Fondazione Politecnico di Milano

EnergIT

Interim Report on Green-IT competences for data centers

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Summary

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1 Introduction

EnergIT project is funded by Regione Lombardia, Italy, (Bando Metadistretto 2008, started in 2009) and aims at developing new tools and methodologies for the design of green data center. The project also focuses on the new competences and profiles needed for designing and managing a green data center.

The partners of the project are:

- Beta80
- Enter
- Neptuny
- Fondazione Politecnico di Milano
- Politecnico di Milano

EnergIT project is expected to produce its final results by September 2010.

This report provides an initial overview on some partial results relevant to the identification of green competences and profiles, starting from the European e-Competence Framework.

2 Project Objectives

EnergIT project aims at exploring and discovering new technologies and methodologies for green IT infrastructures and systems. The project has the following objectives:

- Define a methodology that support the designing of data centers. This methodology aims at energy efficiency and cost reducing strategies, both from the logic and from the physical point of view.
- Define a nearly real time methodology to support data centers managers to reduce energy consumption.
- Implement a dashboard that supports to provide key performance indicators of data center, in particular indicators of energy efficiency. This dashboard should be integrated with all the existing tools and methodologies.
- Identify and define competences and professional curricula needed for the green data center.
- Create and manage proper learning programs for green data centers designers and managers.
- Enrich the European e-Competence Framework (e-CF) with a “greener” point of view, considering the competences and the profiles identified at the previous points.

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For more details about the eCF see Section 3.

3 European e-Competence Framework www.ecompetences.eu

"The e-CF is a European wide reference framework of information and communication technologies competences that can be used and understood by ICT professionals and human resources managers from ICT user and supply companies, small and medium sized enterprises, the public sector, as well as educational and social partners across the European Union.

The framework has been developed by a large number of European ICT and human resources experts in the context of the CEN / ISSS Workshop on ICT Skills. The goal of the workshop is to provide a consensus building platform for both national and international representatives from all stakeholders. It aims to foster the development of long-term human resources and competence development solutions for the European ICT community.

In 2005, further to the recommendations of the European e-Skills Forum, the ICT Skills workshop members agreed that national ICT framework stakeholders as well as European ICT industry representatives - both human resources and ICT experts – should consider developing a European e-Competence Framework. With the encouragement of the European Commission, ICT framework stakeholders, representatives from several European larger companies and an applied research foundation met for a kick-off early 2006 in order to put this intention into practice. During an intensive follow-up, they designed a programme for the work towards a European e-Competence Framework under the umbrella of the CEN/ISSS workshop on ICT Skills. These efforts were welcomed and recognised in the Communication of the European Commission on "e-Skills for the 21st Century: Fostering Competitiveness, Growth and Jobs" of September 2007 and the Competitiveness Council Conclusions of November 2007.

In order to achieve a European consensus and useful results at European and national level, the Europe-wide involvement of ICT sector players and stakeholders from business, policy making and education was crucial. Whilst at the political level it was important to get the larger multi-stakeholder public of the European ICT sector on board, at the expert working level focus had been placed upon human resources and ICT management know-how from the European ICT industry.

The European e-Competence Framework is structured from four dimensions. These dimensions reflect different levels of business and human resource planning requirements in addition to job/ work proficiency guidelines and are specified as follows:

- 5 e-Competence areas, derived from the ICT business processes PLAN – BUILD – RUN – ENABLE – MANAGE
- A set of reference e-Competences for each area, with a generic description for each competence. 32 competences identified in total provide the European generic reference definitions of the framework.

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- Proficiency levels of each e-Competence provide European reference level specifications on e-Competence levels e-1 to e-5, which are related to the EQF levels 3 to 8.
- Knowledge and skills related to the e-Competences are indicated as optional framework components for inspiration. They are not intended to be exhaustive.

The e-CF in action project, spring 2010 its deadline, is developing Dimension 4 , related to knowledge and skills, to make the European e-Competence Framework closer to the education and training system, and is updating Dimensions 2-3, adding further competences, if needed".

4 Methodology

The project is composed of four main steps:

- Identification and analysis of data centers' value chain, which is mainly composed of three actors:
  - **Vendors**. This category is composed of those enterprises which sell any kind of product and service to data centers. It covers a wide range of players, starting from hardware to software vendors, from conditioning and cooling systems to facilities providers.
  - **Data Centers**. This category includes the data centers managing and selling services to final users.
  - **Users**. This last category includes all the businesses using data center services, either internal or outsourced.

  It is also possible that some businesses join more than one category. For example, we can consider hardware vendors, who sell data centers products and at the same time manage their own data centers.
- Selection of a list of companies, for each category identified at the previous point, Table 1.

Table 1: companies selected

Vendor	EMERSON Network Power	IBM	neptuny	UNIFLAIR
Data Center	ACANTHO	ENTER	IBM	LOMBARDIA INFORMATICA
User		zerozero39	3	

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- Interviewing process with managers or representative people of the identified companies, to understand their point of views on Green IT issues and solutions. Interviews took place between May and September 2009.
- Data analysis, to identify core competences and profiles related to Green IT issues within data center world.

Interviews were based on e-CF. Dimension 2 crosses target groups to identify which main core competences for which actors, Table 2.

Table 2: e-CF Dimension 2 crosses target gorups

Green IT competences		Vendors	Data Centres	Users
A. PLAN				
	A. 1. IS and Business Strategy Alignment		X	X
	A.2. Service Level Management		X	X
	A.3. Business Plan Development	X	X	X
	A.4. Specification Creation	X	X	
	A.5. Systems Architecture	X	X	
	A.6. Application Design	X		X
	A.7. Technology Watching	X	X	X
NEW	A.8. Production environmental debt estimation	X		
B. BUILD				
	B. 1. Design and Development	X	X	X
	B.2. Systems Integration		X	
	B.3. Testing	X	X	
	B.4. Solution Deployment	X	X	
	B.5. Technical Publications Development	X	X	
C. RUN				
	C.1. User Support	X	X	
	C.2. Change Support	X	X	
	C.3. Service Delivery	X	X	
	C.4. Problem Management	X	X	
D. ENABLE				
	D. 1. Information Security Strategy Development	-	-	-
	D.2. ICT Quality Strategy Development	X	X	X
	D.3. Education and Training Pro vision	X	X	X
	D.4. Purchasing	X	X	X (awareness)
	D.5. Sales Proposal Development	X	X	
	D.6. Channel Management	-	-	-
	D.7. Sales Management	-	-	-
	D.8. Contract Management	-	-	-
E. MANAGE				
	E.1. Forecast Development		X	
	E.2. Project and Portfolio Management	-	-	-

Green IT competences		Vendors	Data Centres	Users
	E.3. Risk Management	-	-	-
	E.4. Relationship Management	-	-	-
	E.5. Process Improvement	X	X	X
	E.6. ICT Quality Management	X	X	X
	E.7. Business Change Management	X	X	X
	E.8. Information Security Management	-	-	-
NEW	E.9. GREEN-IT awareness Development			X

5 Innovative technologies

This section provides a brief overview of innovative technologies for the Green Data Center that have been cited by the people interviewed during the project. Some of them are already consolidated technologies, while some others are more innovative ones.

5.1 *Innovative cooling technologies*

A significant part of the management cost of a data center is due to cooling and refrigeration. For this reason, new more energy efficient solutions are starting to become common solutions in the world of data center (e.g., free cooling, tri-generation and cogeneration).

Free cooling is a method that uses low external air temperatures to assist in chilling water, which can then be used for air conditioning systems in green data centers. When the ambient air temperature drops to a set temperature, a modulating valve allows all or part of the chilled water to by-pass an existing chiller and run through the Free Cooling system, which uses less power and uses the lower ambient air temperature to cool the water in the system. This can be achieved by installing an air blast cooler with any existing chiller or on its own. During period of low ambient temperature a processor can by-pass an existing chiller giving energy savings of up to 75%, without compromising cooling requirements.

Tri-generation is the simultaneous production of mechanical power (often converted to electricity), heat and cooling from a single heat source, such as solar energy. It is sometimes referred to as CCHP (combined cooling, heating, and power generation).

Cogeneration is the consecutive simultaneous production and exploitation of two energy sources, electrical (or mechanical) and thermal, from a system utilizing the same fuel. In the case of data centers, heat by a cogeneration plant is used to produce cooling via absorption cycles.

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5.2 *Monitoring software*

In order to reduce IT energy consumption, it is important to know it in details. For this reason monitoring software applications are fundamental parts of data centers. Without a correct and reliable measure of power consumption, it would be impossible to evaluate any energy saving. Therefore, a lot of different monitoring tools spread out through data centers. They can be mainly divided into two categories: direct and indirect monitoring tools.

Some of them are able to give an estimate of energy consumption of a machine starting from their datasheet and indirectly computing the power absorbed by the machine in a given period of time.

Some other monitoring tools, typically integrated into the hardware, effectively measure the temperature of the underlying hardware and compute the power absorbed by the machine in that given moment.

5.3 *Low consumption hardware*

At a first glance, minimizing the power consumption of a single hardware component is the quickest way to reduce IT energy costs. As a matter of fact, research in this field is well consolidated. All the greatest hardware vendors are going in this direction, and nowadays a wide range of their products is labeled as “green”.

Embedded systems are just an example of a way to reduce energy consumption. Since they are dedicated to a specific task, they can be optimized reducing the size, the cost and the consumed energy, while increasing reliability and performance.

5.4 *Virtualization and consolidation technologies*

One of the most significant issues in enterprise IT is the growing number of servers, which makes costs for infrastructures and their management raise fast. Since some years ago, the addition of a service or an application meant the setup of another server; nowadays it is common to encounter under-used machines dedicated to a single service which exploits a minimal percentage of CPU time and a fraction of the I/O available band.

Server consolidation is an approach that exploits a more efficient utilization of resources, targeting the reduction of the total number of servers needed by a firm.

Virtualization is one of the technologies that help use infrastructures in a more rational way, following the objective of server consolidation. The presence of more virtual instances on a single suitably equipped physical server brings several benefits under different aspects. The best practices products are para-virtualization platforms. Here follow some reasons why these products are well suited for consolidation:

- Centralized and uniform management
- Better management and full exploitation of resources

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- Faster deployment
- Agile resources management
- Faster and more efficient backup and disaster recovery
- Efficient utilization of the underlying storage
- Smaller space occupation and less energy consumption
- Maximum scalability
- More configuration granularity
- Support to obsolete systems
- Easiness to migration from physical to virtual

5.5 *Thermal assessment*

Thermal assessment is a technique that allows the firm have a thermal map of its own data center. This map explains in a precise way how the cooling is used, where its use is efficient and where it is not. This process is typically composed by the following steps:

- Study of the relationships among surface, involved power and cooling power of the conditioning plant
- Determination of the useful cooling power of the data center
- Analysis of needs for cooling, compared with the capacity of the plant
- Check of eventual obstacles in air traffic through the double floor and the ceiling
- Control of laying and orientation of the ventilation grids
- Analysis of the current infrastructures compared with the recommended model in similar situations
- Check of the data center management procedures

6 Green-IT competences

In this section, a set of Green-IT competences, emerging from the interviewing process are analyzed.

6.1 *Green IT understanding*

In the last few years, Green IT has become more and more important; nowadays the impact of technologies on the environment has to be seriously considered. Recent research shows that IT is responsible for the 2% of the world's CO2 emission. The exponential growth of IT has come together with a consequent increment of the energy consumption and this has brought out three main critical factors: - the environmental impact of this phenomenon; - energy costs; - IT energy consumption as limit to its scalability.

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The Green IT issue implies competences, skills and knowledge cross-cutting all the phases of a data center life. Green IT is the motive behind energy consumption reduction, thus, it is crucial to get awareness, develop wide Green IT competences and to be always up to date on new issues related to this area.

6.2 *Data centers architecture*

Nowadays the cost of data centers are evolving and new costs are starting to appear in data centers' bills. These costs include the buildings where data centers are placed and their features; these features do not always meet data centers requirements, thus they represent additional costs. However, data centers do require particular building features; thus, besides run and manage (from purchasing components to their disposal), an effective and efficient data center governance has to cover the whole process, including plan and build phases.

Competences required in the plan and build phases are related to the evaluation of constraints and the choice of the most effective solutions to build data centers in the most efficient ways. Constraints may include the height of the building (with respect to the chosen components) or conditioning requirements; different solutions may explore different kind of floors, walls or dimensions of the rooms.

On the whole, it is important to know how to design, construct and maintain a data center in the most energy efficient way; and the “design to energy efficiency” has to consider and anticipate construction and maintenance requirements.

6.3 *Renewable energy*

Renewable energy is energy generated from natural resources such as sunlight, wind, rain, or geothermal heat, which are naturally replenished. Since energy costs significantly impact on data centers bills, it is important to consider renewable energy as a concrete alternative; in fact, beyond the fact that it is “green”, it is usually also less expensive and can even be pushed by public incentives.

On the other hand, simple knowledge of such energies is no more sufficient. Their complexity and multifaceted aspects demand strong competences on this field. I.e., besides knowing what they are and how they work, it is crucial - to understand the deep differences between them and the overall saving they allow; - to support implementation and installation; - to keep yourself up to date on renewable energy trends and evolutions.

6.4 *New energy efficient technologies*

Since energy costs significantly impact on data centers bills, knowledge about energy efficient technology solutions is important to decrease costs.

Nowadays virtualization is not just related to servers, but it is starting to appear also in other hardware devices, such as networking components. In

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order to make data centers energy efficient as much as possible, it is important to be aware of energy efficient solutions available on the market.

6.5 *Fluid and thermo-dynamics*

This knowledge is important for both data center construction, to design the building according to data center thermal needs, and data center consolidation, to improve efficiency with better fluid and thermo-dynamics. Data centers require strong cooling systems and it is critical to exploit warm and cool currents in the best possible ways to minimize cooling expenses.

Latest studies show that a different physical layout of all the components of a data center can significantly vary the need of cooling and consequently the need of energy. Standard hot and cold aisles based on traditional cooling techniques can be replaced or integrated with new kinds of cooling that exploit fluid and thermo-dynamics. Raised floors, free cooling, precision and technical cooling are just some example of new technologies come out of fluid and thermo-dynamics expertise.

6.6 *Data center measures*

The interviews have pointed out a general lack of tools and methodologies for measuring performances and energy efficiency indicators in a data center. Standard metrics and measurement processes, agreed among vendors, data centers managers and clients, would allow easier communication and a better understanding.

In order to measure the effective impact of a new green solution adopted in a data center, specific performance indicators are needed. These metrics should allow to compare “as-is” situations with possible “to-be” scenarios. For example, one of the most widely used indicators is the Power Usage Effectiveness (PUE). It is the ratio of the total amount of power used by the data center facility divided by the power delivered to IT equipment. In this case, the “ideal” data center should have a PUE with value 1, but there are not consolidate benchmarks of PUE for real data centers that are considered “green”. For this reason, it is strongly suggested to define new sets of metrics to calculate data center efficiency, and to implement specific measurement processes and tools. This would greatly improve data center governance.

6.7 *Computer systems*

Data centers require computer system deep knowledge; in this macro-area the main competences required are related to system administration, configuration and management, networking and UPS. Data centers have to be always upgraded with the latest technologies available on the market; this implies deep knowledge about the state of the art of server hardware, networking systems and UPS, and consequently, awareness of new products and technologies, taking into account Green IT aspects and energy consumptions issues.

6.8 *Green software*

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Data centers require green software competences. This means: - knowledge of some specific software categories, e.g. operating systems, networking software, software virtualization and hardware monitoring tools; - skills on energy efficiency software metrics and products.

Usually software is not considered as an enabler to reduce energy consumption. However, recent studies have shown that the choice of an application against another (completely functionally comparable) can significantly impact on the energy consumption of a system, with differences up to 60%. These differences can be found at any level, from the operating system itself to the application software level. This research branch is quite new and few publications have been produced, but it is possible to evaluate different software solutions with the new energy efficiency dimension in addition to the usual response time and performance evaluation criteria.

6.9 *Green hardware*

Data centers require green computer system hardware competences; in particular, they include knowledge of hardware categories such as UPS systems, networking systems (e.g. switch, routers), servers (e.g. blade, rack) and their energy characteristics.

Hardware machines differentiate from each others; usually their life cycle is between 3 and 5 years. “Finding” the most suitable hardware machines meeting data centers needs is a critical ability. Many factors have to be considered: from compatibility issues to installation and configuration; from costs to performance and energy consumption; from soundness to life cycle. In this scenario, new technologies make even harder the choice of the greenest and the most efficient hardware.

6.10 *Virtualization*

Although virtualization is related to hardware and software competences, currently it is one of the most important and most used energy efficiency methodologies on the market; accordingly, it is here treated as a distinct skill.

Usually virtualization is used to obtain a server consolidation: many small physical servers are replaced with one larger physical server, which can host many "guest" virtual machines. A virtual machine can be more easily controlled and inspected from outside than a physical one, and its configuration is more flexible. Among the advantages that virtualization can bring, one of the most important is the use of the resources: it is possible a dynamic allocation of resources so that each virtual machine has the correct amount of resources and no resources get wasted.

In this way, all the hardware and software components become more efficient, with lower hardware requirements, lower need of cooling, lower energy consumption and lower CO2 emissions, which means a greener data center.

6.11 *Disposal and waste*

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To have a greener data center it is important to minimize the impact of the data center on the environment. Thus, being aware of pollution produced by data centers, is crucial.

There is a set of laws regulating the disposal policy in each state and, on the other hand, a set of certificates offering incentives for an eco-friendly disposal. Both of them have to be well known in order to minimize costs due to incorrect disposal of electronic components.

6.12 *Law and international standards*

Currently, data centers have to be compliant with the international laws and standards related to their energy consumption and their environmental impact (e.g. Energy Star international standard).

6.13 *Monitoring*

Energy consumption of data centers and their environmental impact have to be monitored. Standard parameters have to be collected, such as overall energy consumption, the breakdown of all data center components (e.g servers, networking, UPS, cooling) and their environmental impact; consequently, both hardware disposal and CO2 emissions, have to be known.

This kind of skill is quite crucial for data center governance. Nearly every component should be monitored, since they can be potentially improved – either in performance or in energy efficiency. On the other hand, it is quite impossible to monitor each single component inside a data center area. Hence, monitoring does not mean looking at performances of each elements; it means identifying which components are key and have to be examined; it also implies trying to improve the effectiveness of data centers.

6.14 *Capacity planning*

It aims to identify the production capacity needed by an organization to meet changing demand. In the context of capacity planning, "capacity" is the maximum amount of work that an organization is able to carry out over a given period of time. Discrepancies between organization capacity and customers' demand imply inefficiency that also includes "energy" inefficiency. The goal of capacity planning is to minimize discrepancy.

7 Green-IT job profiles

In this section, Green-IT professional profiles, emerged from the interviewing process, are analyzed.

A key aspect coming out of interviews is the need of multi-disciplinary profiles, instead of people with only specialized knowledge.

On the whole, emerging Green-IT job profiles are as follows.

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7.1 *Data center architect*

This profile includes different and various competences related to responsibility for the design, construction and maintenance of data center buildings; these competences have to be oriented to energy efficiency. Besides architecture competences, this profile has to include further knowledge related to data centers. Some examples are as follows.

Laws and international standards related to data center construction, from industry to cooling standards, from cabling to safety standards and so on.

Hardware components to be installed and used in data centers; i.e. compartmentalization within data centers and their possible evolutions.

Fluid and thermo-dynamics to position hardware components, servers, UPSs and cooling systems.

Consequently, architect profile should not be a simple “builder” and rather develop multidisciplinary skills and knowledge.

7.2 *Application manager (+ SW developer)*

This profile is responsible for the whole software layer of a data center. To select the best software solution, evaluation of software performances, response time and energy consumption is a key ability. Moreover, this profile needs further knowledge. Examples are as follows.

Overview of data center hardware; a particular software solution can be suitable for a machine and not for another one.

Virtualization; together with the infrastructure manager, this profile has to propose, install, configure and deploy a functional and efficient virtual environment.

Monitoring of efficiency, functionality and performances of software to understand the impact that software choices may have on the overall data center energy consumption.

7.3 *Infrastructure manager*

This profile has deep knowledge of data center hardware infrastructures: server, UPS and networking.

This profile has also to be aware of the impact of the selected hardware on the environment, i.e. energy consumption and CO2 emissions. This profile also needs to know international laws and standards related to energy efficient hardware components, understand the monitoring functionalities of the components and be able to use and configure virtualization.

Computer system and capacity planning are further competences required for this profile. The former is needed to manage networking, system

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integration and communication; the latter is needed to reduce resource waste, keeping a close connection with the data center manager.

7.4 *Cooling expert*

This profile is related to all the cooling technologies used in a data center.

Currently, cooling accounts for more than 50% of the data center energy costs; hence, this profile has a key role in the overall data center organization. It has to be able to select the best solution for a data center, in terms of performances vs. costs, also considering all the issues related to reliability, dependability and fault tolerance. Accordingly, besides cooling technologies, it has to be able to understand further data center-related issues. For instance, this profile has to be aware if a group of servers dissipates more energy than another group, to address cooling efforts properly. Accordingly, this profile should participate in the capacity planning processes and operations.

7.5 *Energy manager*

This profile is responsible for data center energy consumption. Hence, it is responsible for monitoring the overall consumption and analyses the breakdown of component consumption (cooling, server, UPS, networking, others). For this reason, knowledge about data center measures is also required. It is needed for data center performance and greenness optimization.

This profile is crucial to measure the energy consumed and to manage it effectively. Accordingly, it has to update on and consider new energy efficient technology solutions and renewable energy, to be able to provide valuable alternatives.

7.6 *Data Centre manager*

This profile is responsible for the whole data center performances and allows connections between data center profiles.

This profile has to be able to keep a close connection with the other managers, and has to have a deep understanding of the different disciplines involved in data centers design, development and management .

In particular, it cooperates with the infrastructure manager and the cooling expert to perform a well-defined capacity planning; moreover, this profile has to update on new laws and international standards to handle disposal and waste processes properly.

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8 Green-IT competences and curricula

Table 3 shows connections between Green-IT competence areas and professional profiles previously identified according to the results that came out from the interviews.

Table 3: connection between Green-IT competence areas and job profiles

Green-IT job profiles / *Green-IT competence areas*	*Data Center Architect*	*Applications manager (+ Software developer)*	*Infrastructure Manager*	*Cooling Expert*	*Energy Manager*	*Data Centre Manager*
Green IT	●	●	●	●	●	●
Data centers Architecture	●					
Renewable energy	◑			●	◑	
New energy efficient technologies			●	◑	◑	
Fluid and thermo dynamics	◑			●		
Data centers measures		◑	◑	◑	●	◑
Computer system	◑	◑	●			◑
Green software		●				
Green hardware	◑	◑	●			
Virtualization		●	●			◑
Disposal and waste						●
Law and international standard	●		◑		◑	●
Monitoring		◑	◑	◑	◑	●
Capacity planning	◑		◑	◑		●

Although every identified profile has a focus on a particular competence area, a general need of shared competences and of multidisciplinary profiles has clearly emerged.

9 EnergIT and the European e-Competence Framework

The starting point of the EnergIT survey on Green-IT competences has been the European e-Competence Framework (e-CF). From the analysis of the e-CF, a new set of competences and profiles has been identified. This set can be homogeneously integrated in the e-CF and give a full overview of the suite of competences needed in the data center area.

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Table 4 shows the mapping between e-CF e-competences and the competences related to Green IT coming out from the interviewing process.

Table 4: e-CF e-competences and Green-IT competence set

Green IT competences / *e-Competence areas*	Data centers arch.	Renewable energy	New energy efficient tech.	Fluid and thermo dynamic	Data center measures	Computer system	Green SW	Green HW	Virtualiz	Disp. and waste	Law and int. standard	Monit.	Capacity planning
A. PLAN													
A. 1. IS and Business Strategy Alignment		X	X							X			
A.2. Service Level Management			X			X					X		
A.3. Business Plan Development						X							X
A.4. Specification Creation	X	X	X	X		X							
A.5. Systems Architecture	X					X		X	X				X
A.6. Application Design							X		X				
A.7. Technology Watching		X	X										
B. BUILD													
B. 1. Design and Development	X			X		X	X	X	X				
B.2. Systems Integration						X	X	X					
B.3. Testing					X						X	X	
B.4. Solution Deployment													
B.5. Technical Publications Development					X								
C. RUN													
C.1. User Support					X						X	X	
C.2. Change Support						X	X	X	X				
C.3. Service Delivery					X						X	X	
C.4. Problem Management						X		X				X	
D. ENABLE													
D. 1. Information Security Strategy Development													
D.2. ICT Quality Strategy Development					X							X	
D.3. Education and Training Provision					X	X					X	X	
D.4. Purchasing							X	X	X				
D.5. Sales Proposal Development		X	X		X						X	X	

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Green IT competences / *e-Competence areas*	Data centers arch.	Renewable energy	New energy efficient tech.	Fluid and thermo dynamic	Data center measures	Computer system	Green SW	Green HW	Virtualiz	Disp. and waste	Law and int. standard	Monit.	Capacity planning
D.6. Channel Management													
D.7. Sales Management													
D.8. Contract Management													
E. MANAGE													
E.1. Forecast Development					x							x	
E.2. Project and Portfolio Management													
E.3. Risk Management													
E.4. Relationship Management		x	x									x	
E.5. Process Improvement						x						x	
E.6. ICT Quality Management						x	x	x	x			x	
E.7. Business Change Management			x										
E.8. Information Security Management													

Table 5 shows the mapping between the e-CF e-competences and the job profiles coming out from the interviewing process.

Table 5: e-CF e-competences and Green-IT job profiles

Profiles / *e-Competence Areas*	DC Architect	Application Manager (+SW Developer)	Infrastructure Manager	Cooling Expert	Energy Manager	Data Centre
A. PLAN						
A. 1. IS and Business Strategy Alignment	x				x	x
A.2. Service Level Management		x	x		x	x
A.3. Business Plan Development	x					x
A.4. Specification Creation	x	x	x	x		x
A.5. Systems Architecture	x		x			x
A.6. Application Design		x				x
A.7. Technology Watching	x		x	x	x	
B. BUILD						

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Profiles *e-Competence Areas*	DC Architect	Application Manager (+SW Developer)	Infrastructure Manager	Cooling Expert	Energy Manager	Data Centre
B. 1. Design and Development	x	x				x
B.2. Systems Integration		x	x	x		x
B.3. Testing		x	x	x	x	
B.4. Solution Deployment						
B.5. Technical Publications Development					x	
C. RUN						
C.1. User Support		x	x	x	x	
C.2. Change Support	x	x	x		x	x
C.3. Service Delivery	x		x	x		
C.4. Problem Management		x	x	x	x	x
D. ENABLE						
D. 1. Information Security Strategy Development						
D.2. ICT Quality Strategy Development		x	x			x
D.3. Education and Training Provision		x	x	x	x	
D.4. Purchasing		x	x			x
D.5. Sales Proposal Development					x	x
D.6. Channel Management						
D.7. Sales Management						
D.8. Contract Management						
E. MANAGE						
E.1. Forecast Development		x	x	x	x	x
E.2. Project and Portfolio Management						
E.3. Risk Management						
E.4. Relationship Management						x
E.5. Process Improvement	x	x	x	x	x	x
E.6. ICT Quality Management		x	x		x	x
E.7. Business Change Management					x	x
E.8. Information Security Management						

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10 Conclusions

EnergIT survey aimed at identifying the core competences and professional profiles needed for the green data center. This goal has been achieved by selecting and interviewing managers of data centers, IT vendor, and data center users. A set of new competences and skills have been identified: the importance of interdisciplinary profiles and shared competences has emerged as of paramount importance.

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