as already in the "Status analysis and recommendations" component, while relating exclusively to the procurer-selected procurement scenario.

4.6.2 PCP

Again, such calculations will not be possible for the first stage of PCP procurements, as per definition historical data and product characteristics are not available that otherwise could feed such calculations. For planned PCP procurements and where the planned tenders have certain size, guidance will be provided on inclusion of life cycle analysis to help assessing the life cycle environmental and energy performance estimations/expectations. This will use the same mechanism that the Commission has used in a number of FP7 research calls, where steering and analysing the projects' technology developments in line with the Commission's ILCD Handbook [European Commission 2010] was requested as part of the project calls.

Where the proposed PCP solutions differ considerably from what is on the market and where a particularly large project volume justifies this additional step, an

approximate life cycle study (both environment/energetic and cost, and in line with the relevant Commission guide ILCD Handbook) could be requested to accompany already the offers, in addition to steering the project implementation in this way, as described just before. It might however be recommended to have the "expected" performance characteristics being reviewed already by an independent data centre expert, to add credibility to the information sent in with the offer (i.e. be part of the Tender Specification). This step will be suitable only where a large volume of the project will justify this additional step.

In any case, and particularly for smaller PCP procurements, references to context-specifically relevant procurement examples as documented in the directory will be provided. This combination will give the best possible support to procurers at this stage.

4.6.3 Award criteria

In direct support of the tender formulations, the EURECA "Procurement knowledge system" will provide the necessary specific formulations and dedicated Award criteria for the award points, all in line with the latest 2014 Procurement Directive, for each of the supported procurement scenarios.

These draw on product characteristics that represent the product's overall life cycle wide environmental and energy performance. In addition to these quantitative elements, as where applicable, adherence to standards and certificates such as EMAS, EUCoC, Energy Star and evidence of deeper analysis of the product (e.g. making available EPDs) contribute to the award points.

The award criteria are a key element of EURECA, as they will directly influence how well environmental energetic performance is considered in the call for tenders. Chapter 7 provides the details.

4.7 Framework component 3: Tender evaluation report

4.7.1 Embedding into tender evaluation procedure

The next important step after sending out the invitation to tender is the evaluation of the offers. The first sub-step will be as always – before the EURECA support in this step will start - the opening of the offers and checking that any formal requirements are met, including the exclusion and selection criteria and that eligible evidence has been provided by the tenderers.

For all offers that have passed this step, the EURECA framework and tool will read in the questionnaires that have been returned with the offers, with two principally different cases that are to be differentiated: standard procurement and PCP/PPI.

4.7.2 Standard procurement (RFQ or RFP, i.e. not PPI or PCP)

In this case, the procurement is of a RFP/RFQ type and historic data is available on the product's characteristics that determine its cost and environmental/energetic performance. In this case, the "Tender results evaluation support" component of the EURECA framework will extract from the returning questionnaires/forms the relevant quantitative information for the award criteria, as well as calculate the life cycle costing results and the environmental and energetic performance of the offered products and/or services. The latter will provide the public sector quantitative information on to be expected savings of greenhouse gases etc. The procurer will also retrieve from the returning questionnaires/forms all eligible additional award-relevant aspects (such as on organisation level having the EMAS implemented or being subscriber to the EUCoC, as applicable and award-relevant for the specific procurement scenario).

This information forms then the basis for the relevant award points that cover these elements, next to any technical performance criteria that the procurer may have defined for the product, or items such as special servicing offers etc.

The procurer will hence be technically supported in the task to determine the winning offer, in line with the 2014 Procurement Directive and hence any EU Member State's national implementation.

4.7.3 PPI or PCP

Where the tender is a PPI or PCP type of procurement, the anticipated characteristics of the final technology system will be assessed, again along the information provided in the questionnaire. However, as the accuracy of the anticipated performance is considerably lower than for existing products and DC services. It can hence not directly be used to determine the winning offer, hence will receive a lower weighting in the award scheme.

Figure 8 presents this component schematically:

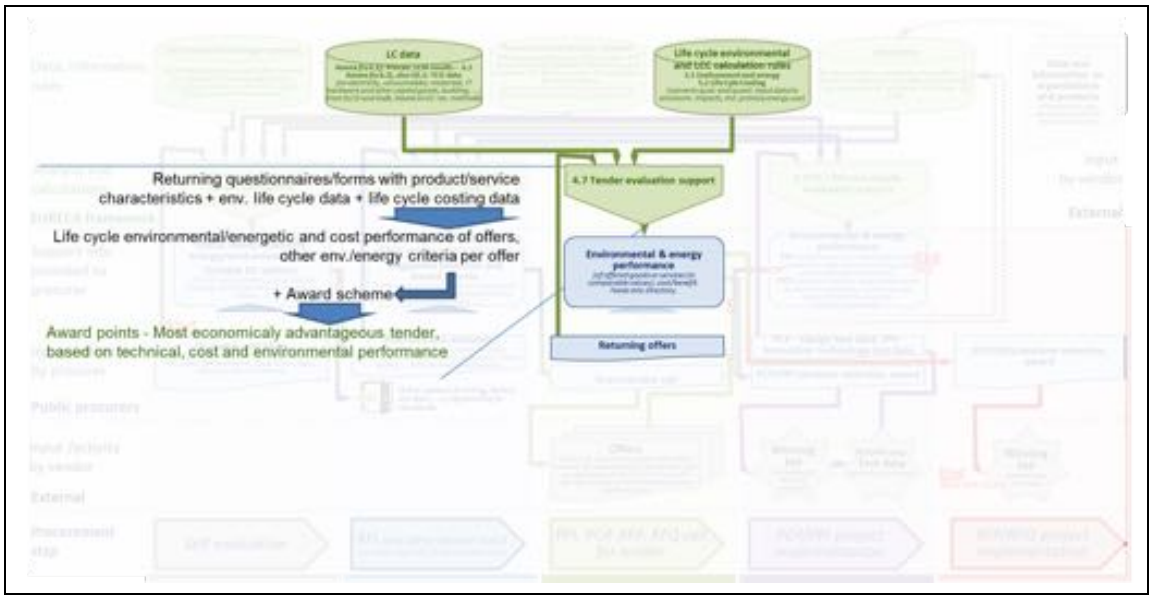

Figure 8 The "Tender evaluation support" component of the EURECA framework, schematic. Details see text.

4.8 Framework component 4: PPI/PCP test results evaluation support

In contrast to procuring existing products, for PPI and even more so for PCP, the actual implementation of the technology (or management/operational measures) will reveal the actual environmental, energetic and cost performance.

4.8.1 PPI

Starting with the case of PPI, the relevant test results of the installation will be used – if the form of innovation allows to translate it into changed electricity, water etc. consumption and standards hardware utilisation figures - to calculate the life cycle wide environmental, energetic and of course cost performance. The results will then be available to the procurer for direct comparison with what had been committed in the offer. In case of relevant under-performance, this can lead to rejection of the implementation or lead to requests for improvements. Otherwise, the implementation would be approved, provided also the other contractual obligations have been met, of course.

4.8.2 PCP

For PCP, more than one, separate development has taken place, so that several independent sets of test results are to be evaluated. Either this will work the same way as for PPI, i.e. with reading in the values in the questionnaires. Or, where instead a life cycle assessment and costing calculations have been part of the project implementation (and possibly already with the mentioned estimates a part of the offer), the actually achieved performance of the implementation will again be modelled in the same life cycle model, revealing to which degree the anticipated performance has been achieved, surpassed or not been achieved.

In comparison among the several competing implementations, this will also give quantitative evidence, which is the most beneficial one on terms of environmental, energetic or cost performance. This evidence will then feed into the subsequent step of preparing a call for RFP or RFQ, analogue to what the EURECA component "Market analysis and tender specification support" provides, while for several options in parallel, for the public procurer to select from.

Figure 9 presents this component schematically:

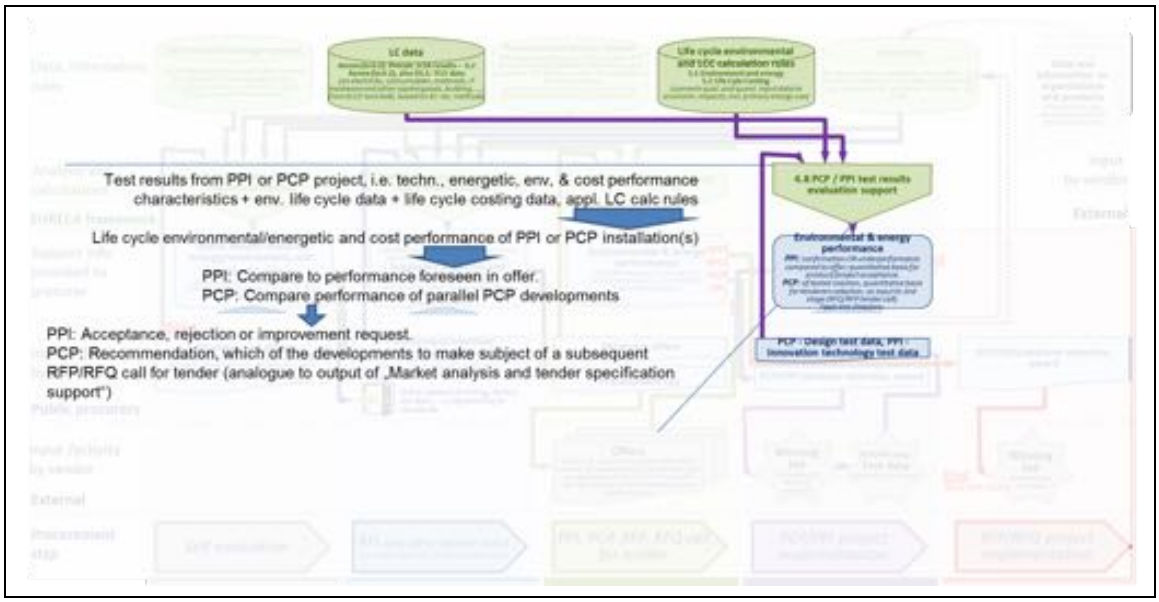

Figure 9 The "PPI/PCP test results evaluation support" component of the EURECA framework, schematic. Details see text.

4.9 Specifications for the EURECA tool

Beyond the framework, and as bridge to the software design and development, D2.1 is also delivering the functional requirements and the basic specification for the

software, the latter in form of format specifications, e.g. for the various components of the EURECA directory and for all data and information that is electronically stored or processed by the software. These essential specifications are typically provided as annexes to the chapters of the respective framework components.

Furthermore, will there be various internal references among specific parts and entries of the framework, for example references from the DCMM and EUCoC best practices on e.g., cooling to all cooling products and services offerings in the market directory, to the procurement examples of innovative energy and environmentally efficient cooling solutions, and so on. The specification of these internal references is prepared in dedicated annexes, with some details to be further worked out during the framework implementation.

5 Status analysis support: DC Maturity Model & EU Code of Conduct, and DC Knowledge system

5.1 Data Centre Maturity Model (DCMM) and EU Code of Conduct (EUCoC)

5.1.1 Overview

Drawing on the publicly available and freely usable Data Centre Maturity Model (DCMM) of The Green Grid (Green Grid 2015) that helps to analysis the detailed status quo of any data centre or server room, the EURECA consortium has brought this into a procurement context, updated some elements and mapped into each elementary EU Code of Conduct (EUCoC) best practices latest edition 7.1 (European Commission 2015).

The level of detail in the maturity model is very high. Combining actual maturity levels and ambitions of the procuring organisation with what is technically achievable will result in specific advice from the EURECA framework for many given situations. However, EURECA foresees to go one step further, to better guide the public organisation towards the most beneficial actions. The framework does this through matching of self-assessment information as per the EU Code of Conduct for Data Centres (Energy Efficiency) & Green Grid Maturity model (DCMM), combined with quantitative information on which procurement scenarios promise the largest energy and environmental savings given the current situation and principal options for improvement, amended with Life Cycle Costing results. This will be brought together with requirements set by the procuring organisation, to best achievable solutions either in-house or those provided by third parties.

This chapter describes the DCMM and the EUCoC best practices and how they are translated into secondary energy and hardware savings.

5.1.2 Data Centre Maturity Model (DCMM)

The Data Centre Maturity Model (DCMM) targets two main areas: facility and IT. Within each area, multiple categories need to be assessed to get information on the respective maturity level regarding the energy efficiency. These are as follows:

Facility

Power

- Critical Power Path Efficiency – Building Entrance to IT load (not including IT PSU)
- Power System Architecture
- Operations
- Generation

Cooling

- PUE – Cooling Contribution
- RCI (high) & RCI (low) – if applicable
- Mechanical/Refrigerant Cooling reduction
- Environmental – set point range at inlet conditions to IT equipment
- Environmental – monitoring and control
- Operations

Other facilities

- Operational Resilience
- Resilience vs. Need
- Lighting
- Building/Shell
- M&E Waste
- Procurement

Management

- Monitoring
- PUE
- CUE
- WUE

- Waste Heat (as measured by ERF/ERE)
- xUE/Additional metrics

IT

Compute

- Utilisation
- Workload Management
- Operations
- Power Management
- Server Population

Storage

- Workload
- Architecture
- Operations
- Technology
- Provisioning

Network

- Utilisation
- Workload
- Operations
- Technology
- Base Performance
- Provisioning

Other

- Overall
- Utilisation
- IT Sizing

- Internal Power Supply Efficiency
- Service Catalogue/SLA's
- Incentivizing change for efficient behaviour (e.g., chargeback and/or cost awareness)
- E-Waste
- Procurement

The complete original DCMM questionnaire is available at https://www.thegreengrid.org/sitecore/content/Global/Content/Tools/DatacentreMaturityModelAssessmentTool.aspx. The EURECA use as well as the mapping to the EUCoC best practices is found in annex 11.3.

Figure 10 Overview of the detailed Green Grid DC Maturity Model. It will be the basis for the DCMM implementation in the EURECA framework and tool.

After the status analysis it is visualized where each (sub)item is in terms of a maturity level. In the illustrative example for the 'EURECA data centre', the visualization looks like this (Figure 11):

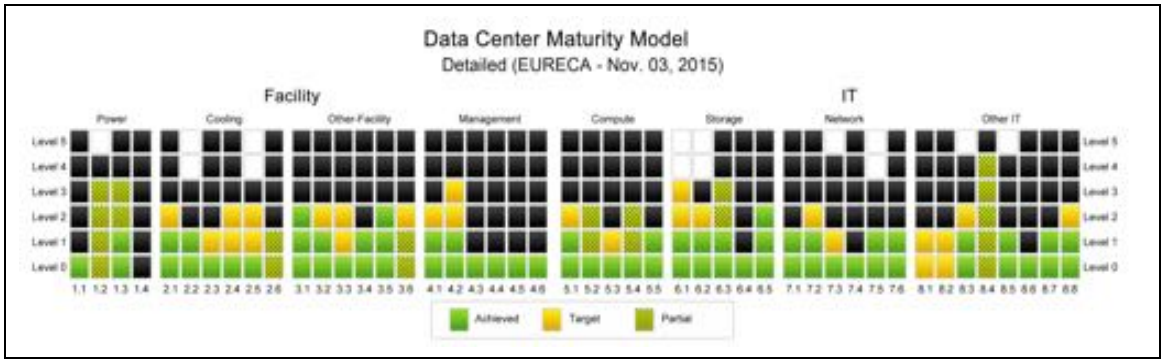

Figure 11 Example result of the DCMM status analysis, illustrative: the green boxes mark achievements from level 0 (bottom line) to level 5 of highest maturity (top line). The yellow boxes mark ambitions by the DC operator for the next improvement steps. Black boxes show the potential way further up towards top-level maturity.

5.1.3 EU Code of Conduct (EUCoC) best practices and expected electricity savings

5.1.3.1 About the EUCoC best practices

The[1] "Best practices" guide is a companion to the EU Code of Conduct on Data Centres and provides the full list of identified Best Practices for data centre operators as referenced in the Code of Conduct Participant and Endorser Guidelines documents.

This Best Practice supplement is provided as an education and reference document as part of the Code of Conduct to assist data centre operators in identifying and implementing measures to improve the energy efficiency of their data centres. To help ensure that Participants to the Code of Conduct are recognised as having committed to a useful and substantial level of energy saving effort, a subset of the Best Practices are identified in this document as being the expected minimum level of energy saving activity for Participant status.

The less disruptive or intrusive of the Practices are identified as being applied to the existing data centre and IT equipment, retrospectively where necessary. It is accepted that a number of the Practices identified as expected are inappropriate or

[1] Text of this subchapter partly taken from the EUCoC bet practices guide, modified.

present an unnecessary burden when applied to an existing running data centre. These Practices are identified as being expected either, when new IT equipment or software is sourced and deployed, or during a retrofit of the facility. These Practices provide substantial benefits and are intended to achieve efficiency improvements through the natural churn of equipment and facilities.

5.1.3.2 Mapping EUCoC Best practices to the DCMM elements

For each DCMM element and level, suitable EUCoC best practice recommendations have been mapped by the EURECA team. The complete mapping is provided in Annex 11.3.

5.1.3.3 Secondary energy (electricity) and hardware changes per best practice

The to-be-expected environmental and energetic benefits of implementing these measures are required to initially prioritise these measures and to estimate the actual benefit of the EURECA advice. In this context, two different forms of best practice are to be distinguished: those that lead to procurement of new capital goods (e.g. new servers, a new cooling system), and those that do not (e.g. advise to increase the server inlet air temperature to 27^{o}C, or recommendation to purchase virtualisation software licenses).

In the former case, the to-be-expected energy and environmental savings can directly be calculated from the new capital goods characteristics (see chapter 6.1).

For the latter case, however, the measure first needs to be translated into the affective change in the consumption of electricity and other consumables (e.g. water), as well as any changes in capital goods (e.g. less servers via workload shifting or virtualisation software). To this end, for the most relevant best practices the to-be-expected changes in electricity and hardware have been estimated by expert judgement and drawing on insights from the general literature on these measures (see Table 2).

Given the interdependencies of the DC components, in many cases it is not possible to give very precise values or even narrow ranges. Nevertheless, with this approach the best possible ad hoc indication of expected environmental and energy benefits can be given. In a second step, and particularly if several measures are implemented (e.g. a full retrofit) based on a more thorough and data centre specific situation by a specialist, the more exact expected changes to consumables and capital goods can be

obtained from that specialist and be used to estimate more precisely the to-be-expected benefits for supporting the related decisions.

The following table provides the initial expert estimates of secondary energy and other savings:

Table 2 Initial expert estimates of secondary energy (electricity) saving due to measures that do not result in capital good procurement. Note that the measures, if combined, will achieve a saving that is usually lower (or even much lower) than the sum of the savings.

Best practice item	Description	Secondary energy (electricity) savings
3.1.1 Group Involvement	Whilst not a procurement practice, organisations should ensure that representatives from the procurement departments (enterprise) should be included in the distribution list of the minutes created by this group, in addition procurement personnel should be invited when procurement decisions are made. When teams are aligned, greater energy efficiency results, projects to identify the quick (policies, processes and procedures) wins, medium wins (minor capex) or hard wins (major capex) can be implemented	Energy Reduction 30%
3.2.8 Sustainable Energy Usage	Procurement personnel should develop sustainable (renewable) energy strategies for data centre use.	Energy Reduction 0% but can offset primary (fossil fuel) use
3.3.1 Build resilience to business requirements	Procurement personnel should be made aware of alternative options for colocation/cloud services in alignment with business needs, for instance 24/7/365 recovery is rarely required and other best practices such as "service charging models " 3.2.3 should be explored.	Energy Reduction 20%, but is avoided energy use
4.1.1/4.1.2/4.1.3/4.1.4/4.16/4.1.7 IT Equipment	Procurement personnel should create "equipment lists" that are regularly updated in line with organisational energy efficiency policies and request servers that meet this, in terms of energy efficiency and sustainability (energy star). This should also be applied to cloud services.	Energy reduction 10-75%, dependent on configuration
4.1.11 Energy/Temperature Reporting hardware	Procurement personnel should ensure that equipment with this capability is procured if DCIM products are in use within the organisation.	Energy reduction 10%, allows greater visibility of data centre energy use (temperature/ IT consumption)

Best practice item	Description	Secondary energy (electricity) savings
4.2.1 Deploy using grid/virtualisation policies	This best practice points to internal /external cloud services for the organisation, the policy should be internal/external cloud first and executive approval should be required for all procurement that falls outside this policy.	Energy reduction 10-75%, dependent on network energy costs (although this is not costed or calculated by an individual organisation) and whether internal/external cloud) care should be taken internally to align cooling equipment with IT equipment if substantial reduction in IT footprint results
4.2.4 Select efficient software	It is difficult (at present) to purchase software products that have been tested on multiple platforms to check for energy efficient operation, however procurement departments should ask the question	Energy reduction 10-25% difficult to determine but servers should be at 1-25% of full power when idle.
4.2.5 Develop efficient software	For the development of ad hoc software, steps should be taken to ensure that testing for energy efficiency should take place on current platforms	Energy reduction 10-25% difficult to determine but servers should be at 1-25% of full power when idle.
4.2.6 Incentives to develop efficient software.	For the development of ad hoc software, steps should be taken to ensure that testing for energy efficiency should take place on current platforms, performance clauses should be considered.	Energy reduction 10-25% difficult to determine but servers should be at 1-25% of full power when idle.
4.4.1 Data Management Policies	Storage, whilst relatively cheap, can grow exponentially if left unmanaged, steps should be taken to restrict the amount and location of personal and business data, reference should be made by procurement personnel to question unrestricted data growth, remove the potential for unwanted data to proliferate, and to use data deduplication software across the organisation. Consider Frozen, Cold, Warm & Hot Storage options.	Energy reduction 10-25% difficult to determine and dependent on data growth, but use of other storage options may have other impacts, for instance placing data in cold storage (data on tape/flash/disks offline,

Best practice item	Description	Secondary energy (electricity) savings
		may have recovery costs (transport)
4.4.4 Low Energy storage devices	Storage should be kept (as above) in the lowest cost/energy efficient options	Energy reduction 10-25% difficult to determine and dependent on data growth
5.1.15 Installation of free cooling	In the EU area, it is possible to obtain 100% free cooling (dependent on location) and in summer there will be a few weeks when mechanical cooling will be required, however procurement departments should look at innovative cooling technologies including free cooling coils etc	Energy reduction 10-75%, dependent on previous cooling strategy and willingness of organisation to adopt higher temps, wider humidity ranges
5.2.1 Modular cooling solutions	Procurement departments should evaluate the use of "team working" CRAC's/CRAH's or retrofit control systems that provide the level of control in a modular fashion.	Energy reduction 10-75%, dependent on previous cooling strategy and willingness of organisation to adopt higher temps, wider humidity ranges.
5.4.2.1 Chillers with high C.O.P	There should be no need to procure chillers in the EU area, but if they are procured they should operate at the highest COP across the required range.	Energy reduction 10-25%, dependent on previous cooling strategy and willingness of organisation to adopt higher temps, wider humidity ranges.
5.6 Reuse of data centre waste heat	This is an offset or avoided energy use elsewhere in the building/campus, and is dependent on the quality of the heat and its method of collection (air/water/liquid cooled via heat exchanger)	Energy reduction 10-25%
6.1.1 Modular UPS	UPS solutions should be modular and only units should be procured for the IT load at that time. Care should be taken to procure UPS systems that are efficient across the curve.	Energy reduction 10-20% primarily avoided or offset
7.1.2 Low energy lighting	LED's or other low energy systems should be procured, alongside automatic PIR sensors.	Energy reduction 1-5%

5.2 DC Knowledge system for improvement advice

The framework/software gives recommendations based on the status analysis information provided. Measures or procurements can take place in any one or more of these areas:

These areas are:

- Power
- Cooling
- Other Facility
- Management
- Compute
- Storage
- Network
- Other IT.

The recommendations are depending on the situation. The process always starts with the need to improve the current situation, either by procuring services or products to process and store data remotely, OR to improve the internal data and computation handling, OR with organization's need to reduce its energy/carbon footprint, and is translated in the need to, for example:

- buy new IT hardware (servers, storage, switches)
- refit or procure new cooling system
- launch a specific (innovation) procurement call from organization.

It ends in buying either products or services (e.g. data centre, Cloud, colocation) or in a decision not to buy, but to improve the DC-internal handling of data and processes.

The knowledge system is foreseen to be part of the EURECA tool, and consists of several knowledge blocks, to facilitate the decision what to do next, taking the technical, legal, financial and other constraints into account.

Figure 12 characterises, how the knowledge system questions will help further filtering out suitable and not suitable measures and procurements:

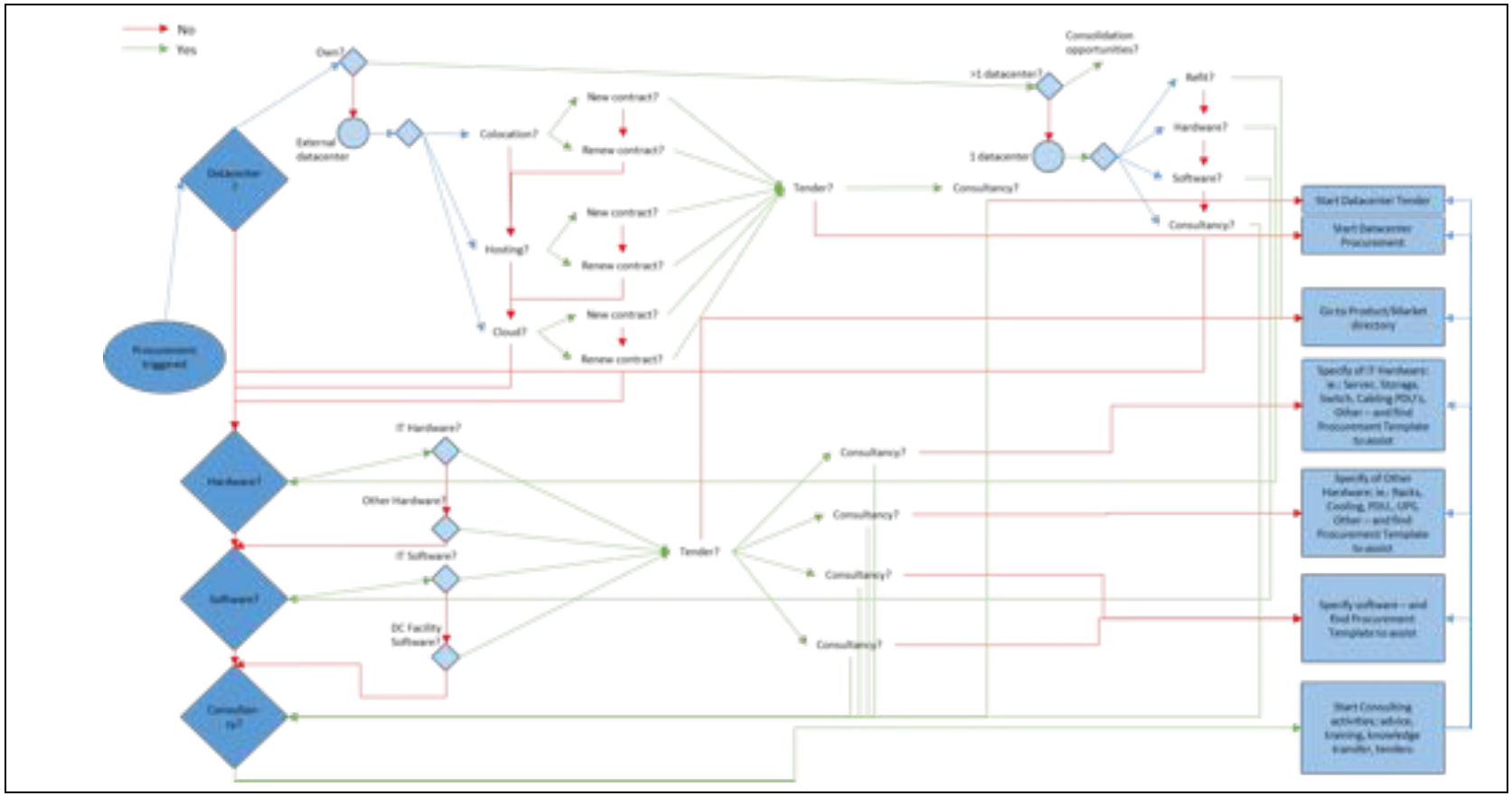

Figure 12 **EURECA knowledge system, to improve accuracy of selected options after DCMM and EUCoC analysis and recommendations.**

The data on which the recommendations are made, are gathered in a database, which is connected to the DCMM and the market directory. This database is containing logical dependencies of various aspects of data centres and server rooms, such as available space (to judge e.g. the possibility to add more servers or a better cooling system), server load information (to judge e.g. the potential for virtualisation), technical possibilities and need for heat transfer to office space or other users, etc. It will connect to the DCMM, as that one already covers some of the necessary information, and the market directory that stores the related information for the specific products.

This heart of the technology knowledge system enables the knowledge system to facilitate procurement, using algorithms that turn data into decision making information. It is therefore very important that the market directory is filled with the right data and connects well to the complementary information in the knowledge system. At the same time, will the best decision for any given data situation depend on a large number of specifics that cannot be all represented in a knowledge system, i.e. the system will filter down the options, but it will often be necessary to still involve a consultant to work out the specifics before any procurement is being prepared. The focus that the EURECA framework and tool will give, will however tailor this to get the right expert in and to already have a very good overview of the market, thanks to the market directory.

6 Energy, environmental and cost performance calculations

6.1 Energy & Environment

6.1.1 Overview

Purpose: Present the quantitative method for calculating the energy and environmental performance of data centre products and services, suitable for use in procurement calls and for the final evaluation of the EURECA projects benefits.

Status: Robust comparison is not possible with existing approaches and (proxy) indicators – requires energy and environment in life cycle perspective. However: complex products and systems.

Base approach: Mixed approach of: default values and life cycle results for all main parts (provided by the project), plus use phase (input data provided by vendors, simple calculation rules to be implemented into EURECA software provided by the project), plus optional: EPD/PEF results of life cycle data on selected products types (provided by vendors).

In addition, for the award points of tenders, and were complementary and adding value to the above base approach, adherence to selected EU and ISO labels, standards and certifications (e.g. Blue Angel Ecolabel, Energy Star, EMAS, ...) will be rewarded (see chapter 7).

6.1.2 Purpose

The purpose of this chapter is to provide calculation prescriptions to obtain quantitative environmental and energy performance results of the various data centre capital goods components, whole data centres and data centre services. Three variants of such results will be required: reasonably worst case default results, market typical/average results and product/offering specific results. These results will:

- be put into the DC knowledge system for each type of product (e.g. the main hardware components servers, UPS, … and DC system or service).
- support decision on suitable procurement scenarios, based on status-quo analysis of current data solutions at public body (e.g. in-house server room →

buy new servers and virtualise, replace CRAC, go co-location, use heat in adjacent admin rooms, …).

- be used in inform the public sector organisation on potential life cycle wide environmental and energy savings (the award criteria will rather draw on technical product characteristics, such as electricity consumption and others), i.e. help to quantify the energy and environmental performance of the offered products and services
- be used in WP 5 for self-evaluating the savings thanks to the EURECA project developments use.

6.1.3 Introduction and status quo

Since the 1970s, sustainability has become an important issue in the national agenda of many countries worldwide. Due to global supply chains, local human activities affect the environment and also social and economic conditions worldwide. Particularly for the product level, many methods have been proposed, but life cycle based methods and particularly LCA that is quantitative and performance based has been found as the most suitable one [Wolf e al. 2012].

Using performance and life cycle based approaches is also required in the 2014 Directive on Public Procurement (European Commission 2014). The relevant part reads:

"(74) The technical specifications drawn up by public purchasers need to allow public procurement to be open to competition as well as to achieve objectives of sustainability. To that end, it should be possible to submit tenders that reflect the diversity of technical solutions standards and technical specifications in the marketplace, including those drawn up on the basis of performance criteria linked to the life cycle and the sustainability of the production process of the works, supplies and services.

Consequently, technical specifications should be drafted in such a way as to avoid artificially narrowing down competition through requirements that favour a specific economic operator by mirroring key characteristics of the supplies, services or works habitually offered by that economic operator. Drawing up the technical specifications in terms of functional and performance requirements generally allows that objective to be achieved in the best way possible. Functional and performance-related requirements are also appropriate means to favour innovation in public procurement and should be used as widely as possible. Where reference is made to a European

standard or, in the absence thereof, to a national standard, tenders based on equivalent arrangements should be considered by contracting authorities. It should be the responsibility of the economic operator to prove equivalence with the requested label.

To prove equivalence, it should be possible to require tenderers to provide third-party verified evidence. However, other appropriate means of proof such as a technical dossier of the manufacturer should also be allowed where the economic operator concerned has no access to such certificates or test reports, or no possibility of obtaining them within the relevant time limits, provided that the economic operator concerned thereby proves that the works, supplies or services meet the requirements or criteria set out in the technical specifications, the award criteria or the contract performance conditions."

(Environmental) Life Cycle Assessment as the most widely used quantitative life cycle based approach, brings a wide range of environmental problems into an integrated assessment framework, captures the pressures and potential impacts over the entire life cycle of the analysed system in a scientific and quantitative manner, relates the pressures and potential impacts to the product (any good or service), and importantly allows fair comparisons as it is based on the functional performance of the product, thereby helping to identify effective areas for improvement.

The most important framework for Life Cycle Assessment since 1997 is the ISO 14040 and 14044 standards set. On European level, the developments of the European Commission's ILCD Handbook [European Commission 2010] and the PEF guide [European Commission 2013] further complete and detail the methodological requirements towards better comparability of results, what the ISO framework is not made for.

Regarding life cycle inventory data sets, the Commission's ELCD database contributes about 500 life cycle inventory data sets for main materials, energy carriers, transport and end-of-life treatment processes. Further data of high quality is available from third-party sources, including for free in between.

For ICT products, the ETSI TS 103 199, the GHG-Protocol ICT sector guide (GHG Protocol 2013), and the Green Grid's framework for Life Cycle Assessment of Data centres bring this into the ICT and Data Centre Context. Currently under development in a Commission-led Europe-wide pilot are moreover Product Environmental Footprint Category Rules (PEFCR) for UPS, enterprise hard disk storage systems, and batteries, photovoltaics, as well as for metal sheets and copper as key materials of interest for Data Centres. Just very recently completed work of key interest the

preparatory studies on enterprise servers in context of the Energy-related Products Directive and by the Commission's JRC on enterprise servers. This evidence base is completed by private sector and research papers on the subject.

While often it is argued that the use phase is the predominantly relevant life cycle stage for data centres, it turns out that it is instead important also for data centres to go beyond the use stage:

While for desktop and laptops many studies have shown the high relevance of the hardware production, that makes up 50% or more of the overall primary energy consumption and Climate change impacts, for enterprise servers used in DCs, typically a lower contribution of production is found. Different studies found different relevance, ranging for primary energy consumption and for servers between 5 and 20% of the overall life cycle due to production, i.e. "embodied" energy and environmental impacts (Stutz 2011; Talens Peiro & Ardente 2015). For other environmental impacts than Climate change however (e.g. particulate matter, toxicity, acidification…), often a much higher, even main contribution from production can be found, compare e.g. our calculations for a UPS system in chapter 6.1.6.

On DC-level, the share for capital goods of the total Climate change impact was found in one detailed study to be 33% (2010 data centre of PUE 1.75; Honée et al. 2012), in another by HP the primary exergy was calculated to be above 50% (Meza et al. 2010). The tendency is moreover that the share of capital goods among over all DC environmental impacts and primary energy consumption is increasing, due to reduced server electricity consumption per same amount of hardware as well as improved PUEs.

For future DCs still in this decade with free cooling or operated with renewable energy, it can be estimated that the contribution of hardware to the overall primary energy can be well above 50%, to the overall fossil primary energy and Carbon footprint it can be close to 100% for some data centres with a high share of clean renewable energy, and similar for other environmental impacts. Another indication of the long-term tendency are data from Apple on mobile devices that are optimized for energy consumption and have no use phase cooling: E.g. the iPhone 6 has 85% of the overall Carbon footprint coming from device production (Apple 2014). In order to make the EURECA framework and tool to be useful for the second half of the current decade, it will be necessary to capture - to the possible degree – the hardware production as well, next to the use phase.

Using conventional KPIs of the data centre industry alone to capture the environmental performance, such as PUE, CUE, REU, cannot at all well capture this situation and are also per definition unsuitable to compare different product options, let alone across different procurement scenarios (e.g. server room, co-location or hosting) – this is however key in procurement context (Wolf 2014).

The strengths and also the intended purpose of the conventional KPIs is the internal management / improvement of the various specific aspects of existing data centres operation – and here they are valuable. Robust and fair comparison however of the environmental and energy performance of alternative options and products of DC hardware, whole DCs and server rooms and DC services require to combine and integrate the existing approaches and data/metrics within a life cycle based, quantitative approach.

Nevertheless, and as was also found in D1.1, the public procurement of DC hardware, of whole DCs and of DC services is typically not looking into environmental and energy performance (D1.1), although the situation is somewhat better in Germany: next to the development of a Type I Ecolabel (Blue Angel for energy efficient data centres; RAL 2015), procurement guidelines that work with these Blue Angel criteria have just been updated (August 2015; UBA 2015). These guidelines are currently rolled out across Germany. On German Federal level, procurement exclusively of Blue Angel Ecolabelled Data Centres is the aim. For the use phase electricity consumption, the Climate change impact over the energy production chain is considered already. These German guidelines however deal with the environmental impacts of the production of the capital goods of DC hardware and whole DCs only in an indirect way: To account for the embodied impacts in the capital goods, high hurdles are put in place for procuring new hardware and if new hardware is procured it has to meet topic requirements, using energy-related criteria (SPECpower_ssj_ops, UPS and PSU efficiencies). The new SPEC SERT KPI for servers is so far only used in the US Energy Star for servers, v. 2, while the most widely used SPEC CPU metric appears to be a good combination of reliability, neutrality and availability (Zeydy 2015). Efforts are already underway on Federal level, to develop the next version of the Blue Angel and procurement criteria (Köhn 2015).

So, what can be done: Full life cycle assessment of hardware and DCs / DC services has been proposed and done (for different hardware) by a couple of companies. However:

- There is currently still clearly an insufficient reproducibility across vendors due to different methods used for the life cycle model, different impact assessment methods, and different background data (quality, completeness, age).
- The effort for collecting production data and modelling the production life cycle impacts of specific electronic products (Boyd 2012), such as servers, is high due to complexity of products and supply-chains.

At the same time:

- There are ongoing industry-wide efforts under EU PEF for production, use and end-of-life of UPS, HDD, batteries and metal sheets (the latter e.g. for the casings and racks); to deliver end of 2016/2017 product-group specific guides and rules for high reproducibility. Current drafts are publicly available (the two EURECA partner maki's staff are moreover official reviewers for the Commission of the PEF screening studies and know the work in all details).
- Two very recent efforts at the Commission on the production of servers provide a very good starting point for obtaining reasonably worst case default and also typical results for the production also of servers: preparatory studies for enterprise servers under ErP Directive (European Commissin 2015), JRC-IES report and full study (Talens Peiro & Ardente 2015).

Having been aware of those developments that now have delivered/are delivering, the EURECA framework has been anticipated to use these achievements. In this setting, the EURECA development is hence very timely to enhance the life cycle elements in procurement – consistent with life cycle costing that is already mandatory in public procurement - to come to a more innovative and hence more effective energy efficient and environmentally sound procurement of data centre products and solutions.

6.1.4 Approach

The EURECA approach to capture the life cycle wide impacts of data centre products, whole data centres and data centre services, builds upon the above named recent developments, that allow achieving a substantially higher level of accuracy and robustness than would have been possible just 2 years ago.

In a nutshell, the approach can be characterised as follows:

- Combination of calculated life cycle impacts of use phase energy and water consumption, of land use, and coolant loss,

- with reasonably worst case default data for selected capital goods production OR using product-specific impact results provided by vendors, where reproducible EU-supported schemes are in place (namely UPS, HDD, and batteries, as well as PV electricity production PEF results)
- with typical life cycle production data sets for all other capital goods, where such provider specific schemes are not yet available,

Figure 13 shows overview picture how LCA fits in: in blue, which information have already prepared as default values to be shipped with the framework and tool. In orange, which kind of information that needs to feed into the EURECA framework, i.e. in this case from the tenderer, and in green, the output from the EURECA framework for the procurer.

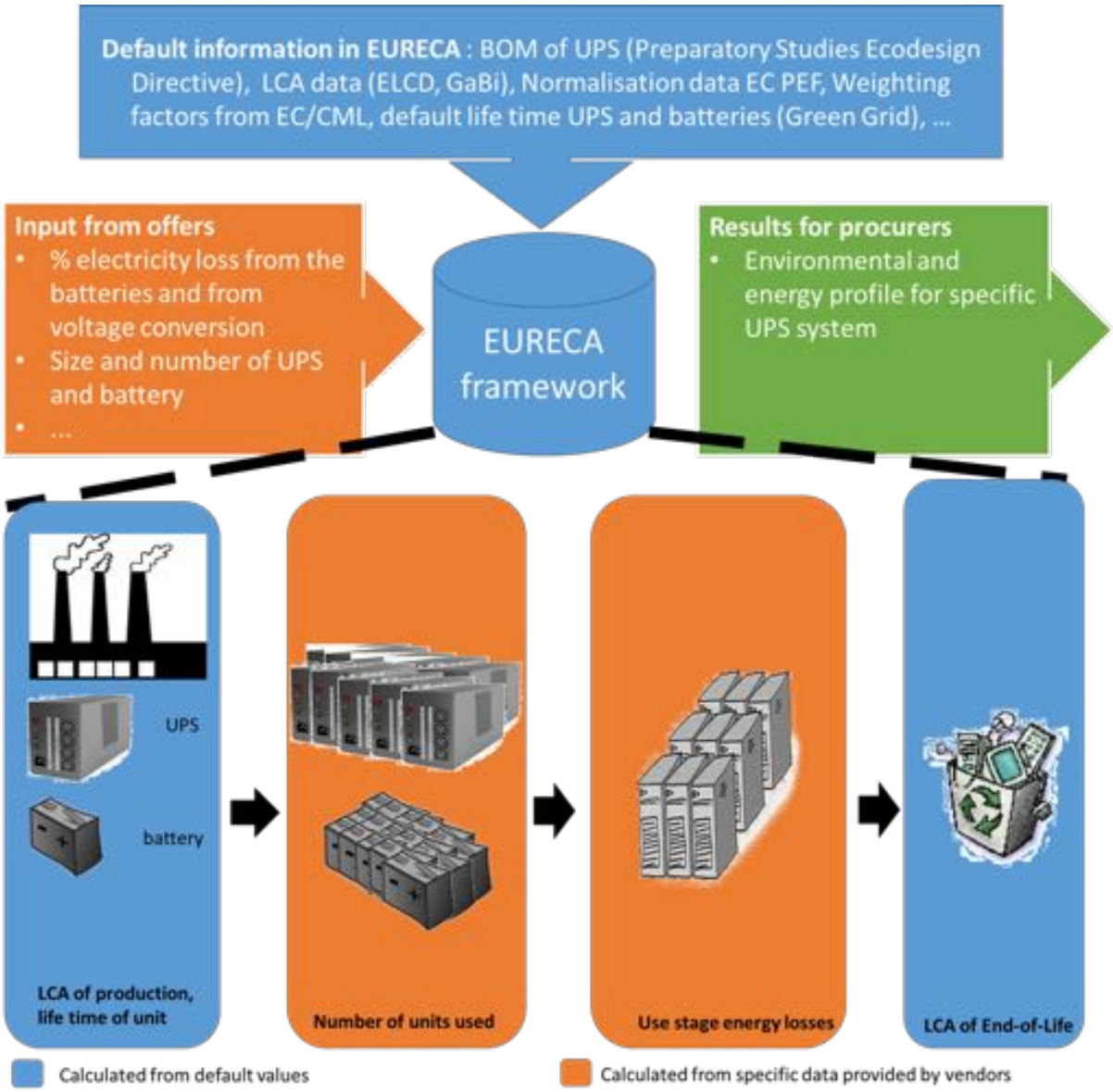

Figure 13 Example for UPS plus batteries, which data and information is combined towards the specific life cycle environmental and energy performance.

- Beyond the quantitative environmental and primary energy calculations, the EURECA framework is additionally awarding the fact of having developed Type I Ecolables awarded or having performed LCA or EPD studies on the product in question for recognizing the higher maturity of the producers in this respect. (This part is addressed in chapter 7.)

- For DC management solutions (e.g. workload shifting), and any PPI solutions, the net effect in changed capital goods and use phase data is used in the same way to calculate the respective impact and savings, always in relation to the equivalent provided service. For PCP, where a generic approach is not possible, a full LCA is recommended, however only for large PCP projects where the additional effort is justified, and using the Commission issued ILCD Handbook as reference.

Focus in terms of differentiation and input data as well as background data is put on items of higher relevance and variability. Data are – wherever relevant and viable – country or region specific, of good technological representativeness and more recent.

The life cycle components of the approach build on and are in line with European Commission recommendations. The system boundaries are moreover consistent with those for the total cost of ownership cost calculation. The best available secondary data sources are used, along recent insights from the mentioned PEFCR developments, independent qualified and external data reviews, and the equally mentioned Commission efforts under the Ecodesign Directive and at the Commission's JRC (Talens Peiro & Ardente 2015). We hence build our model on the Commission's ELCD database and otherwise - where data is not available in the ELCD - the GaBi databases[2]. The life cycle data that is distributed with the EURECA framework and tool is free of charge.

Regarding adherence to selected and context-wise meaningful voluntary policies and standards, the use of governmentally developed or recognized Ecolabel and Environmental management schemes as well as ISO and EN compliant schemes is considered higher than other schemes.

[2] The ELCD is the only Commission-maintained LCA database, the EU ecolabel points to use the ELCD, the Batteries, Metal sheets and Copper PEFCRs under the Commission's Product Environmental Footprint pilots use GaBi data, the UPS PEFCR points to use better data from GaBi or EIME, the HDD PEFCR has been criticised of using old/outdated and partly erroneous background data from other databases, the Ecodesign Preparatory studies have used GaBi data to come to more complete server production data than the EcoReport tool can deliver, the recent JRC study on servers builds predominantly on GaBi and ELCD data, the ELCD database itself is either providing data that is originally from the GaBi database or data from many EU-level industry associations that again are predominantly built on GaBi data. Finally, the EC-coordinated Covenant of Majors uses ELCD data for the life cycle calculation options.

6.1.5 Methodology

The approach hence makes best use of available product information at the vendors and from background sources, achieving sufficiently specific representation of the overall environmental impacts, while being fully feasible during procurement.

Table 10 in the annex shows the used input data per product type in overview, schematically.

This approach has the double advantage that is does not require too much input data from vendors and during the tendering phase and at the same time that it can be easily and modularly be further developed. E.g. when PEFCRs for servers would become available, this option could be enabled and apart from switching from the standard/average case default for the server production and EoL, no other changes are required in the methodology.

6.1.6 LCA calculation example for 10 units of a 6 kVA UPS + batteries system

This chapter shows how the LCA is used in the context of EURECA framework. For details on how LCA works, please see annex 11.10.

For clarity, the approach is illustrated for the UPS itself, step by step:

1. The core is to model the product from its Bill of Materials, see Table 3. For the UPS (other than for servers), the assembly of the parts to the UPS has little environmental relevance and is cut-off in this example, in line with the cut-off rules. The end-of-life LCIA results for the UPS are modelled, considering recycling, waste incineration and landfilling impacts, but also benefits from recovered secondary materials that will replace primary materials on the market, e.g. copper from cables, lead from the batteries, etc.

Table 3 Example Bill-of-materials of a data centre product: UPS 7.5 kVA (5-10 kVA).

Material	Mass [g]	Material	Mass [g]
PVC	241.8	Al sheet/extrusion	1,712
ABS	662.5	Cu wire	1,022.6
PA6	57.5	CuZn38 cast	183.4
PC	5.50	Powder coating	12.50

Epoxy	44.50	Slots. Ext. Ports	275.0
E glass fibre	17.30	PWBs	2,895.9
St tube/profile	15,106	Solder	66.80
Cast iron	125.7	***Total weight***	***23,384.5***
Ferrite	955.5		

2. The default LCIA result data sets for the production, use and end-of-life of the products, are calculated as described in annex 11.10, based on the European Commission's ILCD and PEF guidance documents, wherever possible and using ELCD and GaBi LCA data sets. The example LCIA results for the production of one unit of the 7.5 kVA UPS are shown in Table 4. Note that these are preliminary results and should not be used elsewhere. The "Impact categories" are those prescribed by the Commission under the PEF and also recommended in the ILCD Handbook.

Table 4 LCIA results (and Primary energy) for the production of 1 unit of UPS 7.5 kVA.

Impact category	**Unit**	**Value**
Acidification, accumulated exceedance	Mole of H+ eq.	2.24E+00
Ecotoxicity for aquatic fresh water, USEtox (recommended)	CTUe	6.37E+02
Freshwater eutrophication, EUTREND model, ReCiPe	kg P eq	4.59E-03
Human toxicity cancer effects, USEtox (recommended)	CTUh	2.42E-06
Human toxicity non-canc. effects, USEtox (recommended)	CTUh	5.99E-05
Ionising radiation, human health effect model, ReCiPe	kg U235 eq	3.86E+00
IPCC global warming, incl biogenic carbon	kg CO2-Equiv.	3.13E+02

Marine eutrophication, EUTREND model, ReCiPe	kg N-Equiv.	2.93E-02
Ozone depletion, WMO model, ReCiPe	kg CFC-11 eq	5.73E-07
Particulate matter/Respiratory inorganics, RiskPoll	kg PM2.5-Equiv.	3.06E-01
Photochemical ozone formation, LOTOS-EUROS model, ReCiPe	kg NMVOC	1.45E+00
Resource Depletion, fossil and mineral, reserve Based, CML2002	kg Sb-Equiv.	2.78E-02
Terrestrial eutrophication, accumulated exceedance	Mole of N eq.	5.63E+00
Total freshwater consumption, including rainwater, Swiss Ecoscarcity	UBP	2.43E+02
Primary energy	MJ	3.77E+03

I.e. the production of one unit of this UPS (excl. batteries) results life cycle wide in 313 kg CO2-equivalents emissions that contribute to Climate Change (see row "IPCC global warming…"), as well as consumes 3770 MJ primary energy (last row).

3. As the life time of the UPS is more than one year, the production LCIA results and also the end-of-life LCIA results of the UPS will be divided by the number of years that is assumed as default life time of UPS (with values taken from the Green Grid, i.e. 20 years), obtaining the annual LCIA results for the UPS production plus end-of-life. As the batteries have a shorter life time (3 years, values taken from the Green Grid), their production and end-of-life LCIA results are divided by its life time, to obtain the annual LCIA results, see Table 5.

Table 5 Example LCIA results (and Primary energy) for the production of 10 UPS units of 6 kVA that are scaled down from the default 7.5 kVA size and divided by the technical life time of 20 years.

Impact category	**unit**	**Scaled down from 7.5 kVA to 6 kVA, per unit**	**Env. impact for 10 units UPS of kVA, and per year**
Acidification, accumulated	Mole of H+ eq.	1.79E+00	8.95E-01

exceedance			
Ecotoxicity for aquatic fresh water, USEtox (recommended)	CTUe	5.09E+02	2.55E+02
Freshwater eutrophication, EUTREND model, ReCiPe	kg P eq	3.67E-03	1.84E-03
Human toxicity cancer effects, USEtox (recommended)	CTUh	1.93E-06	9.67E-07
Human toxicity non-canc. effects, USEtox (recommended)	CTUh	4.79E-05	2.40E-05
Ionising radiation, human health effect model, ReCiPe	kg U235 eq	3.09E+00	1.55E+00
IPCC global warming, incl biogenic carbon	kg CO2-Equiv.	2.51E+02	1.25E+02
Marine eutrophication, EUTREND model, ReCiPe	kg N-Equiv.	2.34E-02	1.17E-02
Ozone depletion, WMO model, ReCiPe	kg CFC-11 eq	4.58E-07	2.29E-07
Particulate matter/Respiratory inorganics, RiskPoll	kg PM2.5-Equiv.	2.44E-01	1.22E-01
Photochemical ozone formation, LOTOS-EUROS model, ReCiPe	kg NMVOC	1.16E+00	5.81E-01
Resource Depletion, fossil and mineral, reserve Based, CML2002	kg Sb-Equiv.	2.23E-02	1.11E-02
Terrestrial eutrophication, accumulated exceedance	Mole of N eq.	4.51E+00	2.25E+00
Total freshwater consumption, including rainwater, Swiss Ecoscarcity	UBP	1.94E+02	9.70E+01
Primary energy	MJ	3.02E+03	1.51E+03

4. The use phase of the UPS and batteries is characterised by a % electricity loss, mostly from the batteries and from voltage conversion; the respective default value is multiplied with the annual electricity throughout to obtain the absolute annual number of electricity consumed by the UPS and batteries. This value, in kWh, is then multiplied with the LCIA results per kWh of electricity production in the country, where the UPS will be operated (here: assumed to be Germany). For illustration, the information on annual energy loss from the preparatory studies under the EC Eco-design directive is used, which is 24,966 kWh for 10 units of UPS of 6 kVA each. The result is the annual LCIA result of the UPS use stage, as shown in Table 6.

Table 6 Example LCIA results (plus Primary energy) of the use stage of 10 UPS units of 6 kVA, i.e. due to electricity efficiency loss.

Impact category	Env. Impact use stage
Acidification, accumulated exceedance [Mole of H+ eq.]	2.99E+01
Ecotoxicity for aquatic fresh water, USEtox (recommended) [CTUe]	4.76E+02
Freshwater eutrophication, EUTREND model, ReCiPe [kg P eq]	2.93E-02
Human toxicity cancer effects, USEtox (recommended) [CTUh]	1.08E-05
Human toxicity non-canc. effects, USEtox (recommended) [CTUh]	4.06E-04
Ionising radiation, human health effect model, ReCiPe [kg U235 eq]	1.72E+03
IPCC global warming, incl biogenic carbon [kg CO2-Equiv.]	1.52E+04
Marine eutrophication, EUTREND model, ReCiPe [kg N-Equiv.]	9.17E-01
Ozone depletion, WMO model, ReCiPe [kg CFC-11 eq]	1.52E-06
Particulate matter/Respiratory inorganics, RiskPoll [kg PM2.5-Equiv.]	1.43E+00
Photochemical ozone formation, LOTOS-EUROS model, ReCiPe [kg NMVOC]	1.85E+01
Resource Depletion, fossil and mineral, reserve Based, CML2002 [kg Sb-Equiv.]	1.41E-02
Terrestrial eutrophication, accumulated exceedance [Mole of N eq.]	7.28E+01
Total freshwater consumption, including rainwater, Swiss Ecoscarcity [UBP]	1.14E+04

Primary energy demand from ren. and non ren. resources (net cal. value) [MJ]	2.65E+05

Note that the LCIA results data for the production and the end of life of all main IT and M&E hardware, and per kWh electricity (for each EU Member State separately) are pre-calculated and delivered with the EURECA framework/tool, as a set of each 15 values that represents the annual life cycle environmental impact profile (i.e. the 14 impact categories plus Primary energy) of the respective product. As UPS systems come in different sizes, and our base example is for 7.5 kVA, the LCIA results for the whole life cycle will be scaled up for the size that is used in the real case (e.g. 6 kVA), and then multiplied by the number of UPS units being used (e.g. 10 units) see Table 7. Particularly for UPS, there will be different default values for 4 main size classes of UPS.

5. Next step is to sum up all the parts (i.e. production and end-of-life treatment of UPS and batteries, electricity consumption):

Table 7 Example LCIA results (plus primary energy) of a data centre product: 10 units of UPS of 6 kVA (from table Table 6), including batteries production and UPS and batteries End-of-life (all modelled analogously; details not shown).

Impact category	UPS prod.	Battery prod.	Use stage	EoL battery	EoL ups	TOTAL
Acidification, accumulated exceedance [Mole of H+ eq.]	8.95E-01	1.14E+01	2.99E+01	-6.71E+00	-2.41E-02	3.54E+01
Ecotoxicity for aquatic fresh water, USEtox (recommended) [CTUe]	2.55E+02	3.66E+02	4.76E+02	-2.03E+02	-1.64E+00	8.92E+02
Freshwater eutrophication, EUTREND model, ReCiPe [kg P eq]	1.84E-03	9.20E-04	2.93E-02	6.76E-05	-8.91E-06	3.21E-02
Human toxicity cancer effects, USEtox (recommended) [CTUh]	9.67E-07	1.13E-05	1.08E-05	-1.18E-06	-1.32E-08	2.19E-05
Human toxicity non-canc. effects, USEtox (recommended) [CTUh]	2.40E-05	1.08E-03	4.06E-04	-1.09E-04	-4.69E-07	1.40E-03
Ionising radiation, human health effect model, ReCiPe [kg U235 eq]	1.55E+00	3.92E+01	1.72E+03	3.13E+02	-7.35E-02	2.07E+03

Impact category	UPS prod.	Battery prod.	Use stage	EoL battery	EoL ups	TOTAL
Marine eutrophication, EUTREND model, ReCiPe [kg N-Equiv.]	1.17E-02	4.58E-02	9.17E-01	-2.52E+02	-5.67E+00	2.57E+02
Ozone depletion, WMO model, ReCiPe [kg CFC-11 eq]	2.29E-07	3.28E-08	1.52E-06	-1.30E-02	-9.33E-04	1.39E-02
Particulate matter/Respiratory inorganics, RiskPoll [kg PM2.5-Equiv.]	1.22E-01	1.65E+00	1.43E+00	3.73E-07	-3.70E-07	3.21E+00
Photochemical ozone formation, LOTOS-EUROS model, ReCiPe [kg NMVOC]	5.81E-01	2.69E+00	1.85E+01	-3.37E-01	-2.12E-03	2.14E+01
Resource Depletion, fossil and mineral, reserve Based, CML2002 [kg Sb-Equiv.]	1.11E-02	4.57E+00	1.41E-02	-1.28E+00	-1.22E-02	3.31E+00
Terrestrial eutrophication, accumulated exceedance [Mole of N eq.]	2.25E+00	6.11E+00	7.28E+01	-1.69E+00	-3.49E-04	7.94E+01

Impact category	UPS prod.	Battery prod.	Use stage	EoL battery	EoL ups	TOTAL
Total freshwater consumption, including rainwater, Swiss Ecoscarcity [UBP]	9.70E+00	5.51E+01	1.14E+03	-2.04E+00	-4.04E-02	1.20E+03
IPCC global warming, incl biogenic carbon [kg CO2-Equiv.]	1.25E+02	6.67E+02	1.52E+04	-2.52E+02	-5.70E+00	1.58E+04
Primary energy demand from ren. and non ren. resources (net cal. value) [MJ]	1.51E+03	1.02E+04	2.65E+05	-3.27E+02	2.34E+00	2.76E+05

*** The unit is always 1 divided by the unit of the respective impact category, resulting in results of the dimension 1 ("dimensionless").**

The results show that for primary energy and climate change, the results are strongly dominated by the use stage, while for other impacts (such as toxicity, but also particulate matter or acidification), the production makes up more than 50% of the impacts or contributes a relevant share.

6. To ease decision support and use in the award criteria, these specific LCIA results will be further aggregated via a normalisation and weighting step, using again Commission recommendations for the normalisation.

   Due to the lack of final recommendations for weighting, the suggested weights from a related EC commissioned contract implemented by the Dutch CML are used and adjusted to the impact categories that are used here. The weights in the EURECA framework and tool will use the ones to be provided by the Commission in context of the PEF developments.

   In total and across all the normalised and weighted results, a single value is obtained that represents the overall environmental performance of e.g. the specific UPS + batteries system.

   After adding the LCIA results of the UPS end-of-life, of the batteries production and end-of-life - all as annual values considering the components' life times as described in the preceding text - and adding the annual energy loss' LCIA results, and scaling to the specific UPS system of 6 kVA and multiplying with the number of such systems to be used (10), the following results shown in Table 8 are obtained.

   Multiplying this environmental impact profile with the normalisation and weighting factors, and summing up the obtained normalised and weighted results across the impact categories (i.e. the last column in Table 8), the overall environmental impact single value can be obtained:

Table 8 Example LCIA results (plus Primary energy) of a data centre product: 10 UPS units of 6kVA. Plus normalisation factors and normalised results, plus weighting factors and weighted results. Normalisation data from EC PEF, Weighting factors from EC/CML.

Impact category	TOTAL (from Table 7)	Normalisation factor [*]	Normalisation result	Weighting factor [ ]	Weighted result
Acidification, accumulated exceedance [Mole of H+ eq.]	3.54E+01	2.12E-02	0.75	4	**3.00**

Impact category	TOTAL (from Table 7)	Normalisation factor [*]	Normalisation result	Weighting factor [ ]	Weighted result
Ecotoxicity for aquatic fresh water, USEtox (recommended) [CTUe]	8.92E+02	1.15E-04	0.10	11	**1.13**
Freshwater eutrophication, EUTREND model, ReCiPe [kg P eq]	3.21E-02	6.76E-01	0.02	2.33	**0.05**
Human toxicity cancer effects, USEtox (recommended) [CTUh]	2.19E-05	2.72E+04	0.59	6	**3.57**
Human toxicity non-canc. effects, USEtox (recommended) [CTUh]	1.40E-03	1.88E+03	2.64	4	**10.55**
Ionising radiation, human health effect model, ReCiPe [kg U235 eq]	2.07E+03	8.85E-04	1.83	6	**11.00**
Marine eutrophication, EUTREND model, ReCiPe [kg N-Equiv.]	2.57E+02	5.95E-02	15.31	2.33	**35.72**
Ozone depletion, WMO model, ReCiPe [kg CFC-11 eq]	1.39E-02	4.63E+01	0.64	4	**2.58**
Particulate matter/Respiratory inorganics, RiskPoll [kg PM2,5-Equiv.]	3.21E+00	2.07E-01	0.67	7	**4.66**

Impact category	TOTAL (from Table 7)	Normalisation factor [*]	Normalisation result	Weighting factor [ ]	Weighted result
Photochemical ozone formation, LOTOS-EUROS model, ReCiPe [kg NMVOC]	2.14E+01	3.14E-02	0.67	5	**3.37**
Resource Depletion, fossil and mineral, reserve Based, CML2002 [kg Sb-Equiv.]	3.31E+00	1.00E+01	33.06	7	**231.42**
Terrestrial eutrophication, accumulated exceedance [Mole of N eq.]	7.94E+01	5.75E-03	0.46	2.33	**1.07**
Total freshwater consumption, including rainwater, Swiss Ecoscarcity [UBP]	1.20E+03	1.27E-02	15.23	5	**76.17**
IPCC global warming, incl biogenic carbon [kg CO2-Equiv.]	1.58E+04	1.10E-04	1.73	23	**39.81**
Primary energy demand from ren. and non ren. resources (net cal. value) [MJ]	2.76E+05	3.45E-06	0.95	11	**10.47**

*** The unit is always 1 divided by the unit of the respective impact category, resulting in results of the dimension 1 ("dimensionless").**

Summing up the results of the last column in Table 8, one obtains the overall environmental impact of the UPS+batteries system, per year, of 383.48 [-].

6.2 Life Cycle Costing

6.2.1 Overview

Life cycle costing is a compilation and assessment of all costs related to a product, over its entire life cycle, from production to use and maintenance, and the product's end-of-life.

Life Cycle Costing is a mandatory requirement in the EU Procurement Directive, since 2004; its use has been reinforced in the 2014 Directive. The aim is to estimate the overall costs of procurement alternatives to ensures that the lowest overall cost consistent with its quality and function. Two principle options are in wider use in public bodies and policy: Total Cost of Ownership (TCO), and environmental Life Cycle Costing (eLCC).

The TCO captures costs actually paid by the procurer in direct relationship to the procured product over its life cycle.

eLCC captures in addition the wider societal environmental costs related to emissions and resource depletions over the product system's life cycle, also known as "externality costs". Both are used in different product groups in procurement and policy decision support and Impact Assessment.

In EURECA we focus initially on TCO, but foresee to express the wider environmental impacts calculated in the EURECA framework also by externality costs towards the more complete eLCC.

6.2.2 Purpose

The purpose of this chapter is to select and where necessary adjust a suitable life cycle costing method for use in EURECA self-assessment of existing server rooms / data centres at public bodies and for any subsequent procurement decision support. The method will also be used in WP5 to address the EURECA project's cost-benefit.

6.2.3 Introduction and status quo

Life cycle costing is a compilation and assessment of all costs related to a product, over its entire life cycle, from production to use and maintenance, and the product's end-of-life. Two principal options are in wider use in public bodies and policy: TCO or eLCC.

It is an important to understand the two different concepts that being used for procurement: environmental Life Cycle Costing (eLCC) and Total Cost of Ownership

(TCO); either can be meant with the term Life Cycle Costing (LCC). They are two important financial measures for decision making in acquisitions to evaluate the wider cost of any capital equipment (Hampton 2004; Humphries 2004).

Total Cost of Ownership aims 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.

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 to also include indirect (external) costs shared by society (eLCC). That is, again starting from requirement analysis, design, production, operation and maintenance until disposal. 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 public procurement is stepwise moving to use eLCC instead of “only” TCO.

eLCC 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 (Dinesh Kumar 2004).

Both TCO and eLCC are used in different product groups, e.g. TCO as default case for most procurement cases and eLCC e.g. for vehicles under the Clean Vehicle Directive (European Commission 2015c). Many online tools and guides are available for TCO and also some for eLCC, both generic ones and for specific product groups; a valuable and data centre specific guide for TCO are the German procurement guidelines and online tool for Data Centres and hardware (http://beschaffung-info.de/)

The European Commission currently develops via a support contract a new online LCC tool. The finalisation is expected in 2016.

Figure 14Illustration of life cycle costing approaches. Note that the respective share of the “iceberg” differs considerably among different product groups. Energy-using products often carry a big share in the Use phase and the Environmental damage.

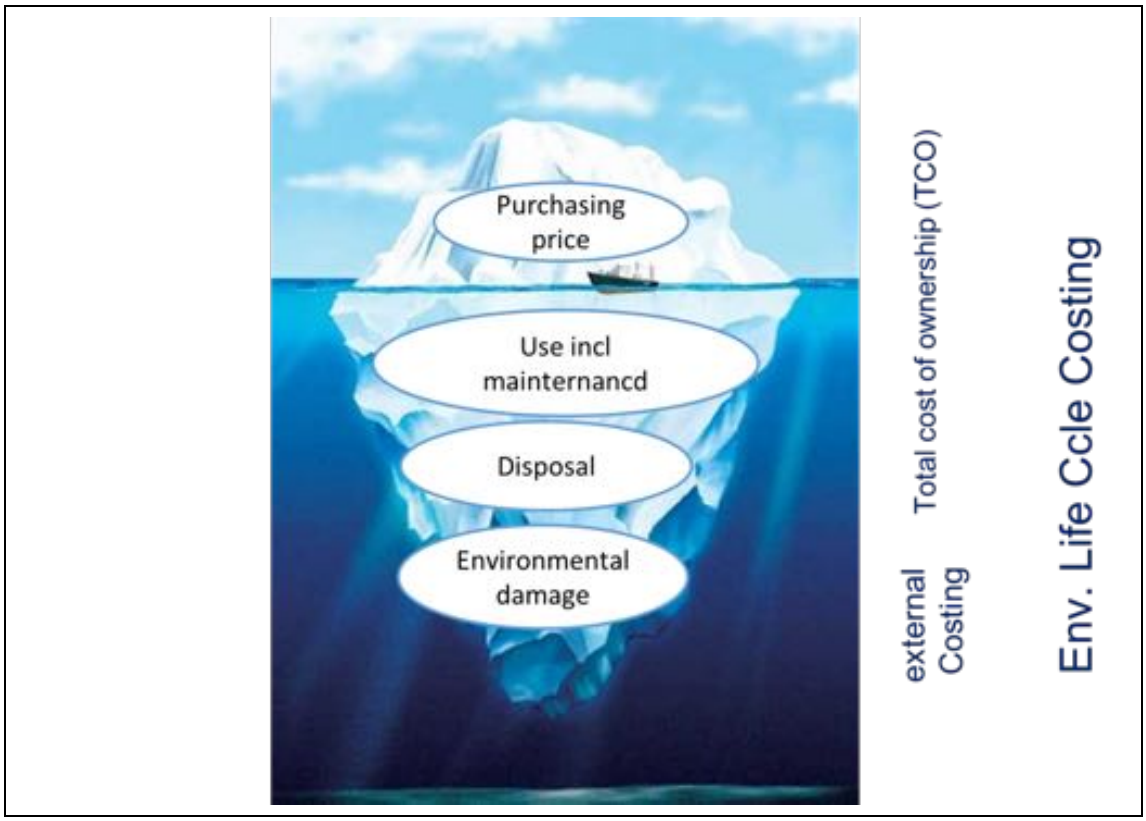

Figure 14 Iceberg analogue to illustrate the different components of environmental life cycle costing

6.2.4 Methodology

Life cycle costing (as TCO) considers a part from data on electricity costs, staff costs (for in-house server rooms) and similar, the following input data are required (taken from German DC procurement guidelines, extended; details see Annex 11.11):

- One-time payments for the procurement of the product (Initial cost):
  - purchase price for hardware
  - purchase price for software
  - purchase price for additional services and related in-house costs (e.g. training of own staff on using a procured innovative technology)
- Information on the calculation of consumption-related costs:
  - total annual energy consumption
  - annual cooling demand (heat load)

- annual license fees
- annual cost of services
- annual costs for consumables
- annual costs for additional services

- One-time payments at end of use
  - Disposal costs at the end of use, future price

Operation and support costs have to be calculated to present value. Other costs include for example taxes and fees and are also calculated to present value.

$$NPV=C0+ t=1NCt(1+r)t$$

Where

NPV = net present value (Monetary)

C0 = initial cost

Ct = consumption related costs

r = the discount rate (cost of capital – interest rate on money used elsewhere): use 5-10%

N = number of year

or

$$LCC=I+Repl-Res+E+W+OM\&R+O$$

Where

LCC = Total LCC in present-value (PV) euro of a given alternative, as TCO

I = PV investment costs (if incurred at base date, they need not be discounted)

Repl = PV capital replacement costs

Res = PV residual value (resale value, salvage value) less disposal costs

E = PV of energy costs

W = PV of water costs

OM&R = PV of non-fuel operating, maintenance and repair costs

O = PV of other costs

Example – TCO of Competing Heating / Cooling Systems [Harvard]

Electric baseboard and window air conditioner

Financial Criteria:

Discount Rate d = 8%

Energy Escalation = 6%

Maintenance Escalation = 5%

Study Period N = 15 years

Investment Related Costs

- Initial Cost 1,500 Euro
- Replacement Cost Year 8 (Base Yr Euro) 400 Euro
- Residual Value (Year 15) 150 Euro

Operation Related Costs

- Base Year Electric Energy Cost 1,200 Euro
- Base Year OM&R Cost 50 Euro

LCC = 1,772 + 16,156 = 17,927 Euro

7 Award criteria rules set

7.1 Overview

A key component of the EURECA framework are the contributions to the award-point scheme of tenders for the procurement of data centre products and data services. These have been developed in line with the latest procurement Directive of 2014.

The new Procurement Directive has a couple of further developments, which are of relevance for EURECA, compared to the previous 2004 Directive:

- Clearer conditions on how to establish collaborative or joint procurements which can provide the necessary demand to launch new solutions;
- The creation of innovation partnerships which enable a public authority to enter into a structured partnership with a supplier with the objective of developing an innovative product, service or works, with the subsequent purchase of the outcome (PPI);
- The exemptions for procurement of R&D services currently included in the new Directives (which are the basis for PCP) will be maintained. Public procurers can therefore continue to undertake pre-commercial procurement.
- Strengthening the use of life cycle costing, which describes all the phases through which a product passes from its design to its marketing and the discontinuation of its production; contracting authorities may select to include costs imputed to environmental externalities in this calculation.
- Technical specifications and award criteria may refer to any stage of a product lifecycle, including addressing specific production practices, „provided that they are linked to the subject-matter of the contract and proportionate to its value and its objectives" (Art. 42).
- Product labels can be required as means of proof in technical specifications, award criteria or contract performance conditions as long as all the underlying criteria of the label are linked to the subject matter of the contract.

The first three items in the above list are relevant on higher level and do not affect the core functionality of the EURECA framework. The last three items are relevant for the award criteria, both the economic ones and the technical ones (including on environmental and energy performance).

The main principle is still the MEAT cost-effectiveness, specified in the Directive "*The most economically advantageous tender from the point of view of the contracting authority shall be identified on the basis of the price or cost, using a cost-effectiveness approach, such as life-cycle costing in accordance with Article 68, and may include the best price-quality ratio, which shall be assessed on the basis of criteria, including qualitative, environmental and/or social aspects, linked to the subject-matter of the public contract in question.*"

Environmental criteria (under which we here include the primary energy consumption) are hence to be part of the quality award criteria.

For the life cycle costing, we will provide the total cost of ownership as base result, but foresee to provide the external cost as additional information to the public procurers, as evidence for the relevance of environmental issues in the respective procurement case.

The combined environmental and energy related performance of the product or service will be judged by their calculated life cycle performance results, calculated as specified in chapter 6.1. In addition relevant, recognised labels as listed in Table 11 more below are considered as well.

Criteria that relate to existing legal requirements (RohS, WEEE, REACH, …) are omitted as not adding information. Finally, information of little quantitative relevance or that is potentially misleading (e.g. use of bio-based materials, use of recycled materials for servers, recycled content for metals, recycling rates for packaging, …) is omitted for efficiency and to ensure robustness and reliability of the data/indicators.

7.2 Exclusion and Selection criteria – not used

EURECA procurement decision support is using exclusively the Award criteria – typically with thresholds to be passed, i.e. has no specific provisions for the Exclusion and the Selection criteria. These are to be defined by the public sector procurer following the standard approach of the organisation.

However, it should be avoided to put any potentially incompatible requirements regarding environmental or energy performance into the Selection criteria: For example, if use of packaging material made exclusively from recycled materials would be made a Selection criterion, this might very easily lead to not be able to select products that in overall perspective are much better environmentally and energetically, than those that may ship in such packaging. The compilation of the award criteria that are provided here - for free use and on own responsibility of

course – have been compiled taking into carefully account the most relevant aspects of the products that determine their environmental and energetic performance. EURECA advises to rely exclusively on the award criteria for differentiating the environmental and energy performance of the offers. As will be detailed below, the balanced EURECA award criteria combine the products' quantitative environmental and energetic performance (i.e. considering their technical performance) as well as qualitative elements, such as adherence to standards and similar.

7.3 Award-point scheme and thresholds

The following considerations have been made when developing the award point scheme and particularly the balance between technical quality and environmental/energy criteria, for procurements were not only the cost is considered, but were also the different technical quality of the products is considered (i.e. RFP, PPI, PCP). Two variants exist however:

- Variant A, where the minimum technical performance e.g. of data storage space and bandwidth and guaranteed traffic is fixed and a better technical performance is not considered. I.e. offering e.g. more storage space is not awarded extra, or a higher-than-required security level is not rewarded extra. This should be considered the normal case, as the public sector organisation is procuring products to meet a specified demand and it is argued that there is generally no value of procuring more than what is needed.
- Variant B, where extra performance is awarded, as it adds value to the public sector organisation. Such can make sense in some cases, e.g. procuring faster servers, having a faster technical service reaction/replacement time guaranteed for defect products, etc.

In Variant A (and equally in cases of RFQ), exclusively the environmental and energy performance criteria make up the Quality criteria, as the technical quality is pre-decided. In that case up to 50% of the award criteria – next to the other at least 50% cost criteria – can hence be used to procure the more environmentally and energy performing products.

In Variant B, in contrast, the technical quality of the products has to be considered as part of the award criteria. This should be done by specifying the minimum required

technical performance for the tender, and awarding extra points for performance beyond this threshold[3].

Furthermore, the different procurement scenarios have a different degree of product-specific life cycle results and other, additional award criteria. The award point system has to be adjusted accordingly, balancing these aspects.

Particularly, as the environmental and energy impact from production and end-of-life is not differentiated for any product or DC data service, except for HDD, UPS/batteries and PV, for the former cases exclusively the use stage is considered in the award criteria; this is illustrated for "Servers" in the below award criteria example. For HDD, UPS/batteries and PV, alternatively, the producer can provide model-specific LCA results in line with the Commission's PEF. For these products the award points have the option that considers these model specific results in relationship to the best-in-market results (that will be provided by the EURECA project). An example for the respective award scheme is provided in the following chapter.

[3] This Variant B is basis for the following considerations:

It is a given that cost (as life cycle costing, LCC) and quality of the product (incl. the technical & service, environmental and energy performance) are to be weighted equally (MEAT principle). We choose a scheme of 100 award points, half of which are attributed to the life cycle cost, half to the quality of the product, which is composed of the technical quality of the product (for illustration we set here up to 40 points) and environmental and energy performance (up to 10 points). Thresholds of 60% of the maximum achievable award points are used to avoid unacceptable low performance in the technical quality and environmental and energy performance.

Now, assuming the cheapest offer is 2/3 of the LCC of the most expensive one that also achieves the minimum technical product quality. In that case, the cheapest offer gets 50 C points, the most expensive offer gets 34 C points (i.e. 2/3 of the cheapest). Would there be no cut-off on the minimum environmental and energy performance, the cheapest offer could have extremely bad environmental and energy performance (i.e. get 0 points) and the most expensive offer - even if it has the highest environmental and energy performance and gets EQ 10 points - will not be able to compete with the cheapest offer. In numbers: 34 + 10 = 44 is lower than 50 + 0 = 50, i.e. the cheapest offer wins.

If the cut-off is 60% for the EQ, i.e. the cheapest offer is now assumed to now also have got at least 6 EQ points, the four points extra that the more expensive and more environmentally sound offer gets do matter even less: 34+10 = 44 vs 50 + 6 = 56.

That illustrates that environmental and energy performance should get more than 10 points, i.e. more than 10% relevance overall. Accordingly, the following example case of the award scheme assumes 20 award points, i.e. 20% overall relevance.

7.4 Example award point scheme

Follows in green font the text for the award criteria with the example for the procurement of 1U servers. This text covers the computational performance and the energy/environmental performance aspects.

Important: any other technical criteria on the server that it must fulfil are to be worked out together with the IT experts at the public body or an external consultant and integrated as minimum specification into the tender documents by the procurer, as selection criteria; these would be not part of the award criteria, while offers where the server does not meet these minimum criteria would be not eligible.

Analogous proposed award criteria texts for procurement calls will be prepared for the other main procurement scenarios; draft aspects to be considered are documented already in Table 11 in the Annex.

Phase II: award

Best value for money

The contract will be awarded to the bid showing the best value for money on the basis of the following criteria, in decreasing order of importance:

1. *Quality (Q)* *(max. 50 points)*
2. *Cost, in life cycle perspective (C)* *(max. 50 points)*

The sum of the above criteria will determine the total score (TS) of an offer:

TS = Q + C

The highest total score TS will determine the bid with the best value for money. A maximum of 100 points can be obtained.

Quality of the offer Q

The quality criterion Q is composed of two subsets; Q = TQ + EQ:

TQ = Technical quality of the offer

EQ = Environmental and energy performance of the offer

A maximum of 50 Q points can be achieved, in line with the Directive that foresees to equally weight life cycle cost and quality.

The TQ and EQ award points are evaluated on the basis of the sub-criteria indicated in the tables below.

The Technical quality TQ points will be given by the sum of the points achieved in each sub-criterion in table below. A maximum of 30 TQ points can be obtained. The total technical quality points will be rounded to the nearest whole number.

Bids achieving a TQ of less than 18 points (60 % of the maximum 30 points to be awarded) will be excluded. The same 60% cut-off minimum requirement also applies to the sub-criterion 1 of table below.

TQ Sub-criteria	***Maximum score***	***Scoring rule***
1. Performance	*25/30*	*This criterion is intended to assess the computational performance of the server. Considered is the. SPECfp_rate_base2006 result.* *The maximum 25 award points will be awarded to results of 130 (or more).* *Proportionally less award points will be awarded for lower results than 130, as follows: Award points = (SPECfp_rate_base2006 results / 130) * 25.* *Note: servers achieving lower SPECfp_rate_base2006 results than 78 are excluded (cut-off at 60% of the maximum considered performance).*
2. Extended warrantee	*5/30*	*This criterion is intended to assess the guaranteed durability (via a replacement guarantee by the same or better model) of the server, in years.* *Each additional full year warrantee beyond the legally obligatory full two years is awarded with an extra of 2 award points, up to a maximum of 5 award points; partial years are not considered.*

Table TQ award sub-criteria for the 1U server

The Environmental and energy performance EQ points will be given by the sum of the points achieved in each sub-criterion in table below. A maximum of 20 EQ points can be obtained. The total technical quality points will be rounded to the nearest whole number.

Bids achieving an EQ of less than 12 points (60 % of the maximum 20 points to be awarded) will be excluded. In addition, a 60% cut-off minimum requirement applies to sub-criterion 1 (i.e. 9 points) and of 20% to sub-criterion 2 (i.e. 1 point), in table below.

EQ Sub-criteria	***Maximum score***	***Scoring rule***
1. Life cycle environmental and energy performance	*15/20*	*This criterion is intended to assess the life cycle wide environmental and energy performance of the offered product.* *Award points = 150 / (((Electricity consumption at max utilization + power consumption at idle) / 2)) * 15* *Notes:* *Since server production and end-of-life are not differentiated, only the use phase electricity consumption is considered. In the above equation it is measured in Watt.* *The value 150 [Watt] in the above equation represents the currently best performing servers in the market.*
2. Other environmental criteria on product or organisation level, as applicable	*5/20*	*This criterion is intended to assess the availability of selected additional criteria, which are awarded points as follows, up to a maximum of 5 award points:* *Product having one or more EU-level or EU Member State recognised Type I labels: 2 award points.* *Product having one or more ISO14040/44 studies, PEF results, and/or type III EPD results provided: 1 ward point.* *Product having the Energy Star version 2 awarded: 2*

		award points. *The main manufacturer of the product having an EMAS or other eligible[4] environmental management scheme implemented: 1 award point.* *The tenderer or manufacturer having a free-of-charge take-back scheme with guaranteed complete recycling down to the contained materials, and disposal of any remaining waste inside the EU: 1 award point.*

Table EQ sub-criteria for the 1U server.

Cost, in life cycle perspective C

The cost criterion C is evaluated as follows:

A maximum of 50 points will be obtained by the bid with the lowest life cycle cost, calculated according to the provisions in chapter X. The other offers will be ranked linearly according to the following formula:

C = (Cmin/Co) x 50

where

C: cost points of each offer

Co: life cycle costs of each offer

Cmin: life cycle costs of the offer with the lowest life cycle cost

50: maximum cost points obtainable

The cost points will be rounded to the nearest whole number.

[4] Eligible environmental management schemes, acc. to 2014 Procurement Directive, Article 62, point 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.*“

8 Directory

8.1 Best practices, Standards and Guides

The structure and format used in D1.1 will be used to characterise and classify the many Standards and Guides that have been compiled.

The Best practices will be characterised by title and description (as provided in the EUCoC) plus reference to the applicable procurement scenario(s) if any.

8.2 Products, Services, and Providers Directory

8.2.1 Overview

The Products, Services and Vendors part of the EURECA Directory (also referred to as "Market Directory") serves different functions within the EURECA framework; details see Figure 3.

Key is the strict vendor neutrality of this Directory. This is achieved by allowing any vendor who wishes to do so, to free-of-charge characterise the offered products or services, using the common template/form provided by the EURECA project. The easiest way to provide entrance to this database is hence to enable vendors to provide information via a template.

The market directory is a database with vendors and data of specific products and services - related to the data centre industry. In this market directory, procurement officers can browse through different products and services from different vendors. An existing example of a data centre market directory of Data Centre Management, a magazine where vendors are grouped in different products categories (http://issuu.com/closerstill/docs/dcm-buyers_guide_2014-15_low_res) and present themselves in alphabetical order. In EURECA however, we go two steps further:

Firstly, will the projects and services be included and not with free descriptions, but with a structured set of characteristics that ease searching and filtering to identify what the market offers for a specific need (e.g. UPS in the size class of 5 to 10 kVA).

As second step, the EURECA project needs to make sure that these templates will retrieve the information needed, in order to also make the LCA analysis to quantify the possible energy savings buy environmentally sustainable products and services. For example, asking the amount of energy a certain piece of hardware needs to perform at certain level (idle state, in full operation). In that way, energy

consumption comparisons can be made. There will be a data field that the vendor would need to fill in, stating the energy use at a certain performance level. This information will have the status of a public claim, hence the vendor alone will be responsible and liable for any potential wrong claims (or can chose to leave the field empty, meaning its environmental performance cannot be calculated/approximated).

The sustainability of the EURECA tool and how to embed this in the right organizational setting is the subject of WP4 Sustainability Strategy (D4.2).

8.2.2 Product and services scope and levels of detail

The market directory will need to identify DC products and services, with the key products and services that will have a detailed characterisation in **bold**; the full specification for all main products of the "products" part of the EURECA Directory is found in Annex 11.8:

- Audit/Assessment
- Cabling
- Certification
- **Cloud services**
- **Colocation**
- **Consultancy services**
- Contamination control
- **Cooling**
- **DC Design & Build**
- DC Monitoring
- Facilities management
- **Fire prevention**
- Fuel solutions
- Humidifiers
- **IT Hardware**
    - **Servers**
    - **Storage**
- **IT Software**
- Legal advice

- Making business case
- **Power distribution**
  - **DC-level**
  - **Batteries**
  - **Transformer**
  - **UPS**
- Project management
- **Racking & Enclosures**
- Remote hands
- Security
- Training and recruitment
- Transportation services
- **Virtualisation**
  - **DCIM**
  - **Server**
  - **Storage**

The products can be seen independently, however, in order to improve data centre procurement or the procurement of data centre services and products, other issues need to be considered. For example, if an organization wants to procure new servers, there are tender issues, energy efficiency issues, price issues. Maybe the procurement process itself requires project management.

8.2.3 Example specification and questionnaire/form for vendors

The following table is an extract for the product type “Servers”, with the key technically, energetically, environmentally and cost-wise relevant characteristics of servers that is sought after in the market by the Public Procurer. The key technical performance criterion is the SPEC SERT (or SPECpoer_ssj2008 - tbd) results (marked in the Table 9 in blue).

The hereunder mentioned characteristics are moreover the necessary basis to identify the best product/vendor, seen from the environmentally and energetically friendly procurement perspective: the respective characteristics will be read in by the EURECA framework and tool and used to calculate the life cycle wide environmental impact profile of the server.

In the award criteria, in addition some qualitative characteristics will receive additional award points, e.g. having the Energy Star.

Table 9 Template/form for vendors to characterise individual servers with the main technically, cost-wise and energetically/environmentally relevant characteristics.

Characteristic	Format/list of possible entries
Type	rack blade other ……
Height (for rack-type), number of U's	[number]
Model release year	[YYYY]
Warrantee in years	[number]
Max energy consumption in Watts	[number]
Energy/Eco mode?	Yes No
Certifications product	EPEAT EU Flower EU national Type I label EnergyStar v. 1 EnergyStar v. 2
Number of standby status available	[number]
Idle Energy consumption in Watts	[number]
Purchase price in EUR	[number]
Long-term reliable server operation inlet temperature in Celsius	[number]
SPEC SERT results (value) **OR** **https://www.spec.org/power_ssj2008/results/power_ssj2008.html**	[number]

Auxiliaries	[Free field (what is in packaging)]
No. of chips	[number]
No. of kernels	[number]
No. of threads	[number]
Onboard storage type	HDD SSD Both other ……
Onboard storage capacity in GB	[number]
LCA/EPD for this model available?	Yes No
Carbon footprint, water footprint for this model available?	Yes No
Link to LCA, EPD, CF, or WF study	[hyperlink]

The full specification for all main products and services of the "products and services" part of the EURECA Directory is found in Annex 11.8.

8.3 Innovative and PCP solutions and support

8.3.1 Characterisation / specification of innovative solutions in the EURECA Directory

An important support to Procurement of Innovative solutions (PPI) and of Pre-Competitive Procurement (PCP) is the provision of success cases in a structured and comparable form, as part of the EURECA Directory. The characterisation of such cases is found in annex 11.7.

8.3.2 Core set of Innovative developments under the DC Cluster projects

As initial contribution to the Directory and drawing on the developments of the DC Cluster projects, the following has been compiled:

A survey conducted over 8 innovative data centre projects shows major concerns for Management (such as adding monitoring capabilities, PUE, CUE or other metrics to the data centre) and Computation (workload management, operations, power management or server populations systems) when addressing new solutions. Cooling, power consumption, network solutions and storage capabilities were of a concern too. Each innovative project PCP/PPI solution has different reasons and concerns for building new data centres or retrofitting existing ones. The following sections describe these projects solutions.

8.3.2.1 Definitions

Power: Critical Power Path Efficiency, Architecture, Operations, Generation

Cooling: Mechanical/Refrigerant Cooling reduction, Environmental – monitoring and control, Operations

Management: Monitoring, PUE, Waste heat reuse, CUE, WUE, xUE/additional metrics

Compute: Utilisation, Workload Management, Operations, Power management, Server populations

Storage: Workload, Architecture, Operations, Technology, Provisioning

Network: Utilisation, Workload, Operations, Technology, Base Performance, Provisioning

New Build: for procurers looking to build a new data centre

Retrofit: for procurers looking to enhance an existing data centre

8.3.2.2 GENiC – Globally optimized ENergy efficient data Centres

Project description

GENiC project is developing an integrated management and control platform for data centre wide optimisation of energy consumption by integrating monitoring and control of computation, communication, data storage, cooling, local and renewable power generation, energy storage and waste heat recovery.

The GENiC platform uses common interfaces and data formats, and provides control and optimisation functions and decision support tools to achieve a substantial reduction in energy consumption.

Data centres used

Small/Medium server rooms, Enterprise data centre

Areas of data centre addressed

Power, Cooling, Management, Compute, Storage, Network

Applicability

New build, Retrofit

Prerequisites for deploying the proposed solution

- virtualization technology
- mathematical solvers
- equipment specifications
- system constraints
- data centre layout
- availability of renewable energy supply
- weather date
- grid energy prices

Expected Benefits

- improve operational performance of data centres (<1.3 PUE)
- 25% energy reduction
- renewable energy penetration in excess of 80%

Return on Investment

IT service provides / data centre owners:

- cost transparency
- lower operational cost, resulting from lower energy cost
- better cost-performance ratio
- Data centre operators / facility managers:

- energy/cost savings without violating service level agreements (SLAs)
- automatic control over several complex components
- monitoring and decision support tools
- fault tolerance

Data centre planners:

- design criteria for energy- and cost-efficient data centres
- optimisation tool chain

Energy providers:

- better distribution of available energy resource
- thriving renewable energy market

Market readiness

- Ongoing pilots in Ireland and Spain
- Available documentation at project website

IPR licensing model

Under commercial license

8.3.2.3 DOLFIN – Data centres Optimization for energy-efficient and environmentalLy Friendly INternet

Project description

DOLFIN aims to significantly contribute towards improving the energy efficiency of Data Centres and stabilizing of Smart Grids, a holistic approach, across networks of Data Centres and Smart Grids. Today, most DCs are part of computing and storage clouds, offering their customers Virtual Machines (VMs) as a virtual operating environment. DOLFIN will model, monitor, and measure energy consumption and enable seamless, autonomic migration of VMs between servers of the same DC or across a group of Energy-conscious, Synergetic DCs, aiming to:

- optimise the overall energy consumption by dynamically changing the percentage of active versus stand-by servers and the load per active server in a DC, and

- stabilize the Smart Grid energy distribution, under peak load and increased demand, by dynamically changing the energy consumption/ production requirements of the local DCs.

Data centres used

Small/Medium Server room, Enterprise Data Centre, Colocation Data Centre

Areas of data centre addressed

Cooling, Management, Compute, Network

Applicability

New build, Retrofit

Prerequisites for deploying the proposed solution

The proposed solution can be integrated in any Data Centre, new or existing, hence, the standard Data Centre equipment (e.g. UPS, Cooling systems, etc.). Regarding the Cloud Management infrastructure, a base requirement is the deployment of a multi-node Openstack Infrastructure and the provider support for flexible, automated SLA Renegotiation. Also, the existence of a IT monitoring framework (e.g. Openstack Ceilometer) is also needed, together with the existence of an energy measurement equipment able to transmit measurements over the LAN.

The existence of renewable energy sources is supported but not necessary for DOLFIN to operate. Similarly, the existence of green servers/rooms and green cooling are supported, but not considered prerequisites.

Expected Benefits

Expected benefits are expected to be over 20% in the energy efficiency of the DOLFIN enabled Data Centres, the cost benefit being slightly larger when combined with active Smart Grid interaction through Demand Response. In the same context, a 15% of CO2 reduction is expected from the respective reduction of the energy consumption for IT and Non-IT (e.g. optimization in the cooling equipment scheduling) equipment. Last, a non-quantifiable benefit derives from the balancing services offered to the Smart Grid, introducing the chance for better energy quality which, in turn, can lead to decreased infrastructure maintenance costs.

Return on Investment

A relevant ROI analysis has not been completed yet. However, based on the expected benefits already presented and considering that the DOLFIN solution will be only gradually adopted at large scale from single-operated Data Centres and even

more gradually to federated ones, it is anticipated that ROI should start approximately 2 years after the initial DOLFIN instantiation by a Data Centre, leading to a gradual increase of ROI as more Data Centres join the DOLFIN federation.

In the case of large-scale adoption of DOLFIN by multiple, synergetic Data Centres, the expected benefits, thus ROI, are anticipated to increase super-linearly to the number of involved Data Centres, due to the coordinated cost-benefits exhibiting super-additive behaviour.

Market readiness

The DOLFIN platform is currently being tested in large Data Centres, both industry- and education-oriented. The respective partners are:

- Wind, Italy (industry)
- Interoute, Italy (industry)
- Greek Research & Technology Network, Greece (NREN)
- Poznan Super Computing Centre, Poland (NREN)

The results of the validation and evaluation of the DOLFIN platform application on top of these infrastructures will be available by the end of the project, September 2016.

IPR licensing model

None

8.3.2.4 GEYSER – Green networked Data Centres as Energy Prosumers in smart city environments

Project description

In the GEYSER vision, Data Centres act as energy prosumers within Smart Cities. They exploit available energy sources and perform flexible management of the ICT workload and non-IT components. This enables Data Centres to optimize their energy demand by continuously selecting the most attractive energy profile available. Proper Smart City (urban) environment with Smart Grid capabilities must be envisioned, that is, a new concept of local energy market able to handle a mix of dispersed energy sources. But each city context is slightly different, which is why any (contributing) technology needs to be flexible enough to create the best fit. GEYSER focuses on some of the key challenges associated with realizing this vision. These include:

- developing solutions which optimize the Data Centre's use of dispersed current and near-term available energy options
- developing solutions which support advanced interaction between the Smart City and the Data Centres, which go beyond demand/response mechanisms
- developing solutions which enable the Data Centre to dynamically adapt its ICT workload to the energy requirements conditions in co-ordination with Data Centres customers.

The crux of GEYSER is to match energy supply with computing resource demand in the most efficient way which ultimately reduces the urban energy footprint.

GEYSER is developing an innovative software-based framework whose main components are:

- an advanced Data Centre management and control system which has a complete and fine-grained view of all Data Centre components as well as current and future energy supplies
- a network-wide Data Centre management and control system which can leverage differences between available resources - both energy and ICT workload - across a network of interconnected Data Centres
- a model of a local energy market which can be used to demonstrate how the Data Centre would react to changing energy conditions.

Data centres used

Enterprise Data Centre, Colocation Data Centre, HPC, Managed Service Provider, Managed Service Provider in colocation

Areas of data centre addressed

Cooling, Management, Compute

Applicability

New build, Retrofit

Prerequisites for deploying the proposed solution

Data Centres considered in the GEYSER are assumed:

- to be layer 3 Data Centres as described in the Green Grid Maturity Model. In particular, they should be equipped with a monitoring infrastructure able to collect measurements related to both IT and Non-IT equipment and to alert the Data Centre Manager in case of fault of sensors, RES (Renewable Energy

Sources) and storage equipment (whereas such available) in order to take the corrective actions for ensuring the proper operation of the GEYSER framework.

- to be located in an urban agglomeration (smart city) implementing policies, operations and infrastructure enabling smart transmission and distribution of energy either electricity, heat or cool.

Under the above mentioned prerequisites, the GEYSER solution will be able to provide a basic set of functionalities but, depending on specific conditions under which Data Centres can operate, further innovative functionalities can be provided.

- Whenever IT Workload Federated Data Centres are considered, they are assumed to have already entered into agreements and secure communication channels for the IT workload relocation.
- Whenever an explicit energy coordination of a group of Data Centres is considered, they are assumed to have already entered into agreements for buying/selling energy as a group through an Energy Aggregator at more profitable prices. It is also assumed that secure communication channels for information exchange are already in place.
- Whenever the possibility of incorporating the on-site generated energy is considered, the Data Centre is supposed to have in-house renewable energy sources such as solar panels on their roof or windmills in their premises as well as available brown energy sources, for example diesel electric generators.
- Whenever the possibility of incorporating temporarily stored energy is considered, the Data Centre has energy storage technology available, such as aquifer, flywheel, ice storage tanks, and UPS (Uninterrupted Power Supply).
- Whenever feeding electricity, heating, cooling or a combination in the related grid is an option, the Data Centre has connection points with the corresponding grid(s).
- Whenever participation to a Demand Response program with the local DSO is an option, the Data Centre Manager has to register the participating asset/resource.
- Whenever participation in the Energy or Ancillary Services Marketplace is an option, the Data Centre Manager has to register as Market Participant and accept the rules of the marketplace operation

Expected Benefits

Expected outcomes will be beyond-SoTA values for energy efficiency metrics, i.e PUE below 1,20 and CUE and ERE improvement by 30% in average.

Return on Investment

It is still under evaluation

Market readiness

The GEYSER suite is being tested and validated within 4 pilot sites:

- Alticom Data Centres, The Netherlands
- ENG Data Centre, Point Saint Martin, Italy
- ASM Terni Data Centre facility, Terni, Italy
- Aachen University Data Centre facility, Aachen, Germany

The results of the evaluation will allow to estimate real benefits for different types of Data Centres.

IPR licensing model

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8.3.2.5 GreenDataNet – Green and Smart Data Centres Network Design

Project description

The GreenDataNet project aims at designing and validating a new, system-level optimisation solution allowing urban data centres to radically improve their energy and environmental performance. The objective is to develop a set of beyond state-of-the-art technologies that will allow urban data centres to reach 80% of renewable power and decrease their average Power Usage Effectiveness (PUE) from 1.6-2.0 today to less than 1.3. GreenDataNet will enable energy monitoring and optimisation of IT, power, cooling and storage at three levels: servers and racks, individual data centres, and networks of data centres. To further reduce the need for grid power, GreenDataNet will also work on the integration of local photovoltaic energy in combination with an innovative, large-scale storage solution that will facilitate the connection of data centres to smart grids. Within this project, second-life electric vehicle Li-ion batteries will be investigated as a more advantageous solution for data centres to become actual smart grid nodes.

The whole solution will be implemented as an open-source platform to allow third parties to provide additional optimisation modules and ensure the long-term sustainability of the project. Three demonstration sites will be utilised to test and validate the GreenDataNet concept: a data centre from Credit Suisse in Switzerland, a data centre from CEA in France that includes a large photovoltaic area and a smart grid test platform, and data centres from end users who contacted the consortium. In addition, research on heat reuse vs. free cooling will be conducted in a new data centre built by ICTroom in Belgium. Performance indicators that go beyond PUE will be experimented in the project and will support the work of the consortium in standardisation bodies like SC39 and CEN/CENELEC/ETSI. Based on the project outcome, GreenDataNet will release guidelines to help make data centres more sustainable in the future.

Data centres used

Small/Medium Server room

Areas of data centre addressed

Power, Management, Compute, Storage

Applicability

New build, Retrofit

Pre-requisites for deploying the proposed solution

The idea is to be able to apply the innovations to any urban data centre (defined in the range of power between 20 and 250 kW).

Ideally it should have some available space to install PV panels and some space to place Nissan EV batteries

Expected Benefits

Urban data centres to reach 80% of renewable power and decrease their average PUE (Power Usage Effectiveness) from 1.6-2 today to less than 1.3.

Increase of the lifecycle duration of Electrical Vehicle Battery (roughly 10 years more)

Additional

Return on Investment

N/A

Market readiness

1 Pilot is already up and running in a small server room and the prototype is ready to be deployed in more pilot sites for Data Centre managers interested in improving their energy consumption and the environmental footprint of their DC.

IPR licensing model

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8.3.2.6 DC4Cities – An environmentally sustainable data centre for Smart Cities

Project description

DC4Cities aims to achieve the optimal energy source usage in urban eco-friendly data centres, through a unified management of computational workload and characterization of available energy.

The goal of DC4Cities is to let existing and new data centres become energy adaptive by

- - adapting the power consumption to the availability of renewable energy
- - being adapted to the requests received by the Smart City Energy Management authority.

Data centre optimization policies will be focused on efficient usage of IT equipment, making sure the workload is concentrated on the minimal amount of hardware, b) scheduling policies will manage workload activities in such a way that IT equipment load will adapt to the energy constraints coming from the authorities managing Smart City energy plans and from the energy provider and c) software applications will have the chance to directly become energy adaptive, and internally reorganize their behaviour to also match energy constraints.

Data centres used

Small/Medium Server room, Enterprise Data Centre, Managed Service Provider

Areas of data centre addressed

Management, Compute

Applicability

New build, Retrofit

Pre-requisites for deploying the proposed solution

- Renewable energy availability prediction
- Weather forecast
- Identification of DC workload that can be flexibly executed on time (earlier or later) always respecting SLAs and GreenSLAs
- Smart city policies and needs with respect to energy supply

Expected Benefits

DC4Cities maximize the usage of renewable energy in a DC. DC4Cities can tune REN usage (lower price) vs. economic penalties coming from cities or customers (SLAs), so the best balance is a decision from the DC manager. REN usage target range can vary from 30% to 80%.

On top of this, DC4Cities saves 20% of energy consumption due to the optimization of workload allocation (single site and federated DCs)

Return on Investment

This depends of the business model adopted. But most obvious one is: One data centre applying DC4Cities will be able to offer a better price to their customers thanks to the savings maximizing the use of REN energies (do the same work in the most convenient timeframe).

Market readiness

TRL 7 - System prototype demonstration in an operational environment. The working prototype will be available at the end of the project, partially public under an Open Source license. Additionally, consultancy and maintenance services will be provided by project partners.

IPR licensing model

The core components will be released under an Open Source license. Connectors to commercial products will be released under Commercial license.

8.3.2.7 All4Green – Active collaboration in data centre ecosystem to reduce energy consumption and GHG emission

Project description

All4Green - Active collaboration in data centre ecosystem to reduce energy consumption and GHG emissions - broadens the scope of energy savings to the full

ecosystem in which data centres operate, instead of focusing on the energy optimization of single ICT elements, or subsets of the ICT elements making up a data centre. The novel approach proposed by All4Green specifically fosters collaboration between all entities in this ecosystem with the common goal of saving energy and emissions (hence the name of the project): ICT users deploying services in the data centre, electrical power providers, and data centres cooperating in a federated way. The project demonstrates that this collaboration is not only beneficial for the environment, but also economically sustainable, and therefore not limited to customers with a strong green/ecological conscience.

All4Green provides new flexible contracts between ICT users and data centres, revolving around the use of Green-SLAs to enable new energy saving policies that can be tailored to different computing styles and can be used with all data centre monitoring and automation frameworks. In addition, matching energy demand patterns of data centres and the energy production/supply patterns of the energy producers/providers enables peak shaving, the reduction of inefficiencies in energy production, and the exploitation of renewable energy sources without endangering the stability of the grid.

Data centres used

Small/Medium Server room, Enterprise Data Centre, Colocation Data Centre, HPC, Managed Service Provider, Managed Service Provider in colocation

Areas of data centre addressed

Management, Compute, Network

Applicability

New build, Retrofit

Pre-requisites for deploying the proposed solution

Active collaboration between ICT users deploying services in the data centre, electrical power providers and data centres cooperating in a federated way.

Expected Benefits

All4Green allows saving 10% energy on top of the existing traditional strategies and policies, approx. 20% saving during certain time periods in traditional DCs and cloud providers offering services to geographically concentrated set of users.

The All4Green collaboration between data centre and power provider is capable to allow a temporary 10%-20% reduction of the data centre energy demand.

By the ability to “migrate” workload across the data centre federation All4Green can reduce the transport needs of energy from remote providers, and thus avoid the 10% energy transport overheads.

Return on Investment

Using All4green solution, one DC (one partner running a trial) would save energy: 490.56 €/year for each server. Starting from this, it will be possible to create a complete investment profile (3-year total cost analysis) based on costs and benefits. This investment analysis will be conservative because it is not so easy to deal with more efficient data centre management, better informed capacity planning, because they cannot be monetized as directly as energy and CO2 emission reduction.

The ROI and payback period can be calculated based on a depreciated investment cash-flow analysis over a 3-year period: according to the previous analysis it is expected that, for the trial DC, this results in a short Payback period (less than 1 year) and a 3-yrs ROI greater that 100% and this will be a good achievement in consideration of our participation in the consortium.

Market readiness

TRL 7 - System prototype demonstration in an operational environment. Additionally, consultancy and maintenance services are available, provided by project partners.

IPR licensing model

Core components are available under Open Source license. Connectors to commercial components are available under Commercial license.

8.3.2.8 RenewIT – Advanced concepts and tools for renewable energy supply of IT Data Centres

Project description

RenewIT is intended to produce five main outcomes:

The RenewIT Tool. This will be a Web-based planning tool to help data centre owners, operators and design organizations (such as consortium partner Deerns) understand the economic, energy and sustainability costs of building a facility that uses a high proportion of on-site or grid renewable energy. A series of drop-down boxes will allow an operator to select different forms of on-site renewables such as wind turbines, solar panels, ground-source heat pumps and solar cooling systems. Users will be able to calculate how the efficiency of these technologies compares in

various regions or countries. For example, does a wind or solar-based facility make more sense in southern or northern Europe. The exact specifications of the tool are still being finalized, but it will build on work done by AIGUASOL for the Spanish Institute for Energy Diversification and Saving of Energy (IDEA), which developed a tool called CHEQ4 to help organizations choose among solar heating systems.

Workload management and scheduling. Researchers at organizations including MIT, Akamai and Carnegie Mellon University have spent several years describing how data centre operators might move loads around to take advantage of cheaper power, reaping real savings. This approach is sometimes known as 'follow the moon' and describes a strategy that involves rolling workloads across time zones – even around the world – from data centre to data centre, chasing cheaper or greener power or simply making use of underused resources. BSC will lead the RenewIT consortium's efforts in this area, building on existing research to develop algorithms for scheduling workloads within a facility or between facilities. The project will also develop an energy and environmental monitoring system to understand the energy requirements of data centres. The system will have some overlap with existing data centre infrastructure management (DCIM) tools but will focus on the monitoring and management of on-site renewable sources of energy, as well as IT systems.

Understand the interaction between multiple sources of renewable energy and cooling within data centres. There are different forms of renewable energy and low-energy cooling that could be deployed in data centres. Lead by TUC, the project will attempt to quantify the benefits of these different technologies, as well as the interaction between different combinations of technologies. Examples include renewable heat sources (biomass, solar thermal, geothermal, cogeneration); renewable power generation (wind, solar, photovoltaic, cogeneration); renewable cooling (fresh/free-air cooling, water, snow, sky radiation); and the use of different forms of energy storage. The project will also examine some technologies in more depth, including the use of heat pumps to increase the temperature of waste heat from data centres (to increase the range of practical uses); heat reuse using district heating and cooling systems; and solar cooling (the use of solar thermal energy to drive thermal cooling systems).

Integration with smart-city technologies. Integration with district heating and cooling systems is also important given the EC's belief that, where possible, urban data centres should integrate more efficiently and intelligently with other local buildings and infrastructure. This could take the form of heat reuse but also so-called demand/response where excess (renewable) energy from data centres could be sold back into the electricity grid. In addition, more informal micro-grids could be

established between data centres and other types of infrastructure to generate and distribute energy on a local basis.

Propose new metrics and contribute to standardization efforts. The project will contribute to work already done in the area of data centre renewable energy use, energy reuse and carbon-emission reduction. These efforts include the CUE and energy-reuse effectiveness metrics from industry group The Green Grid but also work done by international, European and national standards bodies.

Data centres used

Small/Medium Server room, Enterprise Data Centre, Colocation Data Centre, HPC, Managed Service Provider

Areas of data centre addressed

Power, Cooling, Management, Compute, Renewable energy use

Applicability

New Build, Retrofit

Pre-requisites for deploying the proposed solution

The main output of the project is the RenewIT tool which is a web-based tool for assessing energy efficiency and renewable energy use.

Expected Benefits

The aim of the concepts will be a high sharing of renewable energy sources up to 80%, measured in terms of primary energy.

Return on Investment

The RenewIT tool is a tangible tool and is the main "product" output from the project. It will be freely available but it is expected to help drive services revenue for the consortium and other stakeholders.

By "tangible" we mean that it is not of course strictly speaking a physical object, but that it can be seen, manipulated, and used to model Data Centre energy in various dimensions. It will be clearly and intuitively accessible through a web interface. The detailed design of the RenewIT Tool and its functionality is an integral part of the value of the RenewIT tool as an exploitable product.

The tool will enable and encourage Data Centre designers and operators to investigate the possibilities of using RES and other advanced concepts, and in this way, reduce power consumption while at the same time improving the overall

environmental impact. Energy savings of up to 80% and an increase in use of renewable energy sources are expected for Data Centres making use of this tool.

The intended exploitation route for the RenewIT tool within this project is through a publicly available web interface rather than as a paid-for product.

It is not relevant to publish the RenewIT Tool itself as either a closed-source or open-source product, since it will consist of a Web GUI and specially programmed interfaces to the back-end meta-models.

This does not prevent the possibility of future commercial or not-for-profit development, however. In addition, the tool could be used to provide analysis which could form part of a consultancy or Data Centre design service.

All of the partners have clear exploitation plans for the enhancement of their own operations, each in their own different ways depending on their skills and business model.

For the partners who are already well established in the Data Centre market, RenewIT will enhance their expertise with new knowledge about energy efficiency, renewable energy, and smart cities. This will enable them to offer services, which are currently not possible.

Market readiness

The project plans to involve a wide range of outside experts, potential early adopters and other interested parties in the project. These groups will be invited to help shape the development of the project as well as directly exploit the final results.

The project set up an Advisory Board in 2014, along the lines of what was done in the EU CoolEmAll project - some of the RenewIT partners we formerly partners in CoolEmAll and found this experience generally very useful.

The Advisory Board consists of representative experts from industrial companies as well as scientific organisations and other opinion leaders. The Board is designed to ensure that the project stays on-track with developments in the industry and in standardisation, through informal and off-the-record advice and possibly also through quantitative surveys of members. The Board members may act as early adopters, or put the project in contact with potential early adopters, who will help to strengthen the RenewIT outputs as products and also build the user base.

In comparison with CoolEmAll , the Advisory Board represents not only the core Data Centre industry, but also expertise in renewable energy and in smart cities more widely. As well as working within the project, some of the Board representatives

have helped with dissemination of the project through joint press releases, using the contacts of their own organisations, and joint webcasts.

The Advisory Board has the following role:

- Help with promotion of the project through press releases, tweet and other social media, joint webcasts, joint conference presentations, support at industry events
- Provide regular external guidance and feedback on the development of the project
- Act as early adopters and testers of the RenewIT tool and its components
- Potentially develop the outputs further as market-ready products

It is not expected that the Advisory Board will meet physically more than once or twice during the course of the project. Instead, telephone or web conferences and an email list will be the main forms of communication. One or two face-to-face meetings in conjunction with a RenewIT project meeting would be ideal, so that members of the Advisory Board can get to know the project participants and make contacts.

Membership of the Board will not require a great deal of effort; it will, of course, not be remunerated, but, in return for their efforts, members will be able to discuss issues of interest with like-minded professionals and to keep up to date with developments in the Data Centre and energy research communities.

As a core element of the validation process, the project has defined a set of real world case studies and matched the classes against the participating data centres. On one hand, the case studies will enable the developers of the RenewIT tool to compare results from the tool, the mathematical models and the metrics with real-world data, giving far greater rigor to the performance metrics and calculated results. At the same time, this engagement will be sure to raise further questions and provide feedback about what is acceptable to users in technical, economic and operational terms.

It is not possible to name all of the eight participating data centres, for reasons of confidentiality. They include banks, hospitals, multi-tenant or colocation data centres, universities, and a large media conglomerate, with data centre sizes ranging from small to large. Around half of the case-study participants are enterprise-specific; the others serve cloud or colocation customers. The workloads are a spread of Web, database or file servers, high-performance computing, and 'big data.'

Climate is also an important consideration related to the availability of renewable solar energy and cooling. Half of the case studies are located in Northern Europe (mainly the Netherlands and Germany), and half are in Southern Europe (Spain and Italy).

Reflecting RenewIT's interest in integration with local urban infrastructure, several of the data centres are connected to district heating and cooling systems or combined heat and power. Some of the case study data centres are using free cooling, including 'air to air' cooling. Most are using water-based cooling, but there is also some use of other refrigerant cooling. In keeping with current mainstream majority data centre practices, none of the case studies are using direct liquid cooling; however, direct liquid cooling is implemented in the test bed at the IREC laboratory, and this will be used to develop and validate opportunities for heat reuse.

IPR licensing model

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8.3.2.9 CoolEmAll – Energy-efficient and sustainable data centre design and operation

Project description

CoolEmAll project has developed a software toolkit, and other resources, to help improve the efficiency and sustainability of data centres even by 30%. CoolEmAll's web-based Simulation, Visualisation and Decision Support Toolkit (CoolEmAll SVD Toolkit) enables data centre designers, operators and technology suppliers to design and operate more energy-efficient facilities and equipment. The toolkit does this by simulating the complex interactions between IT hardware, software (applications and workloads) and power/cooling systems within data centres.

The web toolkit is supported by a number of useful and innovative methods and tools, which can be applied to make data centres, or IT infrastructure in general, more efficient. These tools include advanced visualisation software, energy-efficient servers, energy monitoring tools, energy saving management policies, and energy efficiency metrics.

Data centres used

Small/Medium Server room, Enterprise Data Centre, HPC, Managed Service Provider

Areas of data centre addressed

Cooling (Mechanical/Refrigerant Cooling reduction, Environmental – monitoring and control, Operations), Management (Monitoring, PUE, Waste heat reuse, CUE, WUE, xUE/additional metrics), Compute (Utilisation, Workload Management, Operations, Power management, Server populations)

Applicability

New build, Retrofit

Pre-requisites for deploying the proposed solution

To make the most of the SVD Toolkit, access to data centre loads is needed (or at least knowledge of workload types and their basis characteristics).

Expected Benefits

Up to 30% savings in energy costs (however it depends on the specific use case as the main result of CoolEmAll is modelling and simulation software).

Return on Investment

Assuming 20-30% savings, ROI should be achieved by 2-3 years (again depending on a specific data centre and types of recommendations).

Market readiness

Availability of a prototype of the Simulation Visualization and Decision Making Toolkit (SVD Toolkit). Information about the project and the toolkit currently available at http://tricoryne.man.poznan.pl.

IPR licensing model

Most of components are open source based on Apache 2.0 or GNU GPL v3.0 licence.

8.4 Business cases of cost savings thanks to innovation

The following is an extract from the case studies described in more detail and for more locations in D1.2. It indicates the kind of information and figures we foresee for the business cases part of the EURECA Directory:

8.4.1 Organization: City of Amsterdam.

Issue: Amsterdam has around 60 data centres scattered over the Amsterdam area. Amsterdam has huge ambitions to cut the emissions of CO2: -40% CO2 emissions compared with the emissions of 1990. In order to accomplish these ambitions,

Amsterdam has launched several plans. One of these, is to make sure that all data centres in the Amsterdam area, are going to be much more energy efficient. To give a good example, the City of Amsterdam agreed to invest in its own data centre's efficiency, building a new energy efficient data centre and decommissioning its old, energy inefficient data centre. Certios led the building of the new energy efficient data centre between 2009 and 2010.

Solution: With the use of an ATES installation to capture and store heat efficiently for later use, the data centre serves as a heat source for the heating installation of the City Hall and the Opera of Amsterdam. With free cooling with the help of the water flow of the nearby river Amstel, the excess heat is cooled efficiently. So, reuse, storage for later use and free cooling were realized in this data centre.

Savings: The reported reduction of CO2 emissions were estimated on a yearly 1515 t of CO2. The savings were higher, because of the decommissioning of smaller, less energy efficient data centre as a result of the possibilities the new data centre offered. 33% of the waste heat is used for heating the office building and saves energy on traditional heating sources (2200 KWh thermic). And, mainly due to the alternative way of cooling, 30% of data centre energy is saved. Payback period of the total project was 4,9 years.

Relevance to EURECA: in this project there has been a very close cooperation with several vendors. Once the procurement was focussed on the right ambition (reducing energy), the best offers were the ones that were most advanced in the field of saving energy, and not so much on price only. In very close cooperation the speed of building this data centre and the energy efficiency of the data centre has been widely recognized in the media. The project was a success, also due to the right focus of procurement. The policy makers explicitly offered space to manoeuvre, enabling vendors to excel with innovative solutions.

Afbeelding 15 ways of dealing with waste heat to save energy and reduce CO2 emissions.

8.4.2 Organization: Hoogheemraadschap van Delfland (HHD)

Issue: HHD was going to move out of its office building to move to another facility. However, their data centre was located in the old facility. What to do? The decision was made to ask an expert to look at the data centre and ask to assess the following ideas:

- - Because of the data centre HHD is not able to relocate
- - If relocation is possible, what will be the options (scenarios)?

Solution: After a data centre scan and drawing up the business case, it became clear that every minute they would remain their data centre in the 'old' location, they would lose money. The business case showed that moving the data centre would offer HHD less costs, better quality, more security and resilience, also before the planned relocation. Decisions were made in the top of the organization, after the presentation of the business case. The data centre was going to be outsourced operated to a new and energy efficient external local data centre.

Savings: in switching to the external data centre, HHD is saving 146 t CO2 and 244.404 KWh annually.

Relevance to EURECA: In the case of HHD the awareness of the savings potential of the data centre was minimal. Once virtualization had been progressed within their

small data centre, the number of racks was reduced to less than a third. Also the energy use already was lower, however, nobody gave attention to the cooling machinery. These had become partly obsolete as well. Furthermore, the room temperature was kept far too low. Even without moving to a professional data centre the savings potential had been lying around for a while. The relevance is that proprietary data centres need to procure and monitor the data centre environment in a more holistic way. The EURECA tool is going to provide this broader insight.

8.4.3 Organization: Dutch Central Government

Issue: The dutch government with its constituting ministries had over 64 locations from which data services were delivered. This situation was extremely complex, costly and hugely inefficient.

Solution: In 2010 a program was started to consolidate these 64 location into 4 regional data centres. These locations were both new build as well as retrofitted scalable data centres. Aside from security, scalability and reliability requirements, the Consolidated Data centre (CDC) project required a significant improvement in the data centre effectiveness, a maximum PUE of 1.5 was asked for.

Savings: As revealed in a recent presentation at the "Symposium Groene ICT en Duurzaamheid" (29-5-2015, Leiden NL), Dennis Kerssens of the Ministry of internal affairs published the most recent numbers on this consolidation project:

http://www.surfsites.nl/duurzaamheid/download/Featured%20sessie%20-%20Dennis%20Kerssens,%20Bob%20Stemmerik,%20Cees%20Plug,%20Tjeerd%20Willem%20Hobma.pptx

(see copy of the sheet below)

	Before	**After**
Energy use	**235 GWh**	**128 GWh**
PUE	**2,3**	**<1,25**

A saving of a 107 GWh annually.

Relevance to EURECA: In the case of the CDC project, extensive external support and expertise for business case creation and analysis was used to include a relatively sustainability into the procurement process. During the course of the project, the initial requirement of a PUE < 1,5 quickly became obsolete. The size of the project however supplied sufficient funding and with it expertise to still obtain this stunning

success. This level of outside support is not available to smaller projects and Eureca would fill the knowledge gap resulting in similar success stories in projects of comparable complexity but different size.

8.4.4 Organization: Omgevingsdienst Noordzeekanaalgebied (ODNZKG)

Issue: ODNZKG is a local government body that monitors adherence to the "Dutch Environmental management act" in Amsterdam and the surrounding regions. The region of Amsterdam belongs to the top 3 of European data centre hubs, a large part of Europe's internet traffic passes through this region.

As a result, data centre energy use is high, The ODNZKG focussed attention on 40 large location, these 40 data centres together use 460 GWh, 11% of commercial electricity use of the region.

The Dutch government and the municipality of Amsterdam has ambitions to lower overall energy use and such concentrated usage offered a perfect opportunity for large savings with limited resources from the ODNZKG.

Solution: a significant improvement in the data centre effectiveness is being achieved through the application of the environmental management act.

All new build data centres must show a design PUE < 1,2 in order to obtain a building permit.

All existing data centres must submit plans to increase energy efficiency towards a future PUE of 1,3.

Savings: As detailed in a recent publication on the savings in Amsterdam data centres (see https://www.amsterdam.nl/publish/pages/444422/20140502_dro_data centres_uk.pdf)

	Before	**After**
Energy use	**460 GWh**	**392 GWh**

A saving of a 68 GWh annually.

Relevance to EURECA: This result demonstrates the effect that can be obtained by demanding better DC performance, either by governments or by customers. Although the ODNZKG approach might appear different than procurement driven efficiency improvement, the common element is the goal of increasing energy

efficiency without impeding growth. Also, both public procurement officers and ODNZKG personnel have to deal with a great variety of companies and products and cannot maintain specialist knowledge on data centre technology all the time. EURECA will again fill the knowledge gap that currently limits the demand for truly sustainable ICT services and as such will accelerate the realization of the real energy savings potential.

8.5 Procurement examples

As a valuable source for information and evidence on successful use, procurement examples will be compiled from public sector bodies and particularly those from EURECA partners be entered by the EURECA consortium in to the respective component of the EURECA Directory.

The specification of the documentation format for procurement examples is found in Annex 0.

8.6 Legal aspects and Service level agreements (SLA)

8.6.1 Legal implications of the EURECA Tool.

The tool itself will not give any legal advice as an output:

- Following the EU directive 2012/27/EU all local laws in Europe are at least “can” regarding taking energy efficiency into account during the procurement process – there is no conflict between local laws and the purpose of the EURECA tool.
- Local laws are very specific though, under which circumstances energy efficiency as an important decision factor steps back behind factors like “public safety” – EURECA tool does not cover these exceptions for an obvious reason.
- EURECA consortium cannot provide legal advice – we are no legal experts on European law.

EURECA tool although will be able to use energy figures as calculation input from sources that buyers should have access to, for example the German “Energieausweis” required for any newer building (according to the ENEV) or the outcome of the “Energieaudit” requested by DIN EN 16274-1.

8.6.2 EURECA tool and SLA´s

Service Level Agreements are typically part of any agreement and the KPI´s (key performance indicators) used to measure if SLA´s are met or violated should reflect the technical and organizational measures taken by the service provider – and not primarily be covered by an insurance and monetised via the Service fees.

This being the reason why SLA´s requested by a potential buyer should reflect all its expectations regarding e.g. uptime, energy efficiency, escalation and reaction times, even if these expectations may be conflicting.

The EURECA tool can provide KPI´s regarding energy efficiency by using the maturity model in conjunction with the EU Code of conduct best practices guidelines plus life cycle impact calculations, but cannot give advice on conflicting goals. Example:

If the customer intends to purchase hardware meeting the ASHRAE Class A1 requirements for example (could also be a KPI for an SLA for example), the data centre to operate this hardware in should be compatible to this requirement - the nearer the temperature and humidity set-points in such data centre are, the better the energy efficiency is (this is what the tool will be able to provide as guideline). This being said, regarding the uptime requirement such efficiency determines a risk in case of a (partial) failure of the cooling system – the nearer the data centre´s temperature set-point is to the maximum temperature the equipment ca deal with, the less headroom (=time to act) it gives the data centre staff in case of a failure – the data centre will probably not be able to meet the uptime requirement. Conflicting SLA requirements can be dealt with during a EURECA training.

Also the tool will provide potential decision parameters to select of potential suppliers like relevant certifications (EMAS – Environmental Management or ISO 50001 Energy Management) or labels like Energy Star.

8.6.3 EU Member State specific situation – example The Netherlands

Dutch government organizations procure almost 60 billion Euro worth of products and services each year. 10 billion of this budget is accounted for by central government, 50 billion by municipal and provincial governments.

As of 1-1-2015 all government bodies committed themselves to “100% sustainable procurement”, the criteria used for this do differ between the various governmental institutions, as far as ICT procurement goes, the “energystar”, the “CO2 prestatieladder” and the criteria cited on the Pianoo website are most often

mentioned. As such one can conclude that the sustainable procurement of data centre services is poorly described.

Aside from the commitment, the Dutch government is bound by (amongst others) Commitments to the European Union, the 2020 20% CO2-reduction compared with 1990 emissions. SER energieakkoord http://www.energieakkoordser.nl/energieakkoord.aspx in which a commitment to a reduction of "final energy" consumption is stated of 1.5% per year.

Also, the Dutch environmental management act, https://www.government.nl/topics/environment/contents/roles-and-responsibilities-of-central-government/environmental-management-act needs to be adhered to. A central clause in this act, relevant to sustainable procurement of data centre services is clause 2.15 in "activiteitenbesluit" that states that any energy efficiency measure with a return on investment time of less than 5 years should be implemented.

This clause is a central theme in the discussion between data centres in the Amsterdam region and the "omgevingsdienst Noordzeekanaalgebied" (ODNZKG). The latter is the institution that is responsible for the adherence by private institutions to the Dutch environmental management act through monitoring and inspections.

As an additional stimulus, the Dutch government, through its subsidiary the "Rijksdienst voor Ondernemend Nederland" (RVO) sponsors and supports covenants between the government and private/public sectors to voluntarily increase the sector energy efficiency. The Dutch ICT sector has such a covenant the "MJA3" in place. The signees commit themselves to a 3% yearly increase in energy efficiency, in return for this commitment several tax benefits can be obtained.

8.7 Terms and Acronyms

The specification for the Terms and acronyms part of the EURECA Directory is found in Annex 11.5.

An initial set of terms and acronyms are the ones in chapter 3 of this report.

8.8 FAQs

The specification for the Terms and acronyms part of the EURECA Directory is found in Annex 11.6.

FAQs are collected during EURECA meetings with public procurers, at presentations, as well as - more extensively - during the upcoming trainings.

9 Consortium for maintenance and update of framework and tool beyond project duration

An important interest of the Commission is the maintenance and in fact update of the EURECA framework and tool well beyond the project duration. This is essential, as the main number of users are expected to want to make use only after the project end, when all developments have been completed and the EURECA Directory is increasingly filled with information also from vendors. Moreover, as DC technology and knowledge are quickly advancing, an unmaintained framework and tool will become obsolete within less than 2 years.

The consortium is hence undertaking the conception and initiation of an organisational setting and structure for maintaining and updating the EURECA framework and tool beyond project lifetime.

The EURECA consortium will assign an organisation to act as secretariat to act as single contact point for third-parties. Revenues will be managed and used to ensure the maintenance and update of the system is financed, i.e. ensuring that the EURECA partners have the necessary resources to update e.g. the DCMM, the EUCoC best practices, background life cycle data, enhance tool functionality, etc.

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11 Appendices

11.1 Annex - Product and data services input data and information for life cycle calculations

The following table provides the provisions which information is used to calculate the life cycle environmental and energy impacts (and benefits) of any of the key DC products and data services.

The table is to be read as follows: per procurement scenario, three principle options can be possible:

- first row (“Specific LCA or EPD”): Specific LCA / type III label results can be used that always cover the entire life cycle. This option is enabled if schemes are available that yield compatible and comparable results with the default calculations in EURECA. This is currently possible for (static) UPS (and UPS-batteries), hard disks, and photovoltaic electricity generation on site.
- second row (“Other characteristics”): Use stage characteristics (e.g. power consumption at a certain server CPU use rate, share of certified green electricity) can be used. This is enabled, if this data allows calculating sufficiently robust and more specific LCA results than the default case. This option is enabled for the main IT and electric/mechanical components (servers, UPS, racks, generators, building, …). This option is also enabled for energy carriers, as available in the Commission’s ELCD database and more updated versions for free from the original data developer, as well as water and land use, and coolant loss during use. Note: Carrying specific government-run/endorsed Type I Ecolabel (EU Flower, Blue Angel, Nordic Swan …), and to lower extent selected other schemes (Energy Star) improve award points; for co-lo providers etc. being signatory to the EUCoC and EMAS are awarded; all this is covered by the separate Annex 11.2.
- third row (“Default settings / results”): The default case of the “reasonably-worst-case” is used for deriving the LCA results in all those cases, where it is foreseen within the framework to provide more specific information (e.g. use phase energy) or LCA / PEF results; this serves as incentive to actually provide more specific data. If such more specific info or LCA / PEF is however not foreseen, instead of the

reasonable worst case, standard/average case default values are used. The last named option (i.e. standard/average case default) is used for all DC data services (co-location, cloud, …), for the core IT equipment such as servers, SSD and tape storage, but also for other M&E plant equipment incl. for "other" equipment that is not covered in more detail by EUECA, such as cabling and networking inside the data centre, since the necessary detail to model company/product-specific life cycle production impacts is very high: one or a few common default data will be used in all cases (e.g. one typical 1U server of two chips).

Table 10 Scheme for calculating the life cycle wide environmental and energy performance of individual capital goods/hardware and of whole DCs / server rooms, and of co-location, hosting, and cloud solutions.

Procurement scenario	Specificity level of LCA input data	Production	Use	EoL	Overall LC	Comment
Capital goods:						
- Site and Building (only as part of DC, not as separate product)	Specific LCA or EPD	-	-	-	-	-
	Other characteristics	-	-	-	-	
	Default settings / results	Default per building type and size (area, levels).	-	Default per building type and size (area, levels)	-	
- Servers	Specific LCA or EPD	-	-	-	-	-
	Other characteristics	-	Power at max utilisation / at iddle. SPEC CPU:	-	-	

Procurement scenario	Specificity level of LCA input data	Production	Use	EoL	Overall LC	Comment
			SPECfp_rate_base2006			
	Default settings / results	Default per type	Default per type	Default per type	-	
- Racks	Specific LCA or EPD	-	-	-	-	-
	Other characteristics	-	-	-	-	
	Default settings / results	Default per rack.	-	Default per rack	-	
- Storage (HDD, SSD, tape)	Specific LCA or EPD	-	-	-	Option for HDD: provide PEF results for whole LC	-
	Other characteristics	-	Power benchmark / metric	-	-	
	Default settings / results	Default per type and capacity.	Default per type and capacity	Default per type and capacity	-	
- UPS and batteries	Specific LCA or	-	-	-	Option for	-

Procurement scenario	Specificity level of LCA input data	Production	Use	EoL	Overall LC	Comment
	EPD				static UPS and batteries: provide PEF results for whole LC	
	Other characteristics	-	Annual loss in default use case.	-	-	
	Default settings / results	Default per type and kVA and kWh battery capacity.	Default per type and kVA and kWh battery capacity.	Default per type and kVA and kWh battery capacity.	-	
- Cooling	Specific LCA or EPD	-	-	-	-	-
	Other characteristics	-	Annual power consumption, water consumption, coolant type and loss. Annual average cooling efficiency.	Certified (low) cooling loss during recycling is quantitatively considered.	-	
	Default settings / results	Default per type, coolant type and cooling capacity.	Default per type, coolant type and cooling capacity	Default per type, coolant type, and cooling capacity	-	

Procurement scenario	Specificity level of LCA input data	Production	Use	EoL	Overall LC	Comment
- Fire suppression (system)	Specific LCA or EPD	-	-	-	-	-
	Other characteristics	-	Annual power consumption and emissions of e.g. CO2, halons etc.	-	-	
	Default settings / results	Default, default per type.	Default, default per type.	Default, default per type.	-	
- PSU	Specific LCA or EPD	-	-	-	-	-
	Other characteristics	-	Annual loss / Loss profile at different loads	-	-	
	Default settings / results	Default per type and/or kW.	Default per type and/or kW.	Default per type and/or kW.	-	
- PDU	Specific LCA or EPD	-	-	-	-	-
	Other characteristics	-	Annual loss / Loss per outlet	-	-	
	Default settings	Default per type and/or kW	Default per type and/or	Default per type and/or kW	-	

Procurement scenario	Specificity level of LCA input data	Production	Use	EoL	Overall LC	Comment
	/ results	and number of outlets.	kW and number of outlets.	and number of outlets.		
- On-site electricity generation	Specific LCA or EPD	-	-	-	Option for PV: provide PEF results for whole LC	-
	Other characteristics	-	Annual net production in kWh	-	-	
	Default settings / results	Default based on type and kW capacity.	0, i.e. not existing	Default based on type and kW capacity	-	
- Heat further use	Specific LCA or EPD	-	-	-	-	-
	Other characteristics	-	Annual net use and form of use (purpose)	-	-	
	Default settings / results	0, i.e. not existing. If existing: default based on kW capacity	0, i.e. not existing. If existing: no default!	0, i.e. not existing. If existing: default based on kW capacity	-	
- Electrical plant	Specific LCA or	-	-	-	-	-

Procurement scenario	Specificity level of LCA input data	Production	Use	EoL	Overall LC	Comment
(incl. purchased electricity), excl. on-site generation, UPS, cooling. (only as part of DC, not as separate product)	EPD					
	Other characteristics	-	Annual electricity purchase, optionally with share of EU-certified green electricity; PUE (PUE is mandatory for co-lo)	-	-	
	Default settings / results	Default based on kW capacity	- (! no default option)	Default based on kW capacity	-	
- DC-internal network and other ICT part only as part of DC, not as separate product)	Specific LCA or EPD	-	-	-	-	-
	Other characteristics	-	-	-	-	
	Default settings / results	Default per DC size.	Default per DC size.	Default per DC size.	-	
- Data transmission via internet (only as part of DC, not as separate product)	Specific LCA or EPD	-	-	-	-	**Only for DC variants that are off-site and connected via the internet; potentially differentiated for national, continental**
	Other characteristics	-	In case of exclusive use of a specific provider: electricity consumption per TB traffic, optionally	-	-	

Procurement scenario	Specificity level of LCA input data	Production	Use	EoL	Overall LC	Comment
			with share of EU-certified green electricity			**and intercontinental transmission (tbc).**
	Default settings / results	Default based on amount of data traffic in TB/a	Default based on amount of data traffic in TB/a	Default based on amount of data traffic in TB/a	-	
Whole DC / server room	Specific LCA or EPD & Other characteristics & Default settings / results : See above at "Capital goods".	Default value based on sum of "capital goods" – data from DC / server room owner (share of building, M&E plant, …) and from public body (server data, storage data, racks, …). Type/Model and number etc. of servers, storage dev, racks, UPS, CRAC and chillers; key building info. Exclusively for data centres connected to users at public body via the internet (i.e. off-site): transmission capital	Derived from DC / server room owner (power sources, power/year, traffic/year, storage load, server load, virtualisation factor, …). Default values as permissible for each component / aspect. Exclusively for data centres connected to users at public body via the internet (i.e. off-site): default transmission energy use (likely distance dependent).	Default value based on sum of capital goods – data from DC / server room owner (share of building, M&E plant, …) and from public body (server data, storage data, racks, …).	-	No additional option on whole LC level, as no existing scheme yet for LCA / PEF of whole DC (same applies to co-lo, hosting, cloud).

Procurement scenario	Specificity level of LCA input data	Production	Use	EoL	Overall LC	Comment
		goods.				
Co-location	Specific LCA or EPD & Other characteristics & Default settings / results : See above at "Capital goods".	Default value co-location, proportional to amount of server space purchased. Plus: Default values for transmission network from Co-location to final user, potentially distance-dependent.	Derived from user (power/year, traffic/year, storage load, server load, virtualisation factor, …) and co-lo owner (PUE, power sources). Default values as permissible for each component / aspect. Plus: Default values for transmission from Co-location to final user, likely distance-dependent.	Default value co-location, proportional to amount of server space purchased. Plus: Default values for transmission network from Co-location to final user, potentially distance-dependent.	-	-
Hosting / Private cloud / Governmental cloud	Specific LCA or EPD & Other characteristics & Default settings / results : See above at "Capital goods".	Default value hosting/private cloud/gov cloud, proportional to amount of service and storage purchased. Plus: Default values for transmission network from site(s) to final user, potentially distance-dependent.	Derived from DC owner (power sources, power/year, traffic/year, storage load, server load, virtualisation factor, …). Default values as permissible for each component / aspect. Plus: Default values for	Default value hosting/private cloud/gov cloud, proportional to amount of service and storage purchased. Plus: Default values for transmission network from site(s) to final user, potentially distance-	-	-

Procurement scenario	Specificity level of LCA input data	Production	Use	EoL	Overall LC	Comment
			transmission from site(s) to final user, likely distance-dependent.	dependent.		
Public Cloud	Specific LCA or EPD & Other characteristics & Default settings / results : See above at "Capital goods".	Default value Public cloud, proportional to amount of service and storage purchased. Plus: Default values for transmission network from site(s) to final user.	Default value Public cloud, proportional to amount of service and storage purchased. Plus: Default values for transmission network from site(s) to final user.	Default value Public cloud, proportional to amount of service and storage purchased. Plus: Default values for transmission network from site(s) to final user.	-	Limited accuracy, as further information about the DCs that make up the cloud is not usually possible to obtain, hence common default values will have to be used.

11.2 Annex - Additional, qualitative award criteria

Beyond use stage characteristics of all energy consuming products, additional, qualitative award criteria are used, as described in the main text. Table 11 provides the default list of which labels, certificates etc. are eligible:

Table 11 Additional award criteria beyond use stage environmental performance. Details see main text.

Procurement scenario	Specificity level of LCA input data	Production	Use	EoL	Overall LC, additional options	Comment
Capital goods:						
- Site and Building (only as part of DC, not as separate product)	Award criteria	EMAS and other eligible* environmental management schemes are awarded.	-	-	LEED, DGNB, BREEAM. Provision of any ISO 14040/44 or PEF or ILCD conform LCA study or Type III label (EPD) is awarded as showing higher maturity.	No type I label reward, as these focus much on use phase – double counting. Guaranteed recycling not considered, as issues of "dirty" recycling in SEA or Africa are not relevant for this product group.
- Servers	Award criteria	EMAS and other eligible* environmental management	-	-	Provision of any ISO 14040/44 or PEF or ILCD conform LCA study or Type III label	- CENELEC – EN 50625 Collection, logistics and treatment requirements for WEEE;.

		schemes are awarded.			(EPD) is awarded as showing higher maturity. Carrying EU gov. Type I label, Energy Star, EPEAT is awarded. Take-back scheme and guaranteed recycling in EU is awarded.	- e-Stewards Standard for Responsible Recycling and Reuse of Electronic Equipment; - Responsible Recycling ("R2") Standard for Electronics Recyclers; and, or - WEEELABEX Treatment Standard
- Racks	Award criteria	EMAS and other eligible* environmental management schemes are awarded.	-	-	Provision of any ISO 14040/44 or PEF conform LCA study or Type III label (EPD) is awarded as showing higher maturity	Guaranteed recycling not considered, as issues of "dirty" recycling in SEA or Africa are not relevant for this product group.

- Storage (HDD, SSD, tapes)	Award criteria	EMAS and other eligible* environmental management schemes are awarded.	-	-	Provision of any OTHER ISO 14040/44 or PEF conform LCA study or Type III label (EPD) is awarded as showing higher maturity. Carrying EU gov. Type I label, Energy Star, EPEAT is awarded. Take-back scheme and guaranteed recycling in EU is awarded	
- UPS	Award criteria	EMAS and other eligible* environmental management schemes are awarded.	-	-	Provision of any OTHER ISO 14040/44 or PEF conform LCA study or Type III label (EPD) is awarded as showing higher maturity. Carrying EU gov. Type I label, Energy Star, EPEAT is awarded.	Guaranteed recycling not considered, as issues of “dirty” recycling in SEA or Africa are not relevant for this product group.

- Cooling	Award criteria	EMAS and other eligible* environmental management schemes are awarded.			Provision of any ISO 14040/44 or PEF conform LCA study or Type III label (EPD) is awarded as showing higher maturity. Carrying EU gov. Type I label, Energy Star, EPEAT is awarded.	No award for coolant type, as already considered in LC-criteria incl. in default values. Guaranteed recycling not considered, as issues of "dirty" recycling in SEA or Africa are not relevant for this product group.
- Fire suppression (system)	Award criteria	EMAS and other eligible* environmental management schemes are awarded.			Provision of any ISO 14040/44 or PEF conform LCA study or Type III label (EPD) is awarded as showing higher maturity. Carrying EU gov. Type I label, Energy Star, EPEAT is awarded.	No award for suppression system type, as already considered in LC-criteria incl. in default values. Guaranteed recycling not considered, as issues of "dirty" recycling in SEA or Africa are not relevant for this product group.

- ***Pending: PSU***	*Award criteria*	*EMAS and other eligible* environmental management schemes are awarded.*	-	-	*Provision of any OTHER ISO 14040/44 or PEF conform LCA study or Type III label (EPD) is awarded as showing higher maturity. Carrying state-run Type I label and Energy Star is awarded.*	
- ***Pending: PDU***	*Award criteria*	*EMAS and other eligible* environmental management schemes are awarded.*	-	-	*Provision of any OTHER ISO 14040/44 or PEF conform LCA study or Type III label (EPD) is awarded as showing higher maturity. Carrying state-run Type I label and Energy Star is awarded.*	

- **On-site electricity generation**	Award criteria	EMAS and other eligible* environmental management schemes are awarded.	-	-	Provision of any ISO 14040/44 or PEF conform LCA study or Type III label (EPD) is awarded as showing higher maturity. Take-back scheme and guaranteed recycling in EU is awarded for PV only	Guaranteed recycling only considered for photovoltaics, as issues of "dirty" recycling in SEA or Africa are not relevant for other systems under this product group.
- **Heat further use**	Award criteria	-	-	-	-	**Not as separate product, only as part of DC, hence no separate award criteria.**
- **DC-internal network and other ICT part (only as part of DC, not as separate product)**	Award criteria	-	-	-	-	**Not as separate product, only as part of DC, hence no separate award criteria.**

- Electrical plant (incl. purchased electricity), excl. on-site generation, UPS, cooling. (only as part of DC, not as separate product)	Award criteria	-	-	-	-	**Not as separate product, only as part of DC, hence no separate award criteria.**
- Data transmission via internet (only as part of DC, not as separate product)	Award criteria	-	-	-	-	**Not as separate product, only as part of DC, hence no separate award criteria.**

Whole DC / server room	Award criteria	EMAS and other eligible* environmental management schemes are awarded.	-	-	See "Capital goods". PLUS: EUCoC signatory, Provision of any ISO 14040/44 or PEF conform LCA study or Type III label (EPD) on level of WHOLE DC / SERVER ROOM is awarded as showing higher maturity.	EMAS makes sense only for the „Production", as the DC/server room will be operated by the public body itself.
Co-location	Award criteria	EMAS and other eligible* environmental management schemes are awarded.	-	-	PLUS: EUCoC signatory, Provision of any ISO 14040/44 or PEF conform LCA study or Type III label (EPD) on level of WHOLE CO-LO is awarded as showing higher maturity. EMAS, ISO 14000 certificates are awarded.	

Hosting / private cloud, Government Cloud	Award criteria	EMAS and other eligible* environmental management schemes are awarded.	-	-	PLUS: EUCoC signatory, Provision of any LCA study or Type III label (EPD) on level of WHOLE DC is awarded as showing higher maturity. EMAS, ISO 14000 certificates are awarded.	
Public Cloud	Award criteria	-	-	-	-	**No additional award criteria, as actual DC locations are usually unknown.**

11.3 Annex Mapping DCMM - EUCoC Best Practices, EUCoC and procurement cases (or other measures)

11.3.1 DCMM to EUCoC best practices mapping

Note: Further notes and comments on each entry are in the separate working file for implementation, not shown here.

	Level	0	1	2	3	4	5
Power							
1,1	Critical Power Path Efficiency - Building Entrance to IT load			3.3.4	3.3.3		
1,2	Architecture		6.1.3	3.3.4	3.3.3		
1,2	Architecture				6.1.1		
1,2	Architecture				6.1.2		
1,2	Architecture						
1,3	Operations				8.1.1		
1,3	Operations				9.3.3		
1,4	Generation						
1,4	Generation				8.2.5	8.2.5	8.2.5
Cooling							
2,1	PUE - Cooling Contribution		5.4.2.2	3.3.4	3.3.3		
2,2	RCI (hi) & RCI (lo) - if applicable			4.1.1			
2,3	Mechanical/Refrigerant Cooling reduction		5.4.1.1 - 5.4.1.5	5.4.1.1 - 5.4.1.5	5.4.1.1 - 5.4.1.5	5.4.1.1 - 5.4.1.5	5.4.1.1 - 5.4.1.5
3,3	Mechanical/Refrigerant Cooling reduction		5.6.1				
2,4	Environmental - set point range at inlet conditions to IT equipment			5.3.2	5.4.2.3	5.3.6	

2,4	Environmental - set point range at inlet conditions to IT equipment			4.1.13, 5.3.1	5.3.3		
2,5	Environmental - monitoring and control		5.6.2		4.1.9		
2,6	Operations			3.3.4	3.3.3		
2,6	Operations		4.1.12	5.1.1	5.1.2		
2,6	Operations		5.1.7				
2,6	Operations			5.5.3, 5.5.4			
2,6	Operations		5.1.1, 5.1.2				
2,6	Operations		5.1.7				
2,6	Operations		5.1.4				
2,6	Operations		4.3.2				
2,6	Operations						
2,6	Operations						

Other - Facility

3,1	Operational Resilience						
3,2	Resilience vs. Need			3.3.1		3.3.2, 3.3.5	3.3.5
3,3	Lighting			7.1.1, 7.1.2			
3,3	Lighting						
3,4	Building/Shell						
3,5	M&E Waste						
3,6	Procurement				4.1.2		
3,6	Procurement						
3,6	Procurement						
3,6	Procurement						

Management

4,1	Monitoring		9.1.1, 9.1.9				
4,2	PUE						
4,3	Waste heat reuse (as measured by ERF/ERE)			5.7.1, 5.7.2			
4,4	CUE						3.2.1
4,5	WUE						3.2.1
4,6	xUE/additional metrics						

Compute

5,1	Utilization		9.4.1	4.3.3, 4.3.6			

5,1	Utilization						
5,2	Workload Management			4.1.9			
5,2	Workload Management		4.3.4, 4.3.5				
5,2	Workload Management			4.3.4, 4.3.5			
5,3	Operations		4.3.1, 4.3.2				
5,3	Operations						
5,4	Power Management				3.3.5		
5,4	Power Management				4.1.10		
5,4	Power Management						
5,5	Server population						
5,5	Server population						
5,5	Server population						

Storage

6,1	Workload						
6,2	Architecture						
6,3	Operations						
6,3	Operations						
6,3	Operations						
6,3	Operations						
6,4	Technology						
6,5	Provisioning						

Network

7,1	Utilization			9.4.2			
7,1	Utilization						
7,2	Workload						
7,2	Workload						
7,2	Workload						
7,3	Operations						
7,3	Operations						
7,4	Technology						
7,4	Technology						
7,5	Base performance						
7,6	Provisioning						

Other IT

8,1	Overall						
8,1	Overall			3.1.1	3.1.1		
8,2	Utilization						
8,3	IT sizing						

8,4	Internal Power Supply Efficiency						
8,4	Internal Power Supply Efficiency						
8,5	Service Catalogue/SLA's						
8,6	Incentivizing change for efficient behaviour (e.g. chargeback and or cost awareness)						
8,7	E-Waste						
8,8	Procurement			4.1.8	4.1.1		3.2.1
8,8	Procurement						
x	Procurement					4.1.2	4.1.14

11.3.2 EUCoC best practices to DCMM mapping

EUCoC Best Practice **TGG DCMM**

Number	Name	CoC Value		Number	Level	comment	
Involvement of Organisational Groups							
3.1.1	Group involvement	5		8,1	2+	not explicitly mentioned, BP could be broken down into multiple maturity levels	
General Policies							
3.2.1	Consider the embedded energy in devices	3		4.4, 4.5, 8.8	5		
3.2.2	M&E Operating Ranges	4		2,4	5		
3.2.3	Service Charging Models	3		3,2	4,5		
3.2.4	Life Cycle Assessment	3		3,6	5		
3.2.5	Environmental Management ISO14001	3		8.7, 8.8			
3.2.6	Energy Management	3				Not Explicit	

Number	Name	CoC Value		Number	Level	comment	
	ISO50001						
3.2.7	Asset Management ISO55000	3		3,1	3,4,5		
3.2.8	Sustainable Energy usage	1		1,4	5		
3.2.9	Powering of devices via the IT cabling	1		6,5	3	Thin Provisioning	
3.2.10	Impact of mobile/shifting workloads	2		5,2	5		
3.2.11	Alternative power generation technologies	1		1,4	5		
Resilience Level and Provisioning							
3.3.1	Build resilience to business requirements	3		3,2	2+	CoC BP cuts across multiple levels of maturity	
3.3.2	Consider multiple levels of resilience	3		3,2	3	not in dcmm	
3.3.3	Lean provisioning of power and cooling for a maximum of 18 months of data floor capacity	3		2.1, 2.6, L3 1.2, 1.1	~3	has PUE breakdowns for each level	
3.3.4	Design to maximise the part load efficiency once provisioned	3		"	2	"typical" in DCMM == part load	
3.3.5	Design effective resilience	4		3,2	4, 5		
IT Equipment and Services							
Selection and Deployment of New IT Equipment							
4.1.1	IT hardware – Power	5		2.2, 5.4	2, 3		
4.1.2	New IT hardware – Restricted operating temperature and humidity range	4		8.8 (3.6)	3		
4.1.3	New IT hardware – Expected operating temperature and humidity range	5		8.8 (3.6)	4	no level 4 in DCMM but between 3 and 5	
4.1.4	New IT hardware – Extended operating temperature and humidity	3		8.8 (3.6)	5		

Number	Name	CoC Value		Number	Level	comment	
	range						
4.1.5	Select equipment suitable for the data centre – power density	3				not in dcmm, explicitly	
4.1.6	IT equipment power usage against inlet temperature			3,6	4,5		
4.1.7	Select rack mount equipment suitable for the data centre – air flow	4		8,1	1		
4.1.8	Enable power management features	5		5,4	1+		
4.1.9	Provision to the as configured power	3		?	?		
4.1.10	Energy Star Hardware	3		8,8			
4.1.11	Energy & temperature reporting hardware	3		2.5, (L2 5.4)	3	other options e.g., rack level in DCMM, not on storage side	
4.1.12	Control of equipment energy use	5		5,4	3+		
4.1.13	Select free standing equipment suitable for the data centre - Air flow direction	4		8,1	1	same as CoC 4.1.5	
4.1.14	Operating temperature range - Liquid Cooled IT equipment	4				DCMM is technology agnostic	
4.1.15	AC/DC Converter Efficiency	3					
Deployment of New IT Services							
4.2.1	Deploy using Grid and Virtualisation	5		5,1	1+	increased util, not specific tech	
4.2.2	Reduce IT hardware resilience level	4		5,1	1+		

Number	Name	CoC Value		Number	Level	comment	
4.2.3	Reduce Hot / Cold standby equipment	4		6,3	2	partial coverage, not explicit, utilisation	
4.2.4	Select efficient software	4				new section for DCMM v2?	
4.2.5	Develop efficient software	4				new section for DCMM v2?	
4.2.6	Incentives to develop efficient software	4				new section for DCMM v2?	
4.2.7	Eliminate traditional 2N hardware clusters	4				not in DCMM 5.2, L4?	
Management of Existing IT Equipment and Services							
4.3.1	Audit existing physical and service estate	4		5.2, 5.3	1		
4.3.2	Decommission unused services	5		5,3	1+		
4.3.3	Virtualise and archive legacy services	5		5,1	2+	no explicit mention of archiving services	
4.3.4	Consolidation of existing services	5		5,2	1+		
4.3.5	Decommission low business value services	4		5,2	1+		
4.3.6	Shut down idle equipment	3		5,1	1+	not explicit	
4.3.7	Control of system energy use	4		5,2	3+		
4.3.8	Audit of existing IT environmental requirements	4		2,4	2+	not explicit	
Data Management							
4.4.1	Data Management Policy	3		6,3	2		
4.4.2	Separate user logical data storage areas by retention and protection policy	3		6,3	3		

Number	Name	CoC Value		Number	Level	comment	
4.4.3	Separate physical data storage areas by protection and performance requirements	4		6,2	1+		
4.4.4	Select lower power storage devices	3		6,4	1+		
4.4.5	Reduce total data volume	4		6,3	3+		
4.4.6	Reduce total storage volume	4		6.1, 6.5	1+		
Cooling							
Air Flow Management and Design							
5.1.1	Design Hot/Cold Aisle	5		2,6	1+		
5.1.2	Design Contained Hot/Cold Aisle			2,6	1+		
5.1.3	Design Contained Hot/Cold Aisle - Retrofit			2,6	1+		
5.1.4	Rack air flow management – Blanking Plates	3		2,6	1		
5.1.5	Rack air flow management – Other Openings	3		2,6	1		
5.1.6	Provide adequate free area on rack doors			2,6		not explicit	
5.1.7	Raised floor air flow management	3		2,6	1		
5.1.8	Raised floor air flow management – obstructions	2		2,6	2		
5.1.9	Design – Return plenums	3		2,6	3		
5.1.10	Design – Raised floor or suspended ceiling height	3		2,6	3		
5.1.11	Equipment Segregation	3				not explicit In DCMM	
5.1.12	Separate environmental zones	4				not explicit, increases operating range vs zoning	
5.1.13	Separate environmental zones - colo or managed service provider	4				not explicit	
5.1.14	Control of supplied air flow volumes	4				not explicit	
5.1.15	Installation of free cooling			2,3	2+		

Number	Name	CoC Value		Number	Level	comment	
Cooling Management							
5.2.1	Scalable or modular installation and use of cooling equipment	3		2.1, 2.6, L3 1.2, 1.1		check	
5.2.2	Shut down unnecessary cooling equipment	3		"			
5.2.3	Review of cooling before IT equipment changes	2				not explicit	
5.2.4	Review of cooling strategy	2				not explicit	
5.2.5	Review CRAC Settings	3		2,6	1		
5.2.6	Dynamic control of building cooling	3		2,6	3		
5.2.7	Effective regular maintenance of Cooling Plant	2				not explicit	
Temperature and Humidity Settings							
5.3.1	Review and if possible raise target IT equipment intake air temperature	4		2,4	2+		
5.3.2	Review and increase the working humidity range	4		2,4	2+		
5.3.3	Expanded IT equipment inlet environmental conditions (temperature and humidity)	5		8.8, 2.3, 2.4 (3.6)	5		
5.3.4	Review and raise chilled water temperature	4		2,4	3+		
5.3.5	Industrial Space	3		2,4	2+	Not explicit, based on hitting PUE target	
Free and Economised Cooling							
5.4.1.1	Direct air free cooling	5		2,3	1+	tech agnostic, target based on refrigerant cooling hours	
5.4.1.2	Indirect air free cooling	5		2,3	1+	tech agnostic,	

Number	Name	CoC Value		Number	Level	comment	
						target based on refrigerant cooling hours	
5.4.1.3	Indirect water free cooling with CRAH & dry cooler/cooling tower	5		2,3	1+	tech agnostic, target based on refrigerant cooling hours	
5.4.1.4	Indirect water free cooling with CRAC with integrated free cooling coil	5		2,3	1+	tech agnostic, target based on refrigerant cooling hours	
5.4.1.5	Indirect water free cooling with CRAH and free cooling chiller	4		2,3	1+	tech agnostic, target based on refrigerant cooling hours	
5.4.1.6	Indirect water free cooling with condensor water cooling chilled water	3		2,3	1+	tech agnostic, target based on refrigerant cooling hours	
5.4.1.7	Alternative cooling sources	1					
High Efficiency Cooling Plant							
5.4.2.1	Chillers with high COP	3		2,1	1+	not explicit	
5.4.2.2	Cooling system operating temperatures	3		2,4	3		
5.4.2.3	Efficient part load operation	3		2,1	1+	not explicit	
5.4.2.4	Variable speed drives for compressors, pumps and	2		2,6	1	not visible	

Number	Name	CoC Value		Number	Level	comment	
	fans					on tool	
5.4.2.5	Select systems which facilitate the use of economisers	4		2,3		not explicit	
5.4.2.6	Do not share data centre chilled water system with comfort cooling	4				not in DCMM	
5.4.2.7	Do not allow non IT equipment to dictate cooling system set-points	4				not explicit in DCMM but covered by 3.6	
5.4.2.8	Chilled water pump control strategy	1					
5.4.2.9	Direct liquid cooling of IT devices	4				tech agnostic, target based on refrigerant cooling hours	
Computer Room Air Conditioners							
5.5.1	Variable Speed Fans	4		2,6	1		
5.5.2	Control on CRAC unit supply air temperature	2		2,5	1		
5.5.3	Run variable speed CRAC units in parallel	4				not in DCMM	
5.5.4	Sequencing of CRAC units	2				not in DCMM	
5.5.5	Do not control humidity at the CRAC	4				not in DCMM	
5.5.6	Cooling unit sizing & selection						
Reuse of Data Centre Waste Heat							
5.6.1	Waste heat re-use	3		4,3	2+	ere reuse	
5.6.2	Heat pump assisted waste heat re-use	2		4,3			
5.6.3	Use data floor waste heat to warm generator and fuel storage areas	1				not in DCMM	
5.6.4	Energy reuse metrics & reporting	1					

Number	Name	CoC Value		Number	Level	comment	
Data Centre Power Equipment							
Selection and Deployment of New Power Equipment							
6.1.1	Modular UPS Deployment	3		1,2	3		
6.1.2	High efficiency UPS	3		1.1, L3 1.2	1+		
6.1.3	Use efficient UPS operating modes	2		1.1, L1+ 1.2	1+		
6.1.4	Code of Conduct Compliant UPS (where technology is included)	2				not explicit in DCMM	
6.1.5	Elimination of Isolation Transformers	3					
6.1.6	Efficient part load operation	3					
Management of Existing Power Equipment							
6.2.1	Reduce Engine-generator heater temperature set-point	2				not in DCMM, L3 1.2	
6.2.2	Power factor correction	2					
Other Data Centre Equipment							
Office and Storage Spaces							
7.1.1	Turn off Lights	1		3,3	1+		
7.1.2	Low energy lighting	1		3,3	1+		
7.1.3	Pale coloured fixtures and fittings	1					
7.1.4	Energy & temperature reporting hardware	3					
Data Centre Building							
Building Physical Layout							
8.1.1	Locate M&E plant outside the cooled area	2		1,3	3		
8.1.2	Select a building with sufficient ceiling height	3				not in DCMM	
8.1.3	Facilitate the use of economisers	3				not explicit in DCMM	
8.1.4	Optimise orientation of the data centre	2				not in	

Number	Name	CoC Value		Number	Level	comment	
						DCMM	
8.1.5	Minimise direct solar heating	2				not explicit in DCMM	
Building Geographic Location						not in DCMM	
8.2.1	Locate the Data Centre where waste heat can be reused	2		3.4, 4.5			
8.2.2	Locate the Data Centre in an area of low ambient temperature	3					
8.2.3	Avoid locating the data centre in high ambient humidity areas	1					
8.2.4	Locate near a source of free cooling	3					
8.2.5	Colocate with power source	2					
Water sources						not in DCMM	
8.3.1	Capture rain water	1		3.4, 4.5			
8.3.2	Other water sources	2		3.4, 4.5			
8.3.3	Metering of water consumption	2					
Monitoring							
Energy Use and Environmental Measurement							
9.1.1	Incoming energy consumption meter	3		4,2	1	broken down differently in DCMM	
9.1.2	IT Energy consumption meter	3		4,2	1	broken down differently in DCMM	
9.1.3	Room level metering of air temperature and humidity	2		2.4,2.5		broken down differently in DCMM	

Number	Name	CoC Value		Number	Level	comment	
9.1.4	CRAC unit level metering of supply or return air temperature and humidity	3				broken down differently in DCMM	
9.1.5	PDU level metering of IT Energy consumption	3				broken down differently in DCMM	
9.1.6	PDU level metering of Mechanical and Electrical energy consumption	3				broken down differently in DCMM	
9.1.7	Row or Rack level metering of temperature and humidity	2				broken down differently in DCMM	
9.1.8	Device level metering of temperature	4				broken down differently in DCMM	
9.1.9	IT device level metering of energy consumption	4				broken down differently in DCMM	
Energy Use and Environmental Collection and Logging				4,2		broken down differently in DCMM	
9.2.1	Periodic manual readings	3		4,2	1		
9.2.2	Automated daily readings	4		4.2, 4.1	2+		
9.2.3	Automated hourly readings	4		4.2, 4.1			
9.2.4	Acheived economised cooling hours	4					
Energy Use and Environmental Reporting						not explicit in DCMM, add to 4.1	
9.3.1	Written report	3					
9.3.2	Energy and environmental reporting console	3					

Number	Name	CoC Value		Number	Level	comment	
9.3.3	Integrated IT energy and environmental reporting console	4					
9.3.4	Acheived economised cooling hours	4					
IT Reporting							
9.4.1	Server Utilisation	3		5,1			
9.4.2	Network Utilisation	3		7,1			
9.4.3	Storage Utilisation	3				not in DCMM	
9.4.4	Business relevant dashboard	3					

11.3.3 EUCoC and procurement or other measures

Notes:

DCIM = Data Centre Infrastructure Management, ADCIM = Advanced DCIM, EnMS = Energy Management System, BMS = Building Management System

Table 12 EU Procurement by best practice

No	Name	Procurement	Comments
3.1.1	Group Involvement	None	Management
3.2.1	Embodied Energy	None	Management
3.2.2	M&E Operating Ranges	UPS & Cooling	
3.2.3	Service Charging Models	None	Management
3.2.4	LCA	IT, Cooling & UPS	
3.2.5	Environmental Management	Standards	Management & Tender Appendices
3.2.6	Energy Management	Standards	Management & Tender Appendices
3.2.7	Asset Management	Standards	Management & Tender Appendices
3.2.8	Sustainable Energy Usage	Standards	Management & Tender Appendices
3.2.9	PoE IT Devices	None	PUE Calculation
3.2.10	Impact of Mobile/Shifting Workloads	Cloud Services	Management & Tender Appendices
3.2.11	Alternative Power Generation	Energy Services	Management & Tender Appendices
3.3.1	Build resilience	UPS/Cooling/Servers & Cloud	Management & Tender Appendices

3.3.2	Multiple levels of resilience	Colocation/Hosting Services	Management & Tender Appendices
3.3.3	Lean provisioning	UPS/Cooling/Servers & Cloud	Management & Tender Appendices
3.3.4	Part load strategy	UPS/Cooling/Servers & Cloud	Management & Tender Appendices
3.3.5	Design effective resilience		Management & Tender Appendices

Table 13 IT Services – Selection & Deployment of New IT Equipment

No	Name	Procurement	Comments
4.1.1	IT Hardware Power	Servers, Storage, Network	Tender Appendices
4.1.2	IT Hardware (Restricted)	Servers, Storage, Network	Tender Appendices
4.1.3	IT Hardware Expected	Servers, Storage, Network	Tender Appendices
4.1.4	IT Hardware Extended	Servers, Storage, Network	Tender Appendices
4.1.5	Density	Servers, Storage, Network & Cooling	Tender Appendices
4.1.6	Power V Inlet Temp	Servers	Tender Appendices
4.1.7	Air Flow Direction	Servers, Storage, Network	Tender Appendices
4.1.8	Power Management	IT ops	IT Management
4.1.9	IT Provisioning	IT Ops	IT Management
4.1.10	Energy Star	Servers, Storage and Networking	Tender Appendices
4.1.11	Energy/Temp	Servers	Tender Appendices

	reporting		
4.1.12	Control of Equipment Energy Use	Servers, Storage, Network	Tender Appendices
4.1.13	Free Standing Equipment Air Flow	Storage	Tender Appendices
4.1.14	Op Temp Liquid Cooled	Servers	Tender Appendices
4.1.15	AC/DC Convertors	Servers, Storage, Network	Tender Appendices

Table 14 IT Equipment – Deployment of New IT Services

No	Name	Procurement	Comments
4.2.1	Grid/Virtualisation	Servers, Storage, Network & Cloud Services	Tender Appendices
5.2.2	Reduce hardware resilience level	IT Ops	IT Management
4.2.3	Reduce hot/cold standby eqpt	IT Ops	IT Management
4.2.4	Select Efficient Software	Software	Tender Appendices
4.2.5	Develop Efficient Software	Software	Tender Appendices
4.2.6	Incentives Software	Software	Tender Appendices
4.2.7	Eliminate 2N clusters	IT Ops	IT Management

Table 15 Management of existing IT Equipment & Services

No	Name	Procurement	Comments
4.3.1	Audit	Standards, Software (Asset Mgmt)	ISO55000
4.3.2	Decommission	IT Ops	IT Management
4.3.3	Virtualise/Archive	IT Ops	IT Management
4.3.4	Consolidation	IT Ops	IT Management
4.3.5	Decommission low value Business Services	IT Ops	IT Management
4.3.6	Shut down idle equipment	IT Ops	IT Management
4.3.7	Control of system energy use	Servers, Storage, & Network	
4.3.8	Audit - Environmental	IT Ops, Software	IT Management

Table 16 Data Management

No	Name	Procurement	Comments
4.4.1	Data Mgmt Policy	IT Ops	IT Management
4.4.2	Logical Storage	IT Ops	IT Management
4.4.3	Physical Storage	IT Ops	IT Management
4.4.4	Lower Power Storage Devices	Storage	Tender Appendices
4.4.5	Reduce total data volume	Storage/Software	Deduplication Software, Storage Software
4.4.6	Reduce total storage volume	Storage/Software	Deduplication Software, Storage Software

Table 17 Cooling – Air Flow Management & Design

No	Name	Procurement	Comments
5.1.1	Design Hot/Cold Aisle	Design & Cooling	Tender Docs
5.1.2	Design Contained Hot/Cold Aisle	Design & Cooling	Tender Docs
5.1.3	Design Contained Hot/Cold Aisle Retrofit	Design & Cooling	Tender Docs
5.1.4	Blanking Plates	Rack Eqmpt	Tender Docs
5.1.5	Other Openings	Rack Eqmpt	Tender Docs
5.1.6	Doors	Rack Eqmpt	Tender Docs
5.1.7	Raised Floor Air Management	IT/Facilities Ops	Facilities Ops
5.1.8	Raised Floor Air Flow Management (Obstructions)	IT/Facilities Ops	Facilities Ops
5.1.9	Design (Plenums)	Design & Cooling	Tender Docs
5.1.10	Design (Slab to Slab)	Building Design	Tender Docs
5.1.11	Equipment Segregation	Design	Tender Docs
5.1.12	Separate Environmental Zones	Design	Tender Docs
5.31.13	Separate Environmental Zones (CoLo/Hosting)	Design/Colo/Hosting	Tender Docs
5.1.14	Control of Supply Air Volumes	Facility Ops	Facility Ops

5.1.15	Free Cooling	Design	Tender Docs

Table 18 Cooling Management

No	Name	Procurement	Comments
5.2.1	Modular Cooling Equipment	Cooling/Design	Tender Documents
5.2.2	Shut Down Unnecessary Equipment	IT/Facility Ops	Ops
5.2.3	Review of Cooling	IT/Facility Ops	Ops
5.2.4	Review of Cooling Strategy	IT/Facility Ops	Ops
5.2.5	Review CRAC/CRAH settings	IT/Facility Ops	Ops
5.2.6	Dynamic Control of building cooling	Design	Tender Docs
5.2.7	Effective Maintenance	Maintenance	Tender Docs

Table 19 Temperature/Humidity Settings

No	Name	Procurement	Comments
5.3.1	Raise IT inlet Temps		IT Ops/Facilities
5.3.2	Widen Humidity Range		IT Ops/Facilities
5.3.3	Expanded Temps/Humidity		IT Ops/Facilities
5.3.4	Raise Chilled		IT Ops/Facilities

	Water Temp		
5.3.5	Industrial Space		IT Ops/Facilities

Table 20 Free Cooling

No	Name	Procurement	Comments
5.4.1.1	Direct Air FC	Design/Cooling	Tender Docs
5.4.1.2	Indirect Air FC	Design/Cooling	Tender Docs
5.4.1.3	Indirect Water FC (Dry Cooler/Water Tower)	Design/Cooling	Tender Docs
5.4.1.4	Indirect Water FC (Free Cooling Coil)	Design/Cooling	Tender Docs
5.4.1.5	Indirect Water FC (CRAH/Free Cooling Chiller)	Design/Cooling	Tender Docs
5.4.1.6	Indirect Water FC with Condenser/Chilled Water	Design/Cooling	Tender Docs
5.4.1.7	Alternative Water Sources	Design/Cooling	Tender Docs

Table 21 High Efficiency Cooling Plant

No	Name	Procurement	Comments
5.4.2.1	Chillers COP	Chillers/Cooling	
5.4.2.2	Cooling System Op Temp		Ops
5.4.2.3	Part Load Ops		Ops
5.4.2.4	VSD	Cooling	
5.4.2.5	Economisers	Design/Cooling	

5.4.2.6	Comfort Cooling		Ops
5.4.2.7	Set Points		Ops
5.4.2.8	Chilled Water Strategy		Ops
5.4.2.9	Direct Cooling of IT Devices	Design/Cooling	

Table 22 Computer Room Air Conditioners (CRAC's)

No	Name	Procurement	Comments
5.5.1	VSD	Cooling	Tender Docs
5.5.2	Control of CRAC/CRAH Supply		Facility Ops
5.5.3	CRAC/CRAH Parallels	Cooling	Facility Ops
5.5.4	Sequencing of CRAC/CRAH's	Cooling	Facility Ops
5.5.5	Humidity Control		Facility Ops
5.5.6	Cooling Unit Sizing & Selection	Cooling/Design	Tender Docs

Table 23 Reuse of Data Centre Waste Heat

No	Name	Procurement	Comments	
5.6.1	Waste Heat Reuse	Design/Cooling		PPI
5.6.2	Heat Pump Assisted Waste Heat Reuse	Design/Cooling		PPI
5.6.3	Internal Heat Reuse	Design/Cooling		PPI
5.6.4	Energy Use & Reporting		Facility Ops	

Table 24 Data Centre Power Equipment – New Power Equipment

No	Name	Procurement	Comments
6.1.1	Modular UPS	UPS	Tender Docs
6.1.2	High Efficiency UPS	UPS	Tender Docs
6.1.3	Operation Modes		Ops
6.1.4	EUCOC UPS	UPS	Tender Docs

Table 25 Data Centre Power Equipment – Management of Existing Power Equipment

No	Name	Procurement	Comments	
6.2.1	Engine Block Set Points	Generator	Facility Ops	Tender Docs
6.2.2	Power Factor Correction	Power Factor Correction Equipment		Tender Docs

Table 26 Other Data Centre Equipment

No	Name	Procurement	Comments	
7.1.1	Turn off Lights	Lighting	Ops	Tender Docs
7.1.2	Low Energy Lighting	Design/Lighting		Tender Docs
7.1.3	Pale Fixtures & Fittings	Design, Rack Equipment		Tender Docs
7.1.4	Energy/Temp reporting hardware	Design, CRAC/CRAH's, Chillers, UPS		Tender Docs

Table 27 Data Centre Building – Physical Layout

No	Name	Procurement	Comments	
8.1.1	M&E Outside Cooled Area	Design		Build Tender Docs/Design
8.1.2	Slab to Slab heights	Design		Build Tender Docs/Design
8.1.3	Economisers	Design		Build Tender Docs/Design
8.1.4	Orientation of Plant	Design		Build Tender Docs/Design
8.1.5	Minimise Direct Solar Heating	Design		Build Tender Docs/Design

Table 28 Building Geographic Location

No	Name	Procurement	Comments	
8.2.1	Locate Waste Heat	Design/Survey	Build Tender Docs/Design	PPI
8.2.2	Locate Low Ambient Temp	Geographic Survey	Build Tender Docs/Design	

8.2.3	Locate Low Ambient Humidity	Geographic Survey	Build Tender Docs/Design	
8.2.4	Locate near Free Cooling	Design/Survey	Build Tender Docs/Design	PPI
8.2.5	Locate nr Power Source	Design/Survey	Build Tender Docs/Design	PPI

Table 29 Water Sources

No	Name	Procurement	Comments	
8.3.1	Capture Rainwater	Rainwater Capture Systems	Tender Document	PPI
8.3.2	Other Water Sources	Water System	Tender Document	PPI
8.3.3	Metering of Water Consumption	Metering	Tender Document	

Table 30 Monitoring – Energy Use & Environmental Management

No	Name	Procurement	Comments
9.1.1	Incoming Energy Meter	Energy/DCIM/EnMS/BMS	Installed by Utility, may be shared, if so, fiscal metering should be procured at Dist Board Level (no other consumers except Data Centre!)
9.1.2	IT Energy Consumption Meter	Electrical Supply System/ADCIM/DCIM/EnMS/BMS	Tender Docs
9.1.3	Room Level Temp/Humidity	ADCIM/DCIM/EnMS/BMS	Tender Docs
9.1.4	CRAC/CRAH	ADCIM/DCIM/EnMS/BMS &	Tender Docs

	Temp/Humidity	Cooling	
9.1.5	Dist Board M&E Energy	ADCIM/DCIM/EnMS/BMS	Tender Docs
9.1.6	Cab IT Energy	ADCIM/DCIM/EnMS/BMS/ Power Distribution Strips	Tender Docs
9.1.7	Cab Temp/Humidity	ADCIM/DCIM/EnMS/BMS & Cooling	Tender Docs
9.1.8	IT Device Temp/Humidity	ADCIM/DCIM/EnMS/BMS/Cooling & IT Devices	Tender Docs
9.1.9	IT Device Energy	ADCIM/DCIM/EnMS/BMS/Cooling & IT Devices	Tender Docs

Table 31 Energy Use & Environmental Collection & Logging

No	Name	Procurement	Comments	
9.2.1	Manual Readings	IT/Facilities Ops	IT Ops	
9.2.2	Auto Daily	ADCIM/DCIM/EnMS/BMS		Tender Docs
9.2.3	Auto Hourly	ADCIM/DCIM/EnMS/BMS		Tender Docs
9.2.4	Achieved FC Hours	ADCIM/DCIM/EnMS/BMS & Cooling System		Tender Docs

Table 32 Energy Use & Environmental Reporting

No	Name	Procurement	Comments	
9.3.1	Written Report	IT/Facilities Ops	IT Ops	May be an output from BMS/EnMS/ADCIM/DCIM/BMS etc
9.3.2	Energy/Environment Console	ADCIM/DCIM/EnMS/BMS		Tender Docs
9.3.3	Integrated IT/Energy/Environmental Console	ADCIM/DCIM/EnMS/BMS		Tender Docs

9.3.4	Achieved FC Hours	ADCIM/DCIM/EnMS/BMS & Cooling System		Tender Docs

Table 33 IT Reporting

No	Name	Procurement	Comments	
9.4.1	Server Utilisation	Server Mgmt Tools	May be pre-existing	Tender Docs
9.4.2	Network Utilisation	Network Mgmt Tools	May be pre-existing	Tender Docs
9.4.3	Storage Utilisation	Storage Mgmt Tools	May be pre-existing	Tender Docs
9.4.4	Business Relevant Dashboard	DCIM/ADCIM		

11.4 Annex “Procurement examples” – specification for EURECA directory

Table 34 Documentation format procurement examples

Main categories	Sub-categories	Classifications & data format	Comment
Organisation profile			
	Organisation name	Free text (1 line)	Request to write official full name of organisation; note: organisations regularly change names throughout time
	Organisation body	Free text (1 line)	Request to write official full name of organisation body; note: organisations regularly change names throughout time
	Country	Dropdown	
	Region	Free text	F.e. Cities, provinces; include option "no information", as whole section is mandatory (or exempt this element)
	No. of employees	Dropdown (ranges)	include option "no information", as whole section is mandatory (or exempt this element)
	Tender title	Free text (1 line)	
	Contact	Department contact details	Refrain from individual personal information; both from privacy perspective and because people (and thus contact details) change regularly and can become out of date quickly. include option "no information", as whole section is mandatory (or exempt this element)
Procurement / tender			
	Procurement / tender description	Free text	Summary description approx 1000 characters

Main categories	Sub-categories	Classifications & data format	Comment
	Scenario	Multiselect options	Multiselect to facilitate possibility it was a combination of 2 or more scenarios
		In-house New Build	
		Retrofit In-house M&E	
		Retrofit In-house Floor	
		New In-house Equip	! This one will be broken down to the main hardware to buy (e.g. servers, cooling, UPS, storage, ...), as specified in the products directory
		New In-house Service	! This one will be broken down to the main hardware to buy (e.g. DC energy consultant, EUCoC training, ...), as specified in the services directory
		Outsource Co-location	
		Outsource Hosting or Private cloud	
		Outsource Governmental Cloud	
		Outsource Public Cloud	
	Procurement Type	1 selection option	
		PCP	Pre-Commercial Procurement (PCP) is the procurement of research and development of new innovative solutions before they are commercially available.
		PPI	Public Procurement of Innovative solutions (PPI) is the procurement of

Main categories	Sub-categories	Classifications & data format	Comment
			innovative goods or services which are not yet available on large scale commercial basis and may include conformance testing.
		RFT/RFP/RFQ	These forms of general procurement are the procurement of goods or services that are generally more widely available on the market, this can include relatively new but accepted technology
	Procurement Model	1 selection option	
		Solitary	Procured as individual public sector body
		Joint internal	Procured jointly in collaboration with other public sector bodies within same PS organisation
		Joint external	Procured jointly in collaboration with other public sector organisations outside their own
		Framework agreement	Procured through a Purchasing Consortium (may include private organisations providing procurement services)
	Constraints	free text	
	Objectives specified	Indicated per 3 topics where applicable	E.g. End-of-life upcoming, emergency need, improve environmental performance, reduce OPEX (electricity, staff, ...), ...
		Quantifiable performance-based	Free text or more constraint form of input form to be determined
		Quantifiable non-performance based	Free text or more constraint form of input form to be determined
		Non-quantifiable	Free text or more constraint form of input form to be determined

Main categories	Sub-categories	Classifications & data format	Comment
Results			
	Objectives results (short-term)	Indicated per 3 topics where applicable	
		Quantifiable performance-based	Free text or more constraint form of input form to be determined (for instance linked to KPIs/metrics selection or environmental life cycle wide savings using EURECA tool, etc. (supplemented by extra option 'no specific target')
		Quantifiable non-performance based	Free text or more constraint form of input form to be determined (for instance linked to KPIs/metrics selection that then triggers to fill in objectives related to these (supplemented by extra option 'no specific target')
		Non-quantifiable	Free text or more constraint form of input form to be determined (supplemented by extra option 'no specific target')
	Objectives results (longer-term)	Indicated per 3 topics where applicable	To further determine what 'longer-term' may be 1, 3 or 5 years)
		Quantifiable performance-based	Free text or more constraint form of input form to be determined (for instance linked to KPIs/metrics selection or environmental life cycle wide savings using EURECA tool, etc. (supplemented by extra option 'no specific target')
		Quantifiable non-performance based	Free text or more constraint form of input form to be determined (for instance linked to KPIs/metrics selection that then triggers to fill in objectives related to these

Main categories	Sub-categories	Classifications & data format	Comment
			(supplemented by extra option 'no specific target')
		Non-quantifiable	Free text or more constraint form of input form to be determined (supplemented by extra option 'no specific target')
	Lessons learned	Free text	Possibility for input why objectives may not have been reached or other lessons other PS bodies may find interesting to learn (max 5000 characters)
Suppliers			
	Supplier(s) awarded	Link to suppliers in EURECA directory database	Include possibility to name supplier not in EURECA market directory
Drivers		Multiselect options	
	Economic	Cost reduction (life cycle cost - total cost of ownership)	
		Cost reduction (operational cost)	
		Cost reduction (environmental life cycle costing incl. externalities)	
	Environmental	Multiselect options	
		Energy	
		Environmental footprint	
		Carbon footprint	
		Water	
		Waste	
		Materials	Possible further specified in LC stages initial investment, production, maintenance, end-of-life; possible link to LCA maturity from self-

Main categories	Sub-categories	Classifications & data format	Comment
			assessment
	Social	Multiselect options	
		Public service improvement	Quantification may vary/to be complex to include in business case, but as procurement example can still serve as example where this was a driver
		Job / Skills development	Quantification may vary/to be complex to include in business case, but as procurement example can still serve as example where this was a driver
		Quality of Life	Quantification may vary/to be complex to include in business case, but as procurement example can still serve as example where this was a driver
		Policy / legislation improvement	Quantification may vary/to be complex to include in business case, but as procurement example can still serve as example where this was a driver
		Community improvement	Quantification may vary/to be complex to include in business case, but as procurement example can still serve as example where this was a driver
	Legal / compliance	Multiselect options	
		National law	Possible further specified in country specific relevant laws/policies such as financial, health and safety, security related, to be investigated for feasibility
		EU law	Possible further specified EU/EC specific relevant laws/policies such as

Main categories	Sub-categories	Classifications & data format	Comment
			financial, health and safety, security related, to be investigated for feasibility
		Insurance compliance	Possible further specified countryinsurrance specific relevant rules such as financial, health and safety, security related, to be investigated for feasibility
		Standard compliance	Possible further specified relevant standards listings, to be investigated for feasibility
		Label/certificate compliance	Possible further specified relevant label/certificates listings, to be investigated for feasibility
	Technical / ICT	Multiselect options	
		Increased / new demand for functionality / application	
		ICT equipment age	
		ICT Infrastructure issues	Possible further specified in power, cooling, network, maintenance, capacity, performance
		New/improved technology	
		Contract renewal	
Solution			
	Maturity level	0...5	Linked to DCMM maturity approach to be used, 6 levels of maturity per technology area
	Previous ICT landscape	free text	
	Solution description	free text	
	Business Case	free text	

Main categories	Sub-categories	Classifications & data format	Comment
Criteria used as award criteria		Multiselect options	
	Eco-labels, standards, certifications	List of labels, standards, certifications, incl. „Other“	
	KPI/Metrics	List of KPI metrics	Indicator which were included in tender criteria, evaluation and awarding; includes EURECA calculated overall environmental impacts.
	LCA or EPD study	Free text plus reference to pdf (stored on EURECA site)	
	Other	Free text	Other criteria used, for instance those outside of EURECA scope (max 100 words)
Attachment		Free text plus reference to pdf (stored on EURECA site)	Possibility to add attachments (pdf, office, photos)
Other information		Free text	Notes on other relevant info

11.5 Annex “Terms and Acronyms” – Specification for EURECA Directory

Table 35 Documentation format “Terms and Acronyms” directory based on terminology use in tool and specifically in the directories

Term/Acronym	Element type	Enumerated entries	Comments

Acronym	string (max 10 characters)		
Term	string (max 100 characters)		
Definition	free text (max 1000 characters)		
Class	Multiple selection from enumerated list	*Data centre level, server, UPS, cooling, other ICT, other M&E, software, building, procurement, life cycle, data services, consulting services, legal, other*	to be aligned with the final procurement cases and other topics (legal) that are covered in detail by EURECA
Example	free text (max 1000 characters)		
Comment	free text (max 1000 characters)		
Alternative terms and acronyms	free text (max 1000 characters)		

Notes:

Format to be searchable in Alphabetic order and Per EURECA functionality

Each Term in the Directory will also be assigned the classes as defined above, which can be used at the back-end to determine where specific ToD's can be accessed from within any place of the EURECA tool.

Each occurrence of a term (that is included in the ToD) will be highlighted in tool's texts and tables (subtle, as to remain user-friendly & keep text pleasantly readable). It should require action (f.e. right mouse click on highlighted word) from the user for the ToD explanation to pop up, otherwise user will have pop-ups continually when moving mouse over text.

Terminology from industries that have commonly accepted definitions should be used within EURECA ToD as well. Same with for instance LCM/LCA/LCC etc.

Include examples in Del 2.1 of how ToD may work within EURECA for visualization purposes. For instance, during self-assessment a technology term is used. This term will be highlighted so that user can instantly check the definition of the term.

11.6 Annex "FAQ" – specification for the EURECA directory

Table 36 FAQ format specification. List of exact questions and answers to be determined in parallel to project, e.g. during the trainings.

	FAQ question	Free text (200 characters)
	FAQ answer	Free text (1000 characters)
EURECA Directory section	**Directory of Terms**	FAQ's on how and where Directory of Terms can be used
	Market Directory	FAQ's on EURECA's Market Directory; for vendors and for procurers
	Maturity Model	FAQ's on EURECA's Maturity Model and its integration with other building blocks
	Self-assessment	FAQ's on EURECA's self-assessment function
	ROI/Business case	FAQ's on EURECA's support to calculate ROI / Business case creation
	RFI	FAQ's on EURECA support for formulating RFI's for different types of procurement (PCP, PPI, ITT)
	RFQ / RFP / ITT	FAQ's on EURECA support for formulating RFQ/RFP's for different types of procurement (PCP, PPI, ITT)
	Awarding	FAQ's on EURECA support for awarding tenders for different types of procurement (PCP, PPI, ITT)
	Monitoring	FAQs on how monitoring functionality can be used
	Procurement case examples	FAQs on how to fill in CE forms, how to interpret case example
Subject matter	**Technology**	FAQ's related to different technology areas; strongly linked to Directory of Terms
	Life cyle aspects	FAQ's related to different LC areas (LCA, LCC); strongly linked to Directory of Terms

Sustainability	FAQ's related to different sustainability topics; strongly linked to Directory of Terms
KPI/metrics	FAQ's related to different KPI/metric; strongly linked to Directory of Terms
Knowledge / Training	FAQ's on knowledge sharing and training possibilities

Notes:

Each FAQ will also be assigned 'classes' which can be used at the back-end to determine where specific FAQ's can be accessed from within any place of the EURECA tool.

Indicators will be integrated throughout the tool and its various building blocks to show the user can access relevant FAQ for that specific part or subject matter in the tool.

Include examples in Del 2.1 of how FAQ may work and be integrated within EURECA tool for visualization purposes. For instance, during business case calculations input for CO2e is used. An associated FAQ may be 'How do I calculate my CO2e? Answer would show how CO2e is calculated and which data is needed to do so. Possibly even include a link to ToD for the definition of CO2e.

11.7 Annex "Innovative solutions – specification for the EURECA Directory

11.7.1 Specifications

Table 37 Documentation format for "Innovative solutions"

Element/characteristic	Format
Project description	Free text
Contact	Free text
Data centres used	Dropdown list (multiselect): Small server rooms, Medium server rooms, Enterprise data centre
Areas of data centre addressed	Dropdown list (multiselect): Power, Cooling, Management, Compute, Storage, Network, M&E general
Applicability	Free text
Prerequisites for deploying the proposed solution	Free text
Expected environmental and energetic benefits	Free text
Return on Investment	Free text
Market readiness	Free text
IPR licensing model	Free text

11.7.2 Definitions

Power: Critical Power Path Efficiency, Architecture, Operations, Generation

Cooling: Mechanical/Refrigerant Cooling reduction, Environmental – monitoring and control, Operations

Management: Monitoring, PUE, Waste heat reuse, CUE, WUE, xUE/additional metrics

M&E general: covers more than one M & E component

Compute: Utilisation, Workload Management, Operations, Power management, Server populations

Storage: Workload, Architecture, Operations, Technology, Provisioning

Network: Utilisation, Workload, Operations, Technology, Base Performance, Provisioning

New Build: for procurers looking to build a new data centre

Retrofit: for procurers looking to enhance an existing data centre

11.8 Annex “Product, Services, and Vendors” – specifications for the EURECA Directory

Table 38 “Products and services” Directory, specifications of the main products and services (in red font) for the Directory. Note for “Element type / unit”: includes list of enumerated entries, if any. And: default entry and also ALWAYS selectable in dropdown fields is "no information". On “Vendors / service providers”: Please see example for “DC Design & Build” (first entry): a very similar characteristics format will be used for any other Vendor / Service provider.

Data model	Main category	Category	Product or service questionnaire / form	Characteristic	Element type and unit	Definition of element / clarification
DC Design & Build	Services	Support and consulting	DC Design & Build		Dropdown (prerequisite to Data centre selected)	
	Services	Support and consulting	DC Design & Build	Business type	Dropdown: DC Architects; DC Generalists; Hardware vendor; Construction company; System integrator; Other	
	Services	Support and consulting	DC Design & Build	Countries offering services	Dropdown (multi-select): ISO country codes	
	Services	Support and consulting	DC Design & Build	Country where based	Dropdown: ISO country list	
	Services	Support and consulting	DC Design & Build	Website	URL	

Data model	Main category	Category	Product or service questionnaire / form	Characteristic	Element type and unit	Definition of element / clarification
	Services	Support and consulting	DC Design & Build	Languages spoken	Dropdown (multi-select): ISO language codes	
	Services	Support and consulting	DC Design & Build	In business since	year	
	Services	Support and consulting	DC Design & Build	Number employees (range)	Classes	
	Services	Support and consulting	DC Design & Build	Organisation awards, signatories, certifications	Enumerated list (multiselect): EMAS, EUCoC, ISO 9001, ISO 14001, Other (which?)	
	Services	Support and consulting	DC Design & Build	Other awards, signatories, certifications	Free text	
Facilities management	Services	Support and consulting	Facilities management		Dropdown (prerequisite to Data centre selected)	
Fire prevention	Products	M&E capital goods	Fire prevention	Brand	Dropdown - Directory-internal hyperlink (prerequisite to Data centre selected)	
	Products	M&E capital	Fire prevention	Type/Model	Free text	

Data model	Main category	Category	Product or service questionnaire / form	Characteristic	Element type and unit	Definition of element / clarification
		goods				
	Products	M&E capital goods	Fire prevention	Life time	years	Expected technical life time
	Products	M&E capital goods	Fire prevention	Warrantee	years	
	Products	M&E capital goods	Fire prevention	Fire prevention/suppression provided for how many servers?	number	Please convert any other basis, e.g. m2 of floor to the number of servers (expressed in 1U servers equivalent).
	Products	M&E capital goods	Fire prevention	Storage space in m2 in MER	m2	
	Products	M&E capital goods	Fire prevention	Storage space in m2 in DC total	m2	
	Products	M&E capital goods	Fire prevention	Method	Dropdown: CO2, N2, water mist, argon, Novec, other (please name)	
	Products	M&E capital goods	Fire prevention	Method - Other	Free text	

Data model	Main category	Category	Product or service questionnaire / form	Characteristic	Element type and unit	Definition of element / clarification
	Products	M&E capital goods	Fire prevention	Loss factor (no discharge)	kg/year	
	Products	M&E capital goods	Fire prevention	Amount freed when discharged	kg/discharge	
	Products	M&E capital goods	Fire prevention	Discharge frequency (statistical)	number/year	
	Products	M&E capital goods	Fire prevention	Danger for people during discharge	free text	
	Products	M&E capital goods	Fire prevention	Agent to be renewed in	Years	
	Products	M&E capital goods	Fire prevention	Height (if rack-integrated)	number of U's	
	Products	M&E capital goods	Fire prevention	Design year	YYYY	
	Products	M&E capital goods	Fire prevention	Energy savings / Eco mode	Y/N	

Data model	Main category	Category	Product or service questionnaire / form	Characteristic	Element type and unit	Definition of element / clarification
	Products	M&E capital goods	Fire prevention	Certifications company or product	Dropdown (multi-select): EMAS, EU National, EU Type I ecolabel, EnergyStar, Other (which?)	
	Products	M&E capital goods	Fire prevention	Other certifications (which)	free text	These are not considered for the award criteria
	Products	M&E capital goods	Fire prevention	Idle Energy consumption	W	
	Products	M&E capital goods	Fire prevention	Purchase price	EUR	
	Products	M&E capital goods	Fire prevention	Installation cost	EUR	
	Products	M&E capital goods	Fire prevention	Maintenance costs/year	EUR	
	Products	M&E capital goods	Fire prevention	Maintenance freq./year	number	
	Products	M&E capital goods	Fire prevention	Cost of refilling (after being discharged)	EUR	

Data model	Main category	Category	Product or service questionnaire / form	Characteristic	Element type and unit	Definition of element / clarification
	Products	M&E capital goods	Fire prevention	End-of-life cost	EUR	
	Products	M&E capital goods	Fire prevention	Max temperature for long-term reliable operation	Celsius	
	Products	M&E capital goods	Fire prevention	LCA/EPD for this model available?	Y/N	LCA or EPDs that are conform with ISO 14040/44, the ILCD handbook and/or the PEF are eligible.
	Products	M&E capital goods	Fire prevention	Carbon footprint, water footprint for this model available?	Y/N	CFs or WFs in line with ISO 14067 or 14069 are eligible.
	Products	M&E capital goods	Fire prevention	Link to LCA, EPD, CF, or WF study	link(s) to pdf, if any (otherwise empty)	
Fuel solutions	Products	Consumables	Fuel solutions		Dropdown (prerequisite to Data centre selected)	
Cabling	Products	M&E capital goods	Cabling		Dropdown (prerequisite to IT Hardware selected)	

Data model	Main category	Category	Product or service questionnaire / form	Characteristic	Element type and unit	Definition of element / clarification
Servers	Products	IT Hardware	Servers	Brand	Dropdown - Directory-internal hyperlink (prerequisite to IT Hardware selected)	
	Products	IT Hardware	Servers	Type/Model	free text	
	Products	IT Hardware	Servers	Type	Dropdown: rack, blade, Other	
	Products	IT Hardware	Servers	Other type (which?)	free text	
	Products	IT Hardware	Servers	Height (for rack-type)	number of U's	
	Products	IT Hardware	Servers	Model release year	YYYY	
	Products	IT Hardware	Servers	Warrantee	years	
	Products	IT Hardware	Servers	Max energy consumption	W	
	Products	IT Hardware	Servers	Energy/Eco mode	Y/N	
	Products	IT Hardware	Servers	Certifications product	Dropdown (multi-select): EPEAT, EU Flower or EU national Type I label, EnergyStar 1, EnergyStar 2	
	Products	IT Hardware	Servers	Number of standby status	number	

Data model	Main category	Category	Product or service questionnaire / form	Characteristic	Element type and unit	Definition of element / clarification
	Products	IT Hardware	Servers	Idle Energy consumption	W	
	Products	IT Hardware	Servers	Purchase price	EUR	
	Products	IT Hardware	Servers	Long-term reliable server operation inlet temperature	Celsius	
	Products	IT Hardware	Servers	SPECfp_rate_base2006 results	value	
	Products	IT Hardware	Servers	SPEC SERT results	value	
	Products	IT Hardware	Storage	Auxiliaries	Free field (what is in packaging)	
	Products	IT Hardware	Servers	No. of chips	number	
	Products	IT Hardware	Servers	No. of kernels	number	
	Products	IT Hardware	Servers	No. of threads	number	
	Products	IT Hardware	Servers	Onboard storage type	Dropdown: HDD, SSD, both, other	
	Products	IT Hardware	Servers	Onboard storage capacity	GB	

Data model	Main category	Category	Product or service questionnaire / form	Characteristic	Element type and unit	Definition of element / clarification
	Products	IT Hardware	Servers	LCA/EPD for this model available?	Y/N	LCA or EPDs that are conform with ISO 14040/44, the ILCD handbook and/or the PEF are eligible.
	Products	IT Hardware	Servers	Carbon footprint, water footprint for this model available?	Y/N	CFs or WFs in line with ISO 14067 or 14069 are eligible.
	Products	IT Hardware	Servers	Link to LCA, EPD, CF, or WF study	link(s) to pdf, if any (otherwise empty)	
Storage	Products	IT Hardware	Storage	Brand	Dropdown - Directory-internal hyperlink (prerequisite to IT Hardware selected)	
	Products	IT Hardware	Storage	Type/Model	free text	
	Products	IT Hardware	Storage	Capacity	GB	
	Products	IT Hardware	Storage	Size	L * W * H	
	Products	IT Hardware	Storage	Medium	Dropdown: Flash, SSD, HDD, tape, other	

Data model	Main category	Category	Product or service questionnaire / form	Characteristic	Element type and unit	Definition of element / clarification
	Products	IT Hardware	Storage	Built year	YYYY	
	Products	IT Hardware	Storage	Warrantee	years	
	Products	IT Hardware	Storage	Max energy consumption	W	
	Products	IT Hardware	Storage	Energy/Eco mode	Y/N	
	Products	IT Hardware	Storage	Certifications product	Dropdown (multi-select): EPEAT, EU Flower, EU national Type I label, EnergyStar v. 1, EnergyStar v. 2, Other (which?)	
	Products	IT Hardware	Storage	Other certifications product (which)	free text	These are not considered for the award criteria
	Products	IT Hardware	Storage	Idle Energy consumption	W	
	Products	IT Hardware	Storage	Purchase price	EUR	
	Products	IT Hardware	Storage	Maintenance costs/year	EUR	
	Products	IT Hardware	Storage	Maintenance freq./year	number	
	Products	IT Hardware	Storage	Auxiliaries	Free field (what is in packaging)	

Data model	Main category	Category	Product or service questionnaire / form	Characteristic	Element type and unit	Definition of element / clarification
	Products	IT Hardware	Storage	Long-term reliable operation inlet temperature	Celsius	
	Products	IT Hardware	Storage	PEF LCIA results for this model	link to pdf	i.e. the production, use, end-of-life results values for the 15 PEF impact categories.
	Products	IT Hardware	Storage	LCA/EPD for this model available?	Y/N	LCA or EPDs that are conform with ISO 14040/44, the ILCD handbook and/or the PEF are eligible.
	Products	IT Hardware	Storage	Carbon footprint, water footprint for this model available?	Y/N	CFs or WFs in line with ISO 14067 or 14069 are eligible.
	Products	IT Hardware	Storage	Link to LCA, EPD, CF, or WF study	link(s) to pdf, if any (otherwise empty)	
Switches	Products	IT Hardware	Switches		Dropdown (prerequisite to IT Hardware selected)	

Data model	Main category	Category	Product or service questionnaire / form	Characteristic	Element type and unit	Definition of element / clarification
Virtualisation	Products	IT Software	Virtualisation	Brand	Dropdown - Directory-internal hyperlink (prerequisite to IT Hardware selected)	
	Products	IT Software	Virtualisation	Name and version	free text	
Virtualisation/Server	Products	IT Software	Virtualisation/Server	Average annual utilization percentage for physical server	percentage	
	Products	IT Software	Virtualisation/Server	Costs per Vserver software	EUR [Free field: per time unit/user/other]	
	Products	IT Software	Virtualisation/Server	Costs for installation	EUR [Free field: per time unit/user/other]	
	Products	IT Software	Virtualisation/Server	Cost for vendor assistence	EUR [Free field: per time unit/user/other]	
	Products	IT Software	Virtualisation/Server	License cost per user	EUR [Free field: per time unit/user/other]	
	Products	IT Software	Virtualisation/Server	Licence model	per named user/concurrent user	
	Products	IT Software	Virtualisation/Server	Closed or open SW architecture	open/closed	

Data model	Main category	Category	Product or service questionnaire / form	Characteristic	Element type and unit	Definition of element / clarification
	Products	IT Software	Virtualisation/Server	Training costs per user (recommended by vendor)	EUR	
Virtualisation/DCIM	Products	IT Software	Virtualisation/DCIM	Energy efficiency monitoring?	Y/N	
	Products	IT Software	Virtualisation/DCIM	Identificaction stranded capacity?	Y/N	
	Products	IT Software	Virtualisation/DCIM	Indentification idle servers?	Y/N	
	Products	IT Software	Virtualisation/DCIM	Advise on capacity utilization improvement?	Y/N	
	Products	IT Software	Virtualisation/DCIM	Identification of anomalies (hot spots)?	Y/N	
	Products	IT Software	Virtualisation/DCIM	Hardware control (CMDB)?	Y/N	
	Products	IT Software	Virtualisation/DCIM	Costs for software DCIM	EUR [Free field: per time unit/user/other]	
	Products	IT Software	Virtualisation/DCIM	Costs for installation software	EUR [Free field: per time unit/user/other]	

Data model	Main category	Category	Product or service questionnaire / form	Characteristic	Element type and unit	Definition of element / clarification
	Products	IT Software	Virtualisation/DCIM	Cost for vendor assistence	EUR [Free field: per time unit/user/other]	
	Products	IT Software	Virtualisation/DCIM	License cost per user	EUR [Free field: per time unit/user/other]	
	Products	IT Software	Virtualisation/DCIM	Licence model	per named user/concurrent user/other	
	Products	IT Software	Virtualisation/DCIM	Closed or open SW architecture	open/closed	
	Products	IT Software	Virtualisation/DCIM	Training costs per user (recommended by vendor)	EUR	
Virtualisation/Storage	Products	IT Software	Virtualisation/Storage	Utilization percentage for physical storage unit	percentage	
	Products	IT Software	Virtualisation/Storage	Costs for installation	EUR [Free field: per time unit/user/other]	
	Products	IT Software	Virtualisation/Storage	Cost for vendor assistence	EUR [Free field: per time unit/user/other]	
	Products	IT Software	Virtualisation/Storage	License cost per user	EUR	

Data model	Main category	Category	Product or service questionnaire / form	Characteristic	Element type and unit	Definition of element / clarification
	Products	IT Software	Virtualisation/Storage	Licence model	GB/per named user/concurrent user/other	
	Products	IT Software	Virtualisation/Storage	Closed or open SW architecture	open/closed	
	Products	IT Software	Virtualisation/Storage	Training costs per user (recommended by vendor)	EUR	
Cooling	Products	M&E capital goods	Cooling	Brand	Dropdown - Directory internal hyperlink (prerequisite to Other Hardware selected)	
	Products	M&E capital goods	Cooling	Type/Model	Free field	
	Products	M&E capital goods	Cooling	Cooling capacity	kW	
	Products	M&E capital goods	Cooling	COD	number	
	Products	M&E capital goods	Cooling	Direct cooling	Dropdown: Water, Air, Other	

Data model	Main category	Category	Product or service questionnaire / form	Characteristic	Element type and unit	Definition of element / clarification
	Products	M&E capital goods	Cooling	Other fluid for direct cooling (which)	free text	
	Products	M&E capital goods	Cooling	Cooling heat transfer fluid	Dropdown: Butane, NH3, PAG, oils, R134a, R22, Air, water, none (free cooling), Other (which?)	
	Products	M&E capital goods	Cooling	Other cooling heat transfer fluid (which?)	free text	
	Products	M&E capital goods	Cooling	Cooling agent loss per year	kg/year	Leakage and through seals etc. i.e. Exclusing chillers
	Products	M&E capital goods	Cooling	Water evaporation	m3/year	For chillers and similar; only evaporative losses.
	Products	M&E capital goods	Cooling	Technology	Dropdown: CRAC, CRAH, IRC's, HVAC, Rear doors, Adiabatic, Immersion, On chip, Direct air, Chillers, Other	
	Products	M&E capital goods	Cooling	VSF (variable speed fans)/EC fans?	Y/N	

Data model	Main category	Category	Product or service questionnaire / form	Characteristic	Element type and unit	Definition of element / clarification
	Products	M&E capital goods	Cooling	Specific location	Dropdown: In row, In rack, MER, Roof, Other	
	Products	M&E capital goods	Cooling	Built year	YYYY	
	Products	M&E capital goods	Cooling	Max energy consumption	W	
	Products	M&E capital goods	Cooling	Energy saving / Eco mode	Y/N	
	Products	M&E capital goods	Cooling	Certifications product	Dropdown (multi-select): EU Flower, EU National Type I ecolabel, EnergyStar, Others (which?)	
	Products	M&E capital goods	Cooling	Other certifications product (which?)	free text	These are not considered for the award criteria
	Products	M&E capital goods	Cooling	Idle Energy consumption	W	
	Products	M&E capital	Cooling	Purchase price	EUR	

Data model	Main category	Category	Product or service questionnaire / form	Characteristic	Element type and unit	Definition of element / clarification
		goods				
	Products	M&E capital goods	Cooling	Installation cost	EUR	
	Products	M&E capital goods	Cooling	Maintenance costs/year	EUR	
	Products	M&E capital goods	Cooling	Maintenance freq./year	number	
	Products	M&E capital goods	Cooling	End-of-life cost	EUR	Dissassembly, waste treatment
	Products	M&E capital goods	Cooling	LCA/EPD for this model available?	Y/N	LCA or EPDs that are conform with ISO 14040/44, the ILCD handbook and/or the PEF are eligible.
	Products	M&E capital goods	Cooling	Carbon footprint, water footprint for this model available?	Y/N	CFs or WFs in line with ISO 14067 or 14069 are eligible.
	Products	M&E capital goods	Cooling	Link to LCA, EPD, CF, or WF study	link(s) to pdf, if any (otherwise empty)	

Data model	Main category	Category	Product or service questionnaire / form	Characteristic	Element type and unit	Definition of element / clarification
DC Monitoring	Products	Other Hardware	DC Monitoring		Dropdown (prerequisite to Other Hardware selected)	
Humidifiers	Products	M&E capital goods	Humidifiers		Dropdown (prerequisite to Other Hardware selected)	
Power distribution	Products	M&E capital goods	Power distribution	Brand	Dropdown - Directory internal hyperlink (prerequisite to Other Hardware selected)	
	Products	M&E capital goods	Power distribution	Type/Model	Free field	
Power distribution /DC level	Products	M&E capital goods	Power distribution/DC level	Specific	Transformator/UPS/PDU/Rack PDU/Other	
	Products	M&E capital goods	Power distribution/DC level	Capacity	kW	
	Products	M&E capital goods	Power distribution/DC level	IP connectivity/Network manageable	Y/N	
	Products	M&E capital goods	Power distribution/DC level	Measured for remote monitoring	Y/N	

Data model	Main category	Category	Product or service questionnaire / form	Characteristic	Element type and unit	Definition of element / clarification
	Products	M&E capital goods	Power distribution/DC level	Remote access	Y/N	
	Products	M&E capital goods	Power distribution/DC level	Design date	YYYY	
	Products	M&E capital goods	Power distribution/DC level	Max energy consumption	kW	
	Products	M&E capital goods	Power distribution/DC level	Idle Energy consumption	kW	
	Products	M&E capital goods	Power distribution/DC level	Energy/Eco mode	Y/N	
	Products	M&E capital goods	Power distribution/DC level	Certifications	Free field	
	Products	M&E capital goods	Power distribution/DC level	Price	EUR	
	Products	M&E capital goods	Power distribution/DC level	Maintenance costs/year	EUR	
	Products	M&E capital goods	Power distribution/DC level	Maintenance freq./year	number	

Data model	Main category	Category	Product or service questionnaire / form	Characteristic	Element type and unit	Definition of element / clarification
Power distribution /Batteries	Products	M&E capital goods	Power distribution/Batteries	Room requirements (RH%/temp range)	Free text	
	Products	M&E capital goods	Power distribution/Batteries	Capacity	VA	
	Products	M&E capital goods	Power distribution/Batteries	Type	Dropdown: valve-regulated lead-acid (VRLA), simple lead-acid, Other (which)	
		M&E capital goods	Power distribution/Batteries	Other (type)	free text	
	Products	M&E capital goods	Power distribution/Batteries	Space requirements	Free text	
	Products	M&E capital goods	Power distribution/Batteries	Certifications company or product	Dropdown: EMAS, EU Flower, EU National Type I ecolabel, EnergyStar, Other (which?)	
	Products	M&E capital goods	Power distribution/Batteries	Other certifications (which?)	free text	These are not considered for the award criteria

Data model	Main category	Category	Product or service questionnaire / form	Characteristic	Element type and unit	Definition of element / clarification
	Products	M&E capital goods	Power distribution/Batteries	Replacement costs	EUR	
	Products	M&E capital goods	Power distribution/Batteries	Hot swappable	Y/N	
	Products	M&E capital goods	Power distribution/Batteries	Replacement after (months, recommended)	months	
	Products	M&E capital goods	Power distribution/Batteries	PEF LCIA results for this model	link to pdf	i.e. the production, use, end-of-life results values for the 15 PEF impact categories.
	Products	M&E capital goods	Power distribution/Batteries	LCA/EPD for this model available?	Y/N	LCA or EPDs that are conform with ISO 14040/44, the ILCD handbook and/or the PEF are eligible.
	Products	M&E capital goods	Power distribution/Batteries	Carbon footprint, water footprint for this model available?	Y/N	CFs or WFs in line with ISO 14067 or 14069 are eligible.
	Products	M&E capital	Power	Link to LCA, EPD, CF, or WF	link(s) to pdf, if any (otherwise	

Data model	Main category	Category	Product or service questionnaire / form	Characteristic	Element type and unit	Definition of element / clarification
		goods	distribution/Batteries	study	empty)	
Power distribution /Transformator	Products	M&E capital goods	Power distribution/Transformator	Type	free text	
	Products	M&E capital goods	Power distribution/Transformator	Capacity	VA	
	Products	M&E capital goods	Power distribution/Transformator	Room requirements (RH%/temp range)	Free field	
	Products	M&E capital goods	Power distribution/Transformator	Space requirements	Free field	
	Products	M&E capital goods	Power distribution/Transformator	Certifications company or product	Dropdown: EMAS, EU Flower, EU National Type I ecolabel, EnergyStar, Other (which?)	
	Products	M&E capital goods	Power distribution/Transform	Other certifications (which?)	free text	These are not considered for the

Data model	Main category	Category	Product or service questionnaire / form	Characteristic	Element type and unit	Definition of element / clarification
			ator			award criteria
	Products	M&E capital goods	Power distribution/Transformator	Voltage (from ...)	V	
	Products	M&E capital goods	Power distribution/Transformator	Voltage (... to)	V	
	Products	M&E capital goods	Power distribution/Transformator	Transformation efficiency	%	
	Products	M&E capital goods	Power distribution/Transformator	LCA/EPD for this model available?	Y/N	LCA or EPDs that are conform with ISO 14040/44, the ILCD handbook and/or the PEF are eligible.
	Products	M&E capital goods	Power distribution/Transformator	Carbon footprint, water footprint for this model available?	Y/N	CFs or WFs in line with ISO 14067 or 14069 are eligible.

Data model	Main category	Category	Product or service questionnaire / form	Characteristic	Element type and unit	Definition of element / clarification
	Products	M&E capital goods	Power distribution/Transformator	Link to LCA, EPD, CF, or WF study	link(s) to pdf, if any (otherwise empty)	
Power distribution /UPS	Products	M&E capital goods	Power distribution/UPS	Integration BMS	Y/N	
	Products	M&E capital goods	Power distribution/UPS	Bypass for maintenance	Y/N	
	Products	M&E capital goods	Power distribution/UPS	Capacity	VA	
	Products	M&E capital goods	Power distribution/UPS	Cos.phi factor	[0...1]	
	Products	M&E capital goods	Power distribution/UPS	Efficiency under 90% load	percentage	
	Products	M&E capital goods	Power distribution/UPS	Idle energy consumption	W	
	Products	M&E capital goods	Power distribution/UPS	Resilience architecture	1/N+1	

Data model	Main category	Category	Product or service questionnaire / form	Characteristic	Element type and unit	Definition of element / clarification
	Products	M&E capital goods	Power distribution/UPS	Method	Dropdown: Online, Other	
	Products	M&E capital goods	Power distribution/UPS	Type	Dropdown: Flywheel, Batteries	
	Products	M&E capital goods	Power distribution/UPS	Certifications company or product	Dropdown: EMAS, EU Flower, EU National Type I ecolabel, EnergyStar, Other (which?)	
	Products	M&E capital goods	Power distribution/UPS	Other certifications (which?)	free text	These are not considered for the award criteria
	Products	M&E capital goods	Power distribution/UPS	Controlled output groups	Y/N	
	Products	M&E capital goods	Power distribution/UPS	Space requirements	m2	
	Products	M&E capital goods	Power distribution/UPS	Room requirements (RH%/temp range)	Free field	
	Products	M&E capital goods	Power distribution/UPS	Emergency Power Off (EPO)	Y/N	

Data model	Main category	Category	Product or service questionnaire / form	Characteristic	Element type and unit	Definition of element / clarification
	Products	M&E capital goods	Power distribution/UPS	Management software	Y/N	
	Products	M&E capital goods	Power distribution/UPS	PEF LCIA results for this model	link to pdf	i.e. the production, use, end-of-life results values for the 15 PEF impact categories.
	Products	M&E capital goods	Power distribution/UPS	LCA/EPD for this model available?	Y/N	LCA or EPDs that are conform with ISO 14040/44, the ILCD handbook and/or the PEF are eligible.
	Products	M&E capital goods	Power distribution/UPS	Carbon footprint, water footprint for this model available?	Y/N	CFs or WFs in line with ISO 14067 or 14069 are eligible.
	Products	M&E capital goods	Power distribution/UPS	Link to LCA, EPD, CF, or WF study	link(s) to pdf, if any (otherwise empty)	
Racking & Enclosures	Products	Other Hardware	Racking & Enclosures	Brand	Dropdown - Directory internal hyperlink (prerequisite to Other Hardware selected)	

Data model	Main category	Category	Product or service questionnaire / form	Characteristic	Element type and unit	Definition of element / clarification
	Products	Other Hardware	Racking & Enclosures	Type/Model	free text	
	Products	Other Hardware	Racking & Enclosures	Type of racks/cabinets	Dropdown (multi-choice): Floor mount, Wall mount, Open, Accoustic, Climate controlled, Other	
	Products	Other Hardware	Racking & Enclosures	Front door	Dropdown: Solid, Mesh, split mesh, tempered glass, Plexi, Fan door	
	Products	Other Hardware	Racking & Enclosures	Back door	Dropdown: Solid, Mesh, split mesh, Plexi, Fan door	
	Products	Other Hardware	Racking & Enclosures	Top panel options	Dropdown: Solid, mesh, none, with fan(s)	
	Products	Other Hardware	Racking & Enclosures	Fans (number in top panel/door)	number	
	Products	Other Hardware	Racking & Enclosures	Anti-tip option?	Y/N	
	Products	Other Hardware	Racking & Enclosures	Mounting rail option	Dropdown: 10-32 threaded holes, M6 square holes	

Data model	Main category	Category	Product or service questionnaire / form	Characteristic	Element type and unit	Definition of element / clarification
	Products	Other Hardware	Racking & Enclosures	Slide panel option	Dropdown: Solid, mesh, none	
	Products	Other Hardware	Racking & Enclosures	Height (U)	number	
	Products	Other Hardware	Racking & Enclosures	Size (mm)	L * W * H [mm]	
	Products	Other Hardware	Racking & Enclosures	Material	Free field or link to BOM	
	Products	Other Hardware	Racking & Enclosures	Locks (standard)	Dropdown: Biometric, Fingerprints, Code, Key, Card, Token, None, Other	
	Products	Other Hardware	Racking & Enclosures	IP connectivity?	Y/N	
	Products	Other Hardware	Racking & Enclosures	Measured for remote monitoring?	Y/N	
	Products	Other Hardware	Racking & Enclosures	Color	Free field	
	Products	Other	Racking & Enclosures	Design year	YYYY	

Data model	Main category	Category	Product or service questionnaire / form	Characteristic	Element type and unit	Definition of element / clarification
		Hardware				
	Products	Other Hardware	Racking & Enclosures	Certifications company or product	Dropdown: EMAS, EU Flower, EU National Type I ecolabel, EnergyStar, Other (which?)	
	Products	Other Hardware	Racking & Enclosures	Other certifications (which?)	free text	These are not considered for the award criteria
	Products	Other Hardware	Racking & Enclosures	Price	EUR	
	Products	Other Hardware	Racking & Enclosures	Maintenance costs/year	EUR	
	Products	Other Hardware	Racking & Enclosures	Maintenance freq./year	number	
	Products	Other Hardware	Racking & Enclosures	LCA/EPD for this model available?	Y/N	LCA or EPDs that are conform with ISO 14040/44, the ILCD handbook and/or the PEF are eligible.

Data model	Main category	Category	Product or service questionnaire / form	Characteristic	Element type and unit	Definition of element / clarification
	Products	Other Hardware	Racking & Enclosures	Carbon footprint, water footprint for this model available?	Y/N	CFs or WFs in line with ISO 14067 or 14069 are eligible.
	Products	Other Hardware	Racking & Enclosures	Link to LCA, EPD, CF, or WF study	link(s) to pdf, if any (otherwise empty)	
Audit	Services	Support and consulting	Audit		Dropdown (prerequisite to Other Hardware selected)	
Certification	Services	Support and consulting	Certification		Dropdown (prerequisite to Consulting selected)	
Consultancy services	Services	Support and consulting	Consultancy services		Dropdown (prerequisite to Consulting selected)	***To be further differentiated***
Contamination control	Services	Support and consulting	Contamination control		Dropdown (prerequisite to Consulting selected)	
Legal advice	Services	Support and consulting	Legal advice		Dropdown (prerequisite to Consulting selected)	
Making business case	Services	Support and consulting	Making business case		Dropdown (prerequisite to Consulting selected)	

Data model	Main category	Category	Product or service questionnaire / form	Characteristic	Element type and unit	Definition of element / clarification
Project management	Services	Support and consulting	Project management		Dropdown (prerequisite to Consulting selected)	
Security	Services	Support and consulting	Security		Dropdown (prerequisite to Consulting selected)	
Cloud services	Services	Data centre	Cloud services	Provider	Dropdown - Directory internal hyperlink (prerequisite to Data centre selected)	
	Services	Data centre	Cloud services	Specific service name	free text	
	Services	Data centre	Cloud services	Type of Cloud	Dropdown: Private, Public, Government	Private cloud includes "Hosting"
	Services	Data centre	Cloud services	If private or gov cloud: annual electricity consumption across all DCs of the cloud	kWh	
	Services	Data centre	Cloud services	If private or gov cloud: Percentage Renewable Energy Directive compliant renewable energy used	Percentage	Meeting requirements of the Renewable Energy Directive 2009/28/EC

Data model	Main category	Category	Product or service questionnaire / form	Characteristic	Element type and unit	Definition of element / clarification
	Services	Data centre	Cloud services	If private or gov cloud: Share windpower (of: total EU-certified renewable)	Percentage	
	Services	Data centre	Cloud services	If private or gov cloud: Share hydropower (of: total EU-certified renewable)	Percentage	
	Services	Data centre	Cloud services	If private or gov cloud: Share biomass (of: total EU-certified renewable)	Percentage	
	Services	Data centre	Cloud services	If private or gov cloud: Share biofuels (of: total EU-certified renewable)	Percentage	
	Services	Data centre	Cloud services	If private or gov cloud: Share PV (of: total EU-certified renewable)	Percentage	
	Services	Data centre	Cloud services	If private or gov cloud: Share biogas (of: total EU-certified renewable)	Percentage	

Data model	Main category	Category	Product or service questionnaire / form	Characteristic	Element type and unit	Definition of element / clarification
	Services	Data centre	Cloud services	If private or gov cloud: Share other (of: total EU-certified renewable)	Percentage	
	Services	Data centre	Cloud services	If private or gov cloud: Certification/signatory DC or site	Dropdown (multi-select): DCA, CEEDA, EUCoC, EU Flower, EU national Type I label, EMAS, Other (which?)	
	Services	Data centre	Cloud services	If private or gov cloud: Other certification DC (which?)	free text	These are not considered for the award criteria
	Services	Data centre	Cloud services	If private or gov cloud: Building classification	Dropdown: LEED, BREEAM, DGNB	
	Services	Data centre	Cloud services	If private or gov cloud: Other building classification (which?)	free text	These are not considered for the award criteria
	Services	Data centre	Cloud services	If private or gov cloud: Design PUE, annual average	real, positive	

Data model	Main category	Category	Product or service questionnaire / form	Characteristic	Element type and unit	Definition of element / clarification
	Services	Data centre	Cloud services	If private or gov cloud: Actual EUE (annual average PUE)	real, positive	
	Services	Data centre	Cloud services	If private or gov cloud: Signatory to EUCoC	Y/N	
	Services	Data centre	Cloud services	If private or gov cloud: LCA/EPD for these sites/service available?	Y/N	LCA or EPDs that are conform with ISO 14040/44, the ILCD handbook and/or the PEF are eligible.
	Services	Data centre	Cloud services	If private or gov cloud: Carbon footprint, water footprint for these sites/service available?	Y/N	CFs or WFs in line with ISO 14067 or 14069 are eligible.
	Services	Data centre	Cloud services	If private or gov cloud: Link to LCA, EPD, CF, or WF study	link(s) to pdf, if any (otherwise empty)	
	Services	Data centre	Cloud services	If private or gov cloud: Conform to standards	Dropdown (multi-select): ISO 9001, 14001, 27001, 50001	

Data model	Main category	Category	Product or service questionnaire / form	Characteristic	Element type and unit	Definition of element / clarification
	Services	Data centre	Cloud services	Type of Vserver	Free text	
	Services	Data centre	Cloud services	Number of Vservers	number	
	Services	Data centre	Cloud services	Configurable Vdrives?	Y/N	
	Services	Data centre	Cloud services	Number of Vstorage per user	GB	
	Services	Data centre	Cloud services	SDDC?	Y/N	
	Services	Data centre	Cloud services	IAAS?	Y/N	
	Services	Data centre	Cloud services	PAAS?	Y/N	
	Services	Data centre	Cloud services	SAAS?	Y/N	
	Services	Data centre	Cloud services	SAAS software available	Free text	
	Services	Data centre	Cloud services	Disaster recovery available?	Y/N	
	Services	Data centre	Cloud services	Backup facilities?	Y/N	
	Services	Data centre	Cloud services	Tools available	Free text	

Data model	Main category	Category	Product or service questionnaire / form	Characteristic	Element type and unit	Definition of element / clarification
	Services	Data centre	Cloud services	Web site services?	Y/N	
	Services	Data centre	Cloud services	Storage per user or contract	Dropdown: contract, user	
	Services	Data centre	Cloud services	Price per user or contract and year	EUR	
	Services	Data centre	Cloud services	Free storage	GB	
	Services	Data centre	Cloud services	Price per GB of extra storage / year	EUR	
	Services	Data centre	Cloud services	Platform (OS)	Dropdown: Linux, Windows, Other	
	Services	Data centre	Cloud services	Type of database	Dropdown: SQL, Oracle, Other	
	Services	Data centre	Cloud services	Location of data, country	Dropdown: ISO Country-codes	
				Location of data, address	free text	
	Services	Data centre	Cloud services	How many hours of usage per month	number	
	Services	Data centre	Cloud services	Alarms signaling?	Y/N	

Data model	Main category	Category	Product or service questionnaire / form	Characteristic	Element type and unit	Definition of element / clarification
	Services	Data centre	Cloud services	Connectivity speed (guaranteed minimum)	GB/s	
	Services	Data centre	Cloud services	Pricing policy	Fixed	
	Services	Data centre	Cloud services	Pricing policy	Variable	
	Services	Data centre	Cloud services	Pricing policy	Dropdown: Hour, GB, Time	
Colocation	Services	Data centre	Colocation	Provider	Dropdown - Directory internal hyperlink (prerequisite to Data centre selected)	
	Services	Data centre	Colocation	Specific service name	free text	
	Services	Data centre	Colocation	Location, country	Dropdown: ISO country list	
	Services	Data centre	Colocation	Location, specific	Free text	
	Services	Data centre	Colocation	Percentage Renewable Energy Directive compliant renewable energy used	Percentage	Meeting requirements of the Renewable Energy Directive 2009/28/EC

Data model	Main category	Category	Product or service questionnaire / form	Characteristic	Element type and unit	Definition of element / clarification
	Services	Data centre	Colocation	Share windpower (of: total EU-certified renewable)	Percentage	
	Services	Data centre	Colocation	Share hydropower (of: total EU-certified renewable)	Percentage	
	Services	Data centre	Colocation	Share biomass (of: total EU-certified renewable)	Percentage	
	Services	Data centre	Colocation	Share biofuels (of: total EU-certified renewable)	Percentage	
	Services	Data centre	Colocation	Share PV (of: total EU-certified renewable)	Percentage	
	Services	Data centre	Colocation	Share biogas (of: total EU-certified renewable)	Percentage	
	Services	Data centre	Colocation	Share other (of: total EU-certified renewable)	Percentage	
	Services	Data centre	Colocation	LCA/EPD for this site/service available?	Y/N	LCA or EPDs that are conform with ISO 14040/44, the ILCD

Data model	Main category	Category	Product or service questionnaire / form	Characteristic	Element type and unit	Definition of element / clarification
						handbook and/or the PEF are eligible.
	Services	Data centre	Colocation	Carbon footprint, water footprint for this site/service available?	Y/N	CFs or WFs in line with ISO 14067 or 14069 are eligible.
	Services	Data centre	Colocation	Link to LCA, EPD, CF, or WF study	link(s) to pdf, if any (otherwise empty)	
	Services	Data centre	Colocation	Square meters	m2	
	Services	Data centre	Colocation	Total power requirements	kW	
	Services	Data centre	Colocation	Amps per PDU in rack	16/32/64	
	Services	Data centre	Colocation	Number of PDU's in rack	number	
	Services	Data centre	Colocation	Number of 1/4 racks	number	
	Services	Data centre	Colocation	Number of 1/2 racks	number	
	Services	Data centre	Colocation	Number of racks	number	
	Services	Data centre	Colocation	Total rack requirements	kW	

Data model	Main category	Category	Product or service questionnaire / form	Characteristic	Element type and unit	Definition of element / clarification
	Services	Data centre	Colocation	Resilience architecture	N/N+1/N+2	
	Services	Data centre	Colocation	Need for ATS?	Y/N	
	Services	Data centre	Colocation	Height (U)	number	
	Services	Data centre	Colocation	Minimum number of U's	number	
	Services	Data centre	Colocation	Minimum number of racks	number	
	Services	Data centre	Colocation	Price per rack	EUR	
	Services	Data centre	Colocation	Price per kWh	EUR	
	Services	Data centre	Colocation	Invoice on actual usage kWh/period?	Y/N	
	Services	Data centre	Colocation	Invoice on max usage kWh/period?	Y/N	
	Services	Data centre	Colocation	Installation Fixed Price per rack	EUR	
	Services	Data centre	Colocation	Installation Fixed Price general	EUR	

Data model	Main category	Category	Product or service questionnaire / form	Characteristic	Element type and unit	Definition of element / clarification
	Services	Data centre	Colocation	Handson available?	Y/N	
	Services	Data centre	Colocation	Price handson per hour	EUR	
	Services	Data centre	Colocation	Remote access available	Y/N	
	Services	Data centre	Colocation	Realtime energy use reporting	Y/N	
	Services	Data centre	Colocation	Portal available	Y/N	
	Services	Data centre	Colocation	Certification/signatory DC or site	Dropdown (multi-select): DCA, CEEDA, EUCoC, EU Flower, EU national Type I label, EMAS, Other (which?)	
	Services	Data centre	Colocation	Other certification DC (which?)	free text	These are not considered for the award criteria
	Services	Data centre	Colocation	Class (Tier)	Dropdown: 1, 2, 3, 4	
	Services	Data centre	Colocation	Building classification	Dropdown: LEED, BREEAM, DGNB	

Data model	Main category	Category	Product or service questionnaire / form	Characteristic	Element type and unit	Definition of element / clarification
	Services	Data centre	Colocation	Other building classification (which?)	free text	These are not considered for the award criteria
	Services	Data centre	Colocation	Design PUE, annual average	real, positive	
	Services	Data centre	Colocation	Actual EUE (annual average PUE)	real, positive	
	Services	Data centre	Colocation	Cages option	Y/N	
	Services	Data centre	Colocation	Conform to standards	Dropdown (multi-select): ISO 9001, 14001, 27001, 50001	
	Services	Data centre	Colocation	Locks racking and enclosures (standard)	Dropdown: Biometric, Fingerprints, Code, Key, Card, Token, None, Other	
	Services	Data centre	Colocation	Physical security	Free field	
	Services	Data centre	Colocation	Power Source	Dropdown: single phase, three phased	
Remote hands	Services	Support and consulting	Remote hands		Dropdown (prerequisite to Data centre selected)	

Data model	Main category	Category	Product or service questionnaire / form	Characteristic	Element type and unit	Definition of element / clarification
Training and recruitment	Services	Support and consulting	Training and recruitment		Dropdown (prerequisite to Data centre selected)	
Transportation services	Services	Support and consulting	Transportation services		Dropdown (prerequisite to Data centre selected)	

11.9 Example life cycle data as to be used in EURECA framework

A full set of all required life cycle data sets will be provided and later be shipped with the EURECA tool. To simplify the handling of the data and the later tool implementation, so-called LCIA results data sets will be used. These include data on the level of e.g. a Carbon footprint, Water footprint and so on, for a whole set of 14 impact categories, as well as separately for Primary energy.

These LCIA results data sets will be developed for all main Procurement scenarios of hardware (e.g. servers, cooling systems, UPS, … - see list in chapter 8.2.2), in some cases for sub-types and size classes (e.g. for UPS). These data sets cover production and end-of-life treatment of the product. The same kind of data sets will equally be provided for the electricity provision as consumed during the use stage, for each EU Member State (as available – currently for all EU 27) and separately for the main energy carriers incl. renewables (as available). An example data set looks like this one in Table 39:

Table 39 Illustrative LCIA results data set (draft) for 1 kWh electricity (<1 kV) for Germany:

Impact category	TOTAL
Acidification, accumulated exceedance [Mol of H+ eq.]	1,20E-03
Ecotoxicity for aquatic fresh water, USEtox (recommended) [CTUe]	1,91E-02
Freshwater eutrophication, EUTREND model, ReCiPe [kg P eq]	1,17E-06
Human toxicity cancer effects, USEtox (recommended) [CTUh]	4,33E-10
Human toxicity non-canc. effects, USEtox (recommended) [CTUh]	1,63E-08
Ionising radiation, human health effect model, ReCiPe [kg U235 eq]	6,88E-02
IPCC global warming, incl biogenic carbon [kg CO2-Equiv.]	6,10E-01
Marine eutrophication, EUTREND model, ReCiPe [kg N-Equiv.]	3,67E-05
Ozone depletion, WMO model, ReCiPe [kg CFC-11 eq]	6,10E-11
Particulate matter/Respiratory inorganics, RiskPoll [kg PM2.5-Equiv.]	5,74E-05
Photochemical ozone formation, LOTOS-EUROS model, ReCiPe [kg NMVOC]	7,41E-04
Resource Depletion, fossil and mineral, reserve Based, CML2002 [kg Sb-Equiv.]	5,63E-07

Impact category	TOTAL
Terrestrial eutrophication, accumulated exceedance [Mol of N eq.]	2,91E-03
Total freshwater consumption, including rainwater, Swiss Ecoscarcity [UBP]	4,56E-01
Primary energy demand from ren. and non ren. resources (net cal. value) [MJ]	1,06E+01

These data sets will be modelled in the course of the project and be available in due time for integration into the EURECA tool.

The “Normalisation” and “Weighting” data sets (each one for all cases) have the same structure; they are in fact displayed in Table 8.

11.10 Annex Life Cycle Assessment (LCA) - how does it work

According to the ILCD Handbook (European Commission 2010), a Life Cycle Assessment is carried out in five phases as illustrated in the figure Figure 15 shown below. The phases are often interdependent in that the results of one phase will inform how other phases are completed.

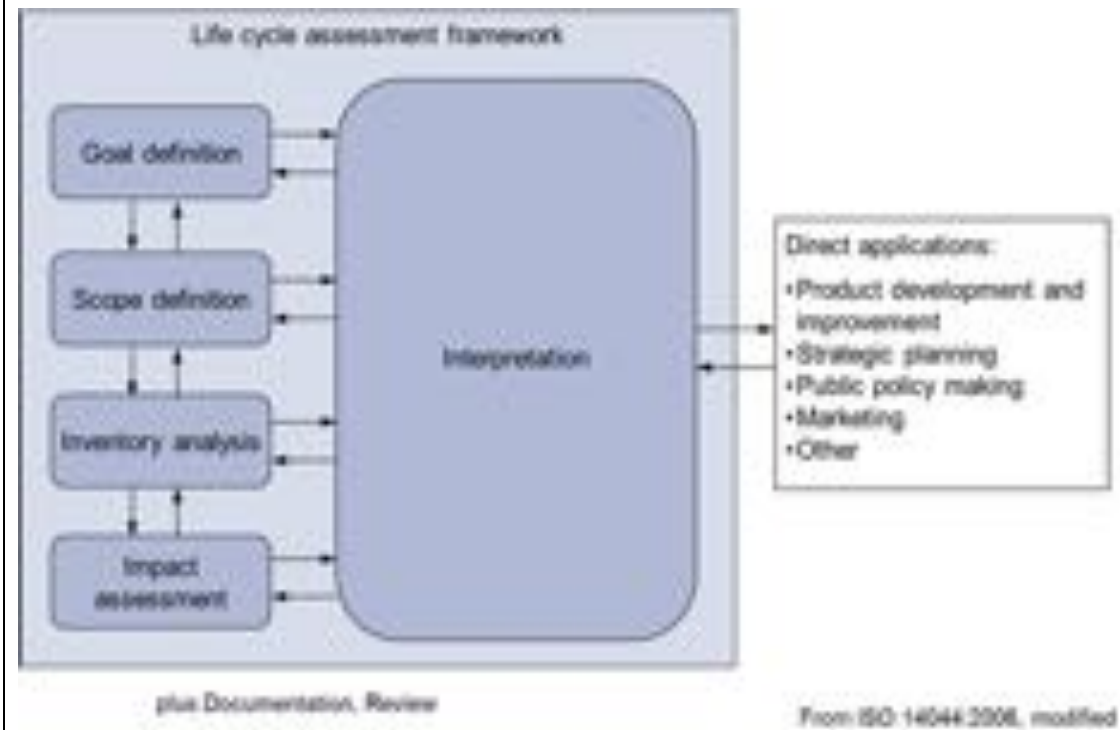


Figure 15 Five phases of LCA

11.10.1 Goal

A LCA starts with an explicit statement of the goal of the study, which sets out the context of the study and explains how and to whom the results are to be communicated. This is a key step and the goal of an LCA is to be clearly defined and consistent with the intended application.

11.10.2 Scope

The next phase is the scoping. It consists of defining among others:

- the functional unit, which defines what precisely is being studied and quantifies the service delivered by the product system, providing a reference to which the resources and emissions and other inputs and outputs can be related. Further, the functional unit is an important basis that enables alternative goods, or services, to be compared and analysed. The actually studied product is then the reference flow for the study.
- the system boundaries;
- any assumptions and limitations;
- the allocation methods used to partition the environmental load of a process when several products or functions share the same process; and
- the impact categories chosen.

11.10.3 Life cycle inventory

Life Cycle Inventory (LCI) analysis involves creating ultimately an inventory of flows from and to nature for the product system, quantified in relation to the functional unit and reference flow. These final inventory flows include inputs of water, energy, and raw materials, and releases to air, land, and water.

To develop the final inventory, a flow model of the technical system is constructed using data on inputs and outputs of product and waste flows, plus resources and emissions, for each process step or plant. The flow model parts of the life cycle are typically illustrated with a technical flow chart that includes the activities that are going to be assessed in the relevant supply chain and gives a clear picture of the technical system boundaries. The input and output data needed for the construction of the model are collected for all activities within the system boundary, including from the supply chain (referred to as inputs from the techno-sphere).

This is a schematic and simplified representation of a life cycle model (Figure 16):

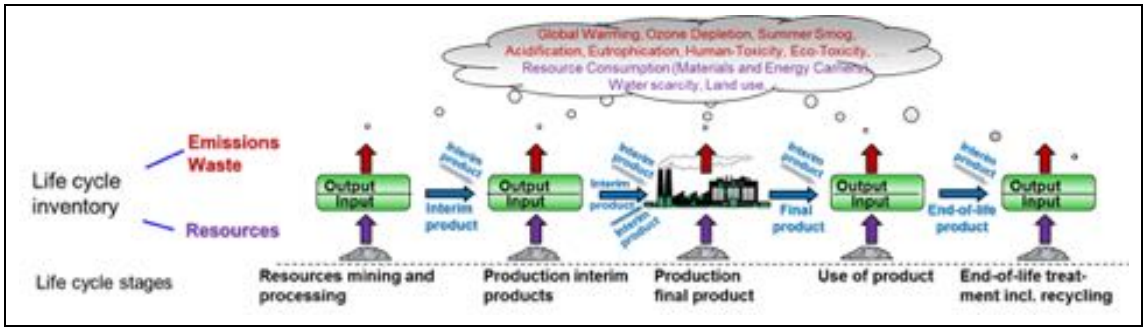


Figure 16 Schematic representation of the life cycle of a product (good or service), with the central process representing the manufacturingof the final good (or the delivery of the final serice). Note that the system is tyoically in form of a supply net, rather than a supply chain as in this simplified graphic and that at each life cycle stage typivally several process steps are to be differentiated. Transport and storage (not shown) are between many transforming processes and also fully considered.

Looking a the production of the final product in the sbove graphic, the following graphic shows the detailed view of that step. Depending on the products' profile, the data can be collected for the entire plant, or for the relavnt process steps that relate to the required, specific product; Figure 17:

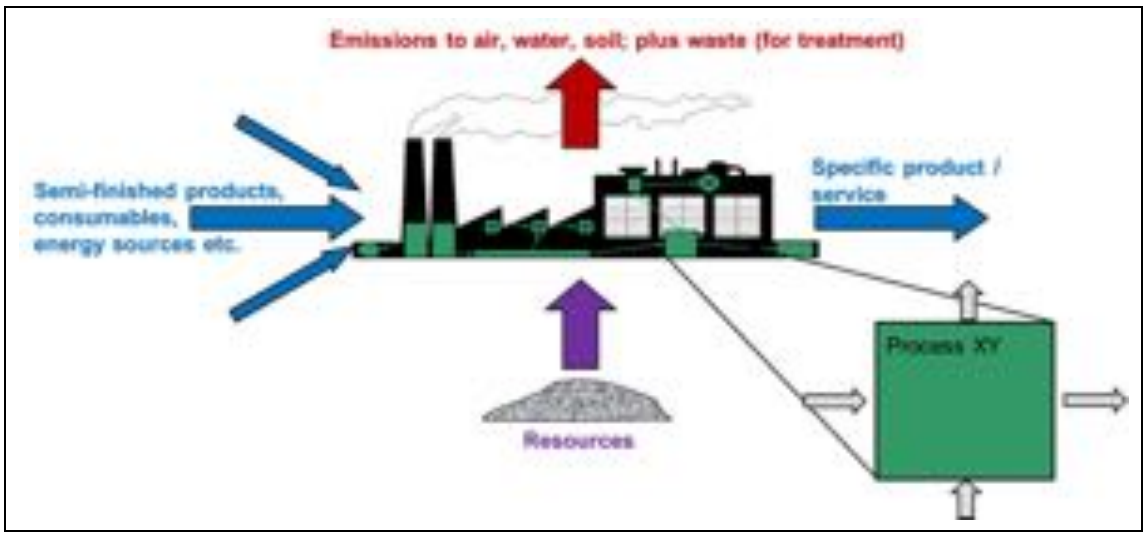


Figure 17 Look into the central process of Figure 16, showing the plant-internal processing steps that relate to the product in question. Data are collected for each relevant process (or for the site as a whole if only one or several similar products are produced).

At each process step, the data is related to the amount of product produced, via the reference flows. If all process steps of this life cycle chain are connected, all interim product and waste flows vanish and only the flows that go from the technosphere to the environment (i.e. emissions) and that come from the environment (i.e. resources) remain in the inventory. The results is hence an LCI which provides information about all inputs and outputs in the form of elementary flows to and from the environment from all the processes involved in the life cycle. Such data sets have been collected and regularly systematically since about 25 years and many industry associations and companies publish such data sets for their products.

11.10.4 Life cycle impact assessment

Inventory analysis is followed by impact assessment. This phase of LCA is aimed at evaluating the significance of potential environmental impacts based on the final LCI flow results. Classical life cycle impact assessment (LCIA) consists of classification, characterisation, normalization and weighting.

Figure 18 shows procedure how to calculate life cycle impact assessment, towards the overall environmental footprint of the analysed system. In EURECA, we will use as input data LCIA results, what renders the handling of the data and calculations in the tool much easier and more performant: there are only 15 data values – each one per impact category - to be handled, opposed to thousands of inventory items that each moreover contribute often to several impact categories.

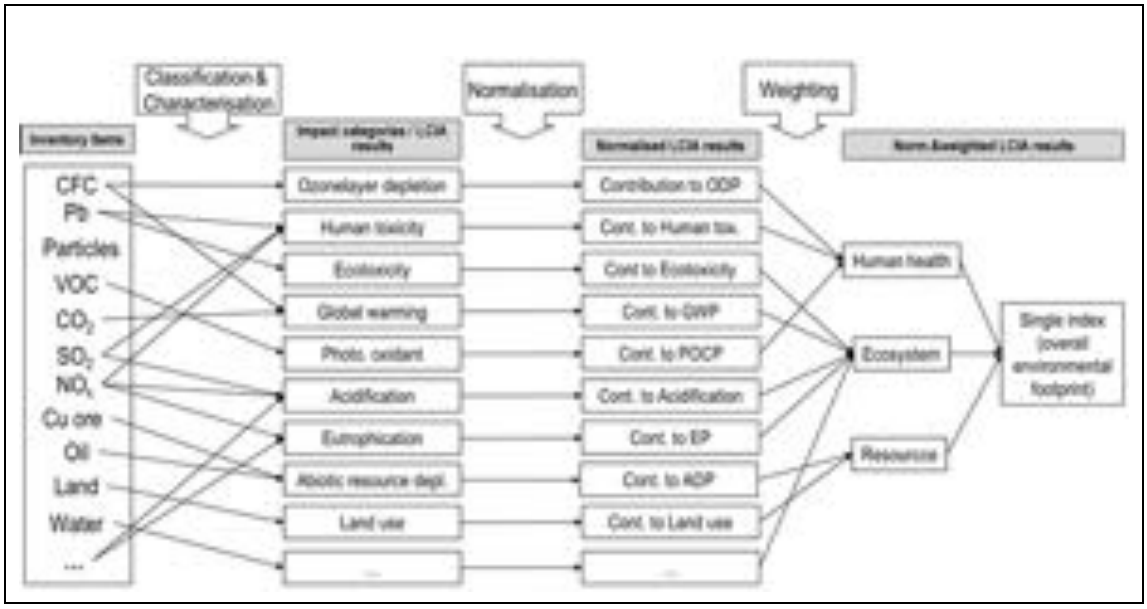


Figure 18 Life cycle impact assessment – overview from inventory, through classification and characterisation, normalisation and weighting to the overall environmental impact.

The classification stage is where the inventory parameters are sorted and assigned to specific impact categories; see Figure 19.

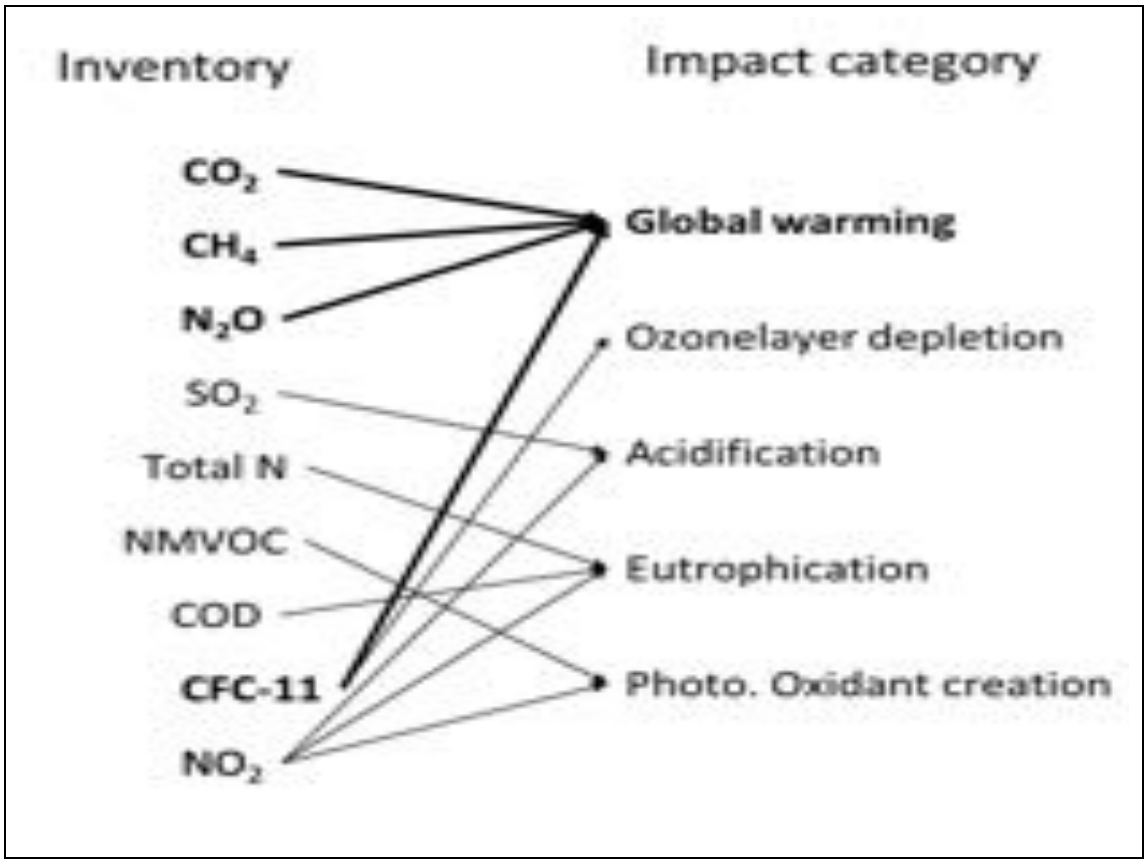


Figure 19 Extract of classification (i.e. assignment) of emissions to Climate change / Global warming, and some other impact categories

The characterization is, where the categorized LCI flows are characterized, using one of many possible LCIA methodologies, into common equivalence units that are then summed to provide an overall impact category total.

$$\text{Environmental Impact} = \sum_{s} (\text{Inv.}_s \times \text{IF}_s)$$

Generally, characterization factors are derived from scientific model, for example "climate change", radiative forcing as the global warming potential with baseline 100 year as IPCC is used. Figure 20 below shows characterization factor of global warming potential:

GWP (Global Warming Potential)*

$$GWP(x) = \frac{\int_0^{TH} a_x \cdot [x(t)]dt}{\int_0^{TH} a_r \cdot [r(t)]dt}$$

Irradiative forcing

Life-time

TH: Time horizon over the calculation is considered, ax: irradiative forcing ($Wm^{-2}kg^{-1}$), x(t):time-dependent decay, r: reference gas (carbon dioxide)

Substances	Lifetime (years)	100 (years)
CO_2	150±5	1
CH_4	14.5±2.5	23
N_2O	120	296
CFC-11	50±5	4600
CFC-12	102	10600
HCFC22	13.3	1700
HCF23	250	12000

Figure 20 Formula for aggregation of global warming effect across all contributing emissions (top). Characterisation factors for key emissions that contribute to Climate change / Global warming (bottom). Source: Intergovernmental Panel on Climate Change (IPCC)

In normalization, the results of the impact categories from the study are usually compared with the total impacts in the region of interest, the U.S. for example; Figure 21 shows for illustration how normalised results look like:

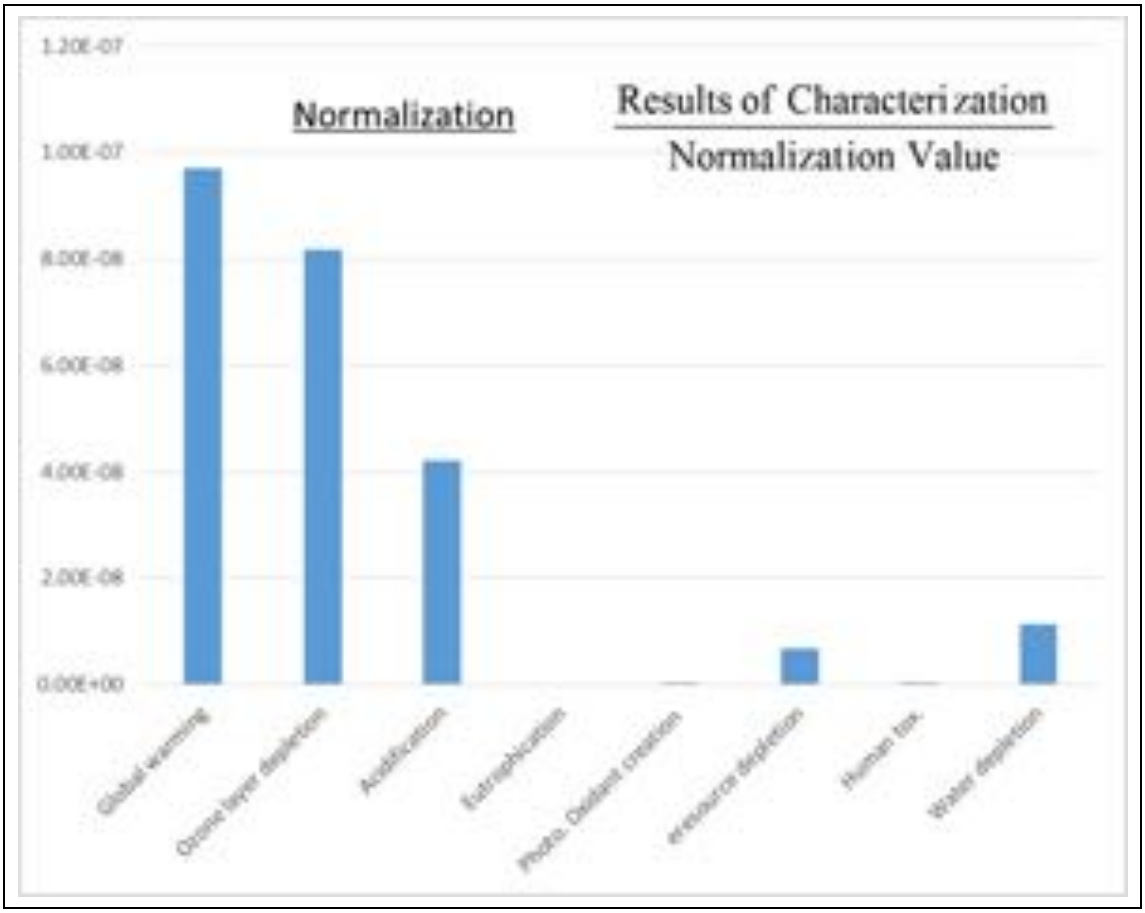


Figure 21 Illustrative results of an LCA, showing the normalised results for the (imaginary) product. In this case, the product crontributes relatively more to climate change and ozone layer depletion impacts, than to the other impacts compared to te contribution of the average EU citizen's total annual consumption does. Normaised results show the main topics for the al+nalysed product, while not judgeing at tis stage about the relative releace of e.g. climate change vs acidification (see "weighting").

During weighting, the different environmental impacts are weighted relative to each other so that they can then be summed to get a single number for the overall environmental impact (not shown here).

11.10.5 Interpretation

Life Cycle Interpretation is a systematic technique to identify, quantify, check, and evaluate information from the results of the life cycle inventory and/or the life cycle impact assessment. The results from the inventory analysis and impact assessment are summarized during the interpretation phase. The outcome of the interpretation phase is a set of conclusions and recommendations for the study.

11.10.6 Example simplified LCA of small cooling system

11.10.6.1 Goal and scope:

The aim of this example is to clarify the environmental impact of a small cooling system at all stages of the life cycle. The research results are to be used as guidelines for development of small cooling system devoid of the chlorofluorocarbon refrigeration medium that constitutes a greenhouse gas. The result are intended for internal use only and not intended for disclosure to third parties.

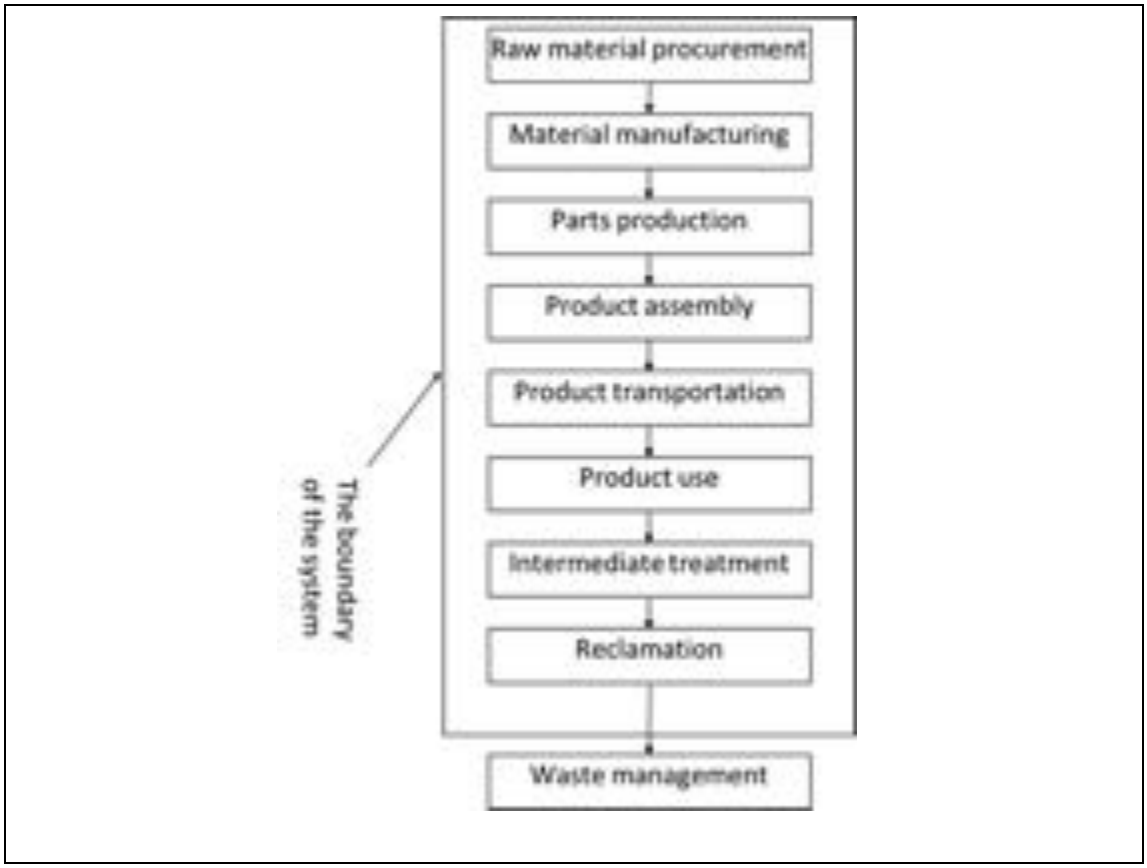


Figure 22 System boundary, schematic for the analysed system, in this case excluding the waste management (illustrative only).

11.10.6.2 Life cycle inventory

For simplicity, this example shows only how to calculate CO_2 for upstream i.e. aluminium.

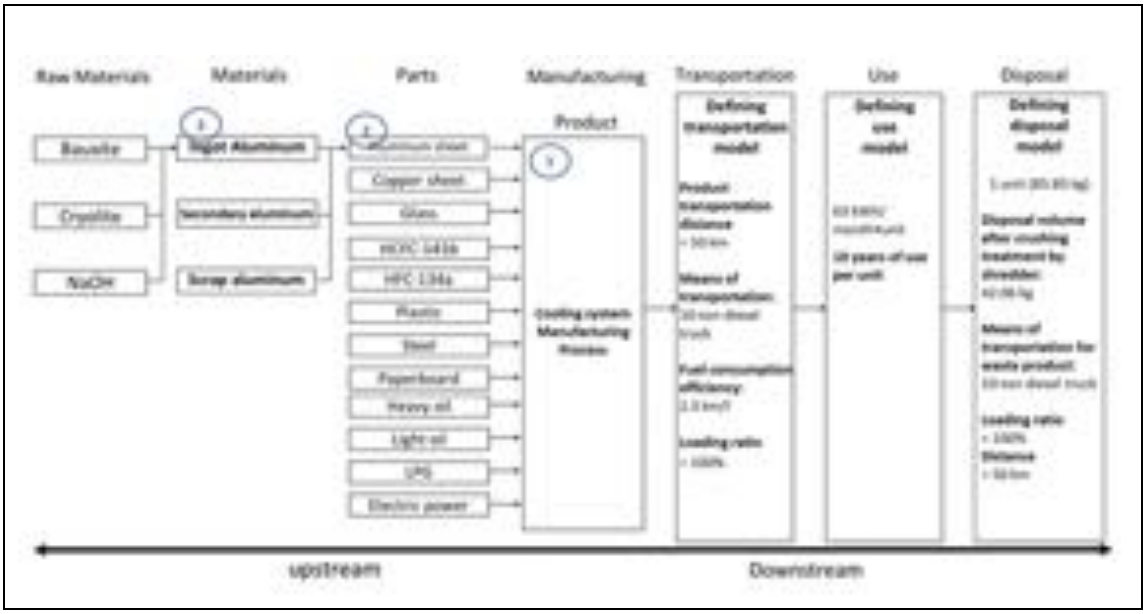


Figure 23 Life cycle model (simplified) for the cooling system

1) Manufacturing

For simplification, we focus only energy carrier in manufacturing process that are heavy oil, light oil, LPG and electricity. From these four sources, we can calculate CO_2 emission as below

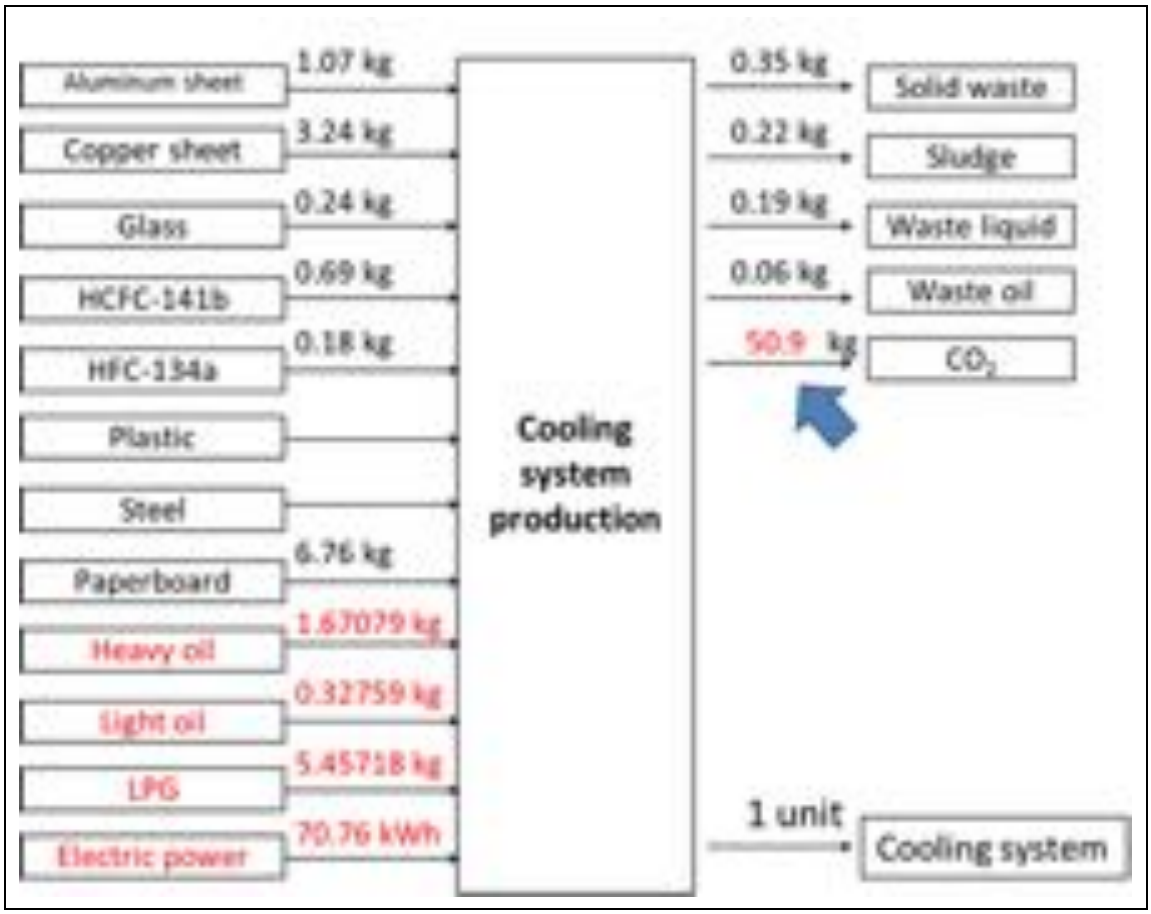


Figure 24 Manufacturing model of the cooling system, based on its BOM using readily available LCA data sets for the main contained materials, as well as consumables for the use as well as waste treatment processes.

Calculate CO2 emission per substance

CO2 emission per heavy oil 1 kg (kg/kg)

= CO2 emission to produce 1 kg of heavy oil + CO_2 emission to burn 1 kg of heavy oil

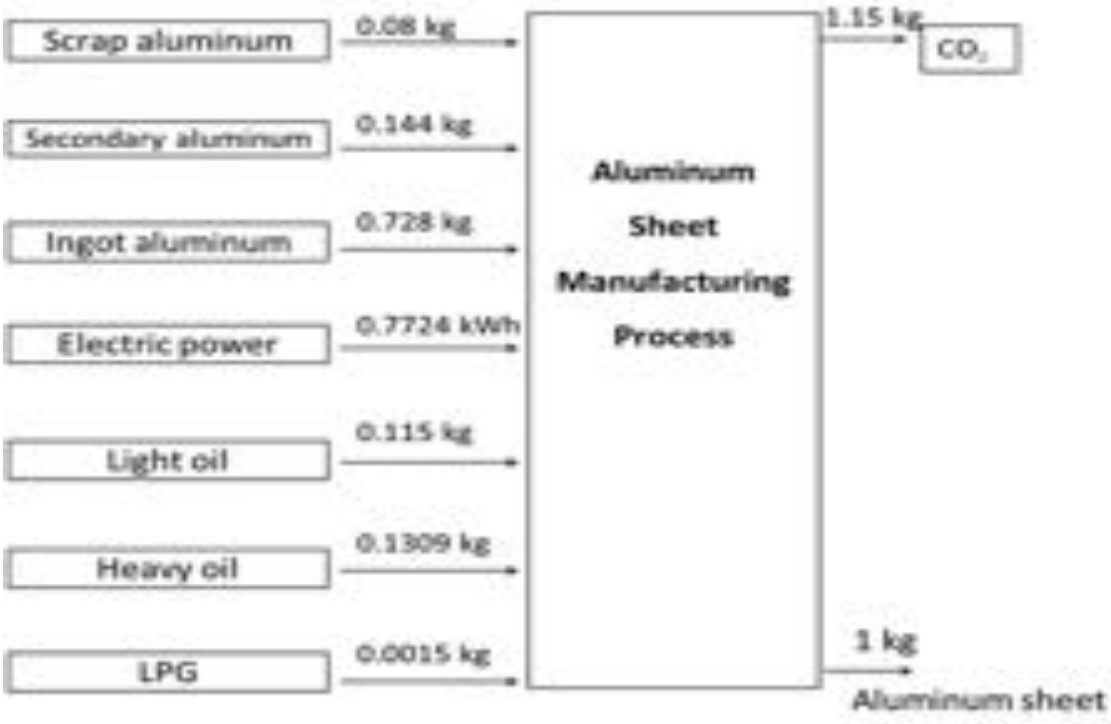
= 0.12 kg/kg + 3.21 kg/kg = 3.33 kg/kg

Note: CO_2 emission to produce heavy oil includes Crude oil collection, transportation, heavy oil production. This principle also apply for other energy carrier.

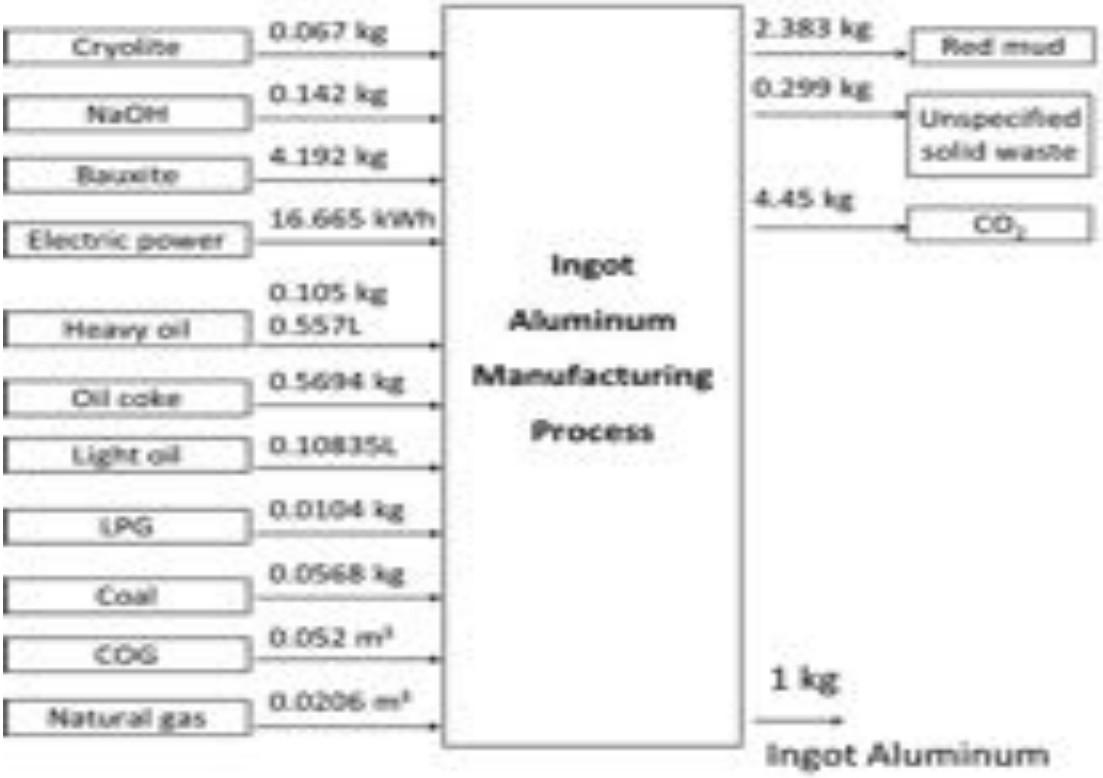
Therefore CO_2 emission from production is:

Inventory (for assembling 1 unit)		CO_2 Emission per Fuel Unit (kg, kWh)	CO_2 Emission
Heavy oil:	1.67 kg	3.33 kg/kg	5.56 kg
Light oil:	0.33 kg	3.30 kg/kg	1.09 kg
LNG:	5.46 kg	2.80 kg/kg	15.2 kg
Electric power:	70.76 kWh	0.41 kg/kWh	29.0 kg
		Total	50.9 kg/unit

2) Aluminium sheet manufacturing process



3) Ingot manufacturing process



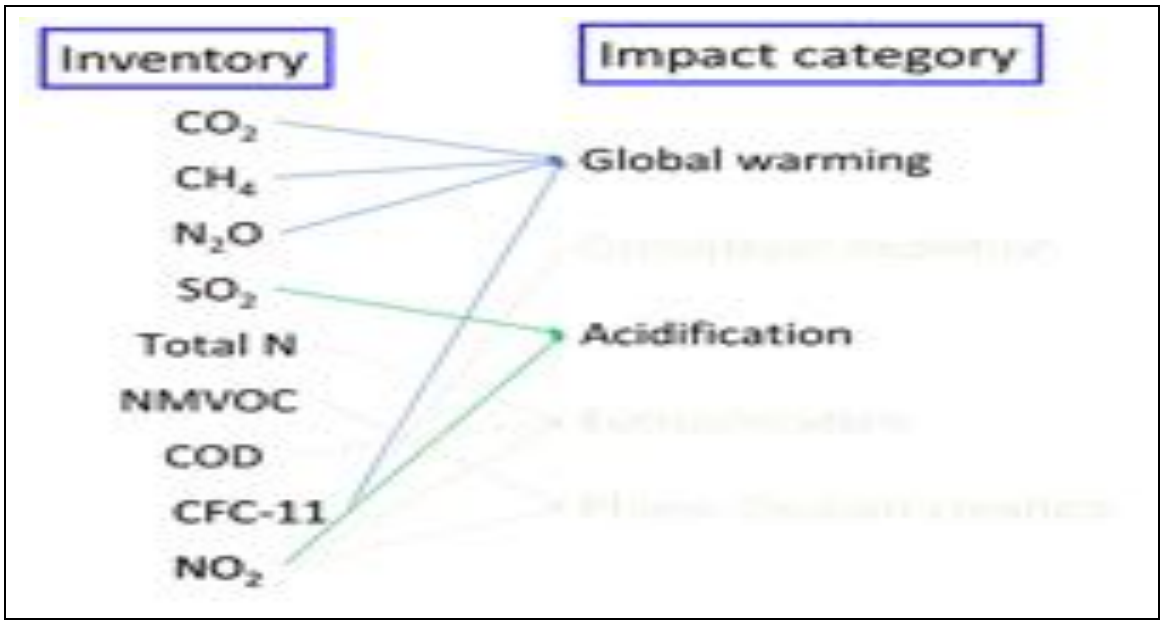
Thus CO_2 emission for whole life cycle of cooling system is

Cooling system assembling:	50.9
Aluminum sheet manufacturing:	1.15
Ingot aluminum manufacturing:	4.45
.	.
.	.
.	.
Transportation:	0.33
Use:	3,150
Disposal:	1.07
Total	**3,210 (kg)**

11.10.6.3 Life cycle impact assessment

For simplicity, only two impact categories are calculated

1) Classification:



2) Characterization

2.1) Global warming

Characterization (Global warming)

Data items	Inventory (kg)		GWP_{100}	Result
CH_4	1.49E-1	x	21	3.13
CO_2	3.21E+3	x	1	3.21E+3
HCFC-141b	1.38	x	630	8.69E+2
HFC-134a	3.60E-1	x	1300	4.68E+2
N_2O	1.99E-1	x	310	6.17E+1
Total				5.28E+3

2.2) Acidification

Characterization (Acidification)

Data items	Inventory (kg)		AP	Result
NOx	4.56	x	0.70	3.19
SO_2	6.09	x	1	6.09
SOx	2.78E-2	x	1	2.78E-2
Total				9.31

3) Normalization

Impact categories	Results of characterization		Normalization factors (nationwide)	Results of normalization (nationwide)
Global warming	5.28E+3	÷	1.36E+12	3.88E-09
Ozone layer depletion	1.51E-1	÷	1.86E+06	8.16E-08
Acidification	9.31	÷	2.21E+09	4.21E-09

4) Weighting

Impact categories	Results of normalization		Weighted modules	Weighted results
Global warming	3.88E-9	x	10	3.88E-8
Ozone layer depletion	8.16E-8	x	10	8.16E-7
Acidification	4.21E-9	x	10	4.21E-8
Eutrophication	3.12E-11	x	5	1.56E-10
Resource depletion	1.62E-9	x	5	8.1E-9
Photo. Oxidant creation	1.37E-10	x	2.5	6.85E-10
Water depletion	7.42E-12	x	5	3.71E-11
Human tox.	1.13E-10	x	10	1.13E-9
Total				9.07E-07

11.11 Annex Life Cycle Costing background data

Table 40 Default values for TCO of ICT at public bodies in German context, as example.

		Einheit	Quelle / Annahme	Link zum Dokument
Diskontsatz/Kalkulationszinssatz	1,7	%	Durchschnittszinssatz Bundesfinanzministerium "Personal- und Sachkosten für Kostenberechnungen/Wirtschaftlichkeitsuntersuchungen (PKS)"	Personal- und Sachkosten für Kostenberechnungen/Wirtschaftlichkeitsuntersuchungen
Nominale Preissteigerungsrate allgemein	1,87	%	Statistisches Bundesamt, Fachserie 17 Reihe 7, Verbraucherpreisindizes für Deutschland, Mai 2014, Verbraucherpreisindex insgesamt, Durchschnitt 2011-2013	Statistisches Bundesamt, Fachserie 17 Reihe 7
Nominale Preissteigerungsrate Haushaltsenergie (Strom, Gas u.a. Brennstoffe)	6,47	%	Statistisches Bundesamt, Fachserie 17 Reihe 7, Verbraucherpreisindizes für Deutschland, Mai 2014, Sondergliederung, Durchschnitt 2011-2013	Statistisches Bundesamt, Fachserie 17 Reihe 7
Nominale Preissteigerungsrate Heizöl und Kraftstoffe	5,53	%	Statistisches Bundesamt, Fachserie 17 Reihe 7, Verbraucherpreisindizes für Deutschland, Mai 2014, Verbraucherpreisindex insgesamt, Durchschnitt 2011-2013	Statistisches Bundesamt, Fachserie 17 Reihe 7
Reale Preissteigerungsrate allgemein	0,167158	%	Preissteigerungsrate abzüglich Diskontsatz	
Reale Preissteigerungsrate Haushaltsenergie (Strom, Gas u.a. Brennstoffe)	4,690265	%	Preissteigerungsrate abzüglich Diskontsatz	
Reale Preissteigerungsrate Heizöl und Kraftstoffe	3,765978	%	Preissteigerungsrate abzüglich Diskontsatz	
Diskontsatz/Kalkulationszinssatz bei längeren Laufzeiten	0,86	%	Annahme: 6 Jahre Laufzeit. Durchschnittszinssatz von 2013	Zinsstrukturkurve
Strompreis (Industrie)	0,1511	€/kWh	Mittlerer Strompreis Industriekunde (ohne Umsatzsteuer) zum 1. April 2014, Jahresverbrauch 24 GWh, Mittelspannung (10 oder 20 kV), Quelle: Monitoringbericht 2014; Bundesnetzagentur,	BNetzA Monitoringbericht 2014

			Bundeskartellamt, November 2014	
Strompreis (Gewerbe)	0,2186	€/kWh	Mittlerer Strompreis Gewerbekunde (ohne Umsatzsteuer) zum 1. April 2014, Jahresverbrauch 50 MWh, Niederspannung (0,4 kV), Quelle: Monitoringbericht 2014; Bundesnetzagentur, Bundeskartellamt, November 2014	BNetzA Monitoringbericht 2014
Strompreis (Haushalte)	0,2953	€/kWh	Mittlerer Strompreis Haushaltskunde (inkl. Umsatzsteuer) zum 1. April 2014, Jahresverbrauch 3.500 kWh, Niederspannung (0,4 kV), Quelle: Monitoringbericht 2014; Bundesnetzagentur, Bundeskartellamt, November 2014	BNetzA Monitoringbericht 2014
Wasserpreis	3,97	€/m³	Durchschnittlicher Wasserpreis laut BDEW: 1,93€/m³ plus Abwassergebühr Schmutzwasser laut DWA: 2,04 €/m³ (2011) DWA - Deutschen Vereinigung für Wasserwirtschaft, Abwasser und Abfall e. V. BDEW - Bundesverband der Energie- und Wasserwirtschaft e.V.	Wirtschaftsdaten Abwasserbeseitigung BDEW Wasserfakten
Erdgaspreis (Haushalte)	0,0678	€/kWh	Statistisches Bundesamt; Daten zur Energiepreisentwicklung; Lange Reihen von Januar 2000 bis Oktober 2014; Erdgaspreis, Abgabe an private Haushalte, Jahresverbrauch 20 Gigajoule bis unter 200 Gigajoule; alle Steuern inbegriffen	https://www.destatis.de/DE/Publikationen/Thematisch/Preise/Energiepreise/Energiepreisentwicklung.html
Kältepreis	0,15	€/kW	Berechnungshilfe zur Berechnung der Lebenszykluskosten von Produkten und Dienstleistungen für Rechenzentren und Serverräume	
Kraftstoffkosten Superbenzin	1,55	€/ Liter	ADAC Autokosten 2014 - Kostenübersicht für über 1.800 aktuelle Neuwagen-Modelle. Stand April 2014. Die Angaben beziehen sich auf den ermittelten Kraftstoffverbrauch nach dem EU-Fahrzyklus sowie den zum Zeitpunkt der Erstellung aktuellen, durchschnittlichen Kraftstoffkosten.	
Kraftstoffkosten Erdgas (CNG)	1,05	€/ kg		http://www.adac.de/_mmm/pdf/autokostenuebersicht_47085.pdf

Note: Other key EU Member States: The ongoing EU-level LCC project, commissioned by DG ENV, will prepare only one set of generic EU-level values that EURECA plans to use or reference as well (delivery mid 2016 acc. to info from contractor). Moreover,

will they not include any DC or otherwise directly suitable product-groups specific model into their tool.