LIFE 12 ENV/ES/000222

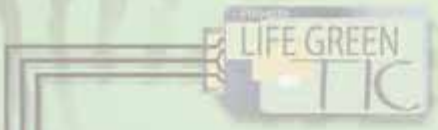
GREEN TIC

Reducing carbon footprint of Information and Communication Technologies

FINAL REPORT

www.lifegreentic.eu

With the contribution of the
LIFE financial instrument of the European Union



LIFE 12 ENV/ES/000222

GREEN TIC

Reducing carbon footprint of Information and Communication Technologies

www.lifegreentic.eu

LIFE GREEN TIC PROJECT BASIC DATA

Project reference:	**LIFE 12 ENV/ES/000222**
Project location:	**Castilla y León, Aragón, La Rioja (Spain)**
Project start date:	**02/09/2013**
Project end date:	**31/08/2016**
Duration (months):	**36**
Total budget:	**1.455.240** €
EU contribution:	**659.120** €

PARTNERS

Beneficiary: **Fundación Patrimonio Natural de Castilla y León (FPNCYL)**
www.patrimonionatural.org

Partners: **Fundación San Valero (FSV)**
www.sanvalero.es
www.gruposanvalero.es

Logroño City Council
www.logroño.es

Contact information

e-mail:	**lifegreentic@patrimonionatural.org**	
Project Director:	**Jesús Díez Vázquez**	jesus.diez@patrimonionatural.org
Project Coordinator:	**Soledad Gómez González**	soledad.gomez@patrimonionatural.org

Project Website: www.lifegreentic.eu
Blog: http://mihuellatic.lifegreentic.eu
Facebook: www.facebook.com/MiHuellaTIC
Twitter: @lifegreentic

With the contribution of the
LIFE financial instrument of the European Union

INDEX

1

EXECUTIVE SUMMARY

1. Executive Summary

Combating climate change is a priority for the European Union (EU). The EU contributes to it by implementing the LIFE programme, its funding instrument aimed at encouraging the development of innovation projects within the framework of the European Union policy in regard to environment.

It is under this programme that the LIFE Green TIC project arises with the aim of contributing to reduce CO_2 emissions from the Information and Communication Technologies (ICT) sector.

Author: Alfonso Domínguez

According to several recent studies, it is estimated that the ICT sector currently consumes 10% of the total amount of energy consumed in the European Union and it is responsible for 4% of its CO_2 emissions.

The Natural Heritage Foundation of Castilla y León (Fundación Patrimonio Natural de Castilla y León – FPNCYL) has coordinated this project counting on the partnership of San Valero Foundation (Aragón) and the Logroño City Council (La Rioja).

To contribute to the Green TIC project objectives the following actions have been defined and implemented from September 2013 to August 2016:

1. Development of Green ICT Action Plans.
2. Definition of Green Procurement Guidelines for ICT equipment.
3. Development of a Best Practices Manual for energy saving in ICT.
4. Social participation in the design of ICT solutions for environmental sustainability through a Living Lab.

In addition to these generic actions, three pilot actions have been developed aimed at testing different experiences related to the application of Green ICT policy within the fields of administration, education and smart cities:

- Pilot Action 1: virtualization in the Environmental Resources Center of Castilla y León in Valladolid (PRAE building).
- Pilot Action 2: Virtual Campus at the University of San Jorge and at San Valero Vocational Training Center (Zaragoza).
- Pilot Action 3: Smart urban environmental management of the city of Logroño.

Throughout these1 actions, the LIFE Green TIC project has helped demonstrate the high potential for reduction of energy consumption that can be achieved with a responsible use of information and communication technologies.

Thus, in the application of ICT to the administration and education fields, by implementing paperless, e-administration and virtual campus policies, the San Valero Group has managed to reduce CO_2 emissions by about 154 tonnes in two years; 31.4 tonnes as 110 vocational training students switched from classroom to online education. The University of San Jorge has reduced those emissions in 65.6 tonnes due to the application of the virtual campus to 2,042 students, and 56 tonnes through the implementation of the Green ICT Action Plan.

As for Logroño City Council, it has achieved total savings of about 51 tonnes of CO_2 by applying rationalization and modernization policies for computer equipment as well as for printers and paper usage.

Finally, the application of virtualization policies done in the PRAE building by FPNCYL, both in its Data Center and in its job positions (desktops), has achieved energy savings of about 31%, therefore, more than 18,500 kWh per year, and a reduction of CO_2 emissions of about 13.2 tons within two years of implementation of the pilot action.

As a whole, the project's actions have helped to achieve total emissions' reduction of 218 tons of CO_2 equivalent.

In addition, the project has made available to public authorities, companies and citizens different tools and methodologies that will facilitate the implementation of Green ICT policies and best practices and their consequent reduction of energy consumption and CO_2 emissions. These tools and methodologies include, among others:

- A methodology for developing Green ICT strategies or action plans.
- A manual for the green procurement of ICT equipment and devices
- A Guidelines document for energy saving best practices targeting ICT users.

Author: magdasalva

2

INTRODUCTION

2 Introduction

2.1 Project Partnership

The consortium that developed the LIFE Green TIC Project was formed by three entities representing three sectors or areas with high potential for application of information and communication technologies, both in management and development of their daily activities, as well as regarding environmental management. These sectors are the public authorities and agencies, education, and Smart cities.

The Natural Heritage Foundation of Castilla y León (FPNCYL), as promoter and coordinating beneficiary of the project, has led and taken responsibility for the implementation of actions aimed at project management, development of financial appraisal and coordination of various technical tasks (such as the pilot action developed at its facilities in the PRAE building in Valladolid, focused on virtualizing data centers and desktops). As a public body linked to the Ministry of Development and Environment of the Castilla y León Regional Government, its activities have been supported by the Regional Government, optimizing thereby the potential transfer of results to the administration of the Region.

The San Valero Foundation, based in Aragon, has contributed to the project representation in the field of education and training through the different institutions that are part of the San Valero Group. The development of the pilot action Virtual Campus and the implementation of online courses and paperless policies in education, both at its Vocational Training Center and at the University of San Jorge are its main actions within the project s framework.

The Logroño City Council has added its experience as Smart City to the project, as Logroño is part of the Spanish Network of Smart Cities. The development of a pilot action monitoring air pollution and noise through sensors located on a street LED lighting infrastructure, as well as the enforcement of energy efficiency and paperless policies in the ICT infrastructure of the City Council, are some of its principal contributions to the project.

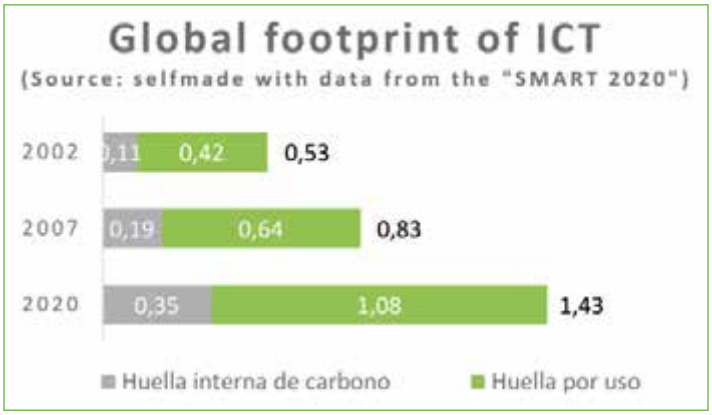
This diversification of sectors and activities represented by the different partners taking part in the project has contributed not only to confer added value on the consortium, but also on the results of the project, validating its products and conclusions in several fields and widening its replicability.

2.2 The Environmental Issue

The fight against climate change is one of the environmental priorities of the European Union (EU) and affects all levels of society, both activities directly emitting greenhouse gases and those referred to as diffuse activities.

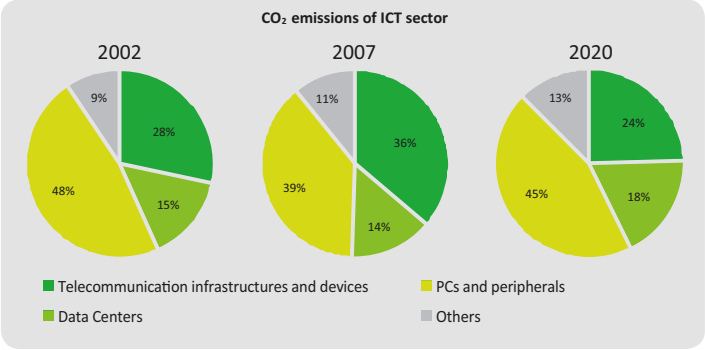
One of these diffuse activities concerns the ICT sector, which is currently responsible for 10% of the total electricity consumption in the EU and of 4% of its CO_2 emissions, being this field in fast and steady growth.

The "Smart 2020 Report" made in 2007 by The Climate Group, estimated that the total carbon footprint of the ICT sector, including personal computers, tablets, peripherals, telecommunication networks, devices and data centers implied emissions of 830 million tons of CO_2. It also foresaw that, despite the continuous improvement in energy efficiency of such equipment, devices and networks, these figures would increase to 6% of full amount of CO_2 emissions from the planet in the year 2020. The manufacture of such equipment causes 25% of these emissions, while the rest of emissions is due to its use.



The needs of data storage, processing and other technology services, have led to an exponential growth of energy consumption in Data Centers, mainly because of air conditioning necessity.

On the other hand, the energy consumption of personal computers, laptops and monitors produced about 200 million tons of CO_2 emissions in 2002, being the largest consumer group within the ICT sector.



Graphics from the Report: "Green ICT, Energy Efficiency and Sustainability in the Business Environment". Regional Observatory of the Information Society (ORSI).

Reducing the ICT ecological footprint must be tackled with a global approach, throughout their whole life cycle:

- Design and manufacture, replacing or minimizing the presence of toxic materials.
- Distribution, applying optimized and efficient logistic methods for storage and distribution.
- Lifespan, through responsible use of these products in any of the productive sectors in which they apply, both by users and by the managers of ICT infrastructure and services.
- End of cycle, ensuring the efficient recycling of products and services.

In spite of the fact that some progress has been made in the private sector, especially in large companies, most organizations and public bodies are still far from deploying Green ICT strategies and actions, although some applications are emerging in regard to green public procurement criteria or application of good practices among employees and users.

2.3 The LIFE GREEN TIC Project Objectives

This LIFE project has been designed to demonstrate that it is possible to enhance the positive impact of ICT on the environment and to reduce their ecological footprint through proper planning and selection of adequate equipment and services, rendering green procurement criteria and the application of best practices by ICT users.

In order to do so, the following objectives were set:

- To demonstrate and quantify the potential that a better use of ICT has for reducing CO_2 emissions, by both reducing the carbon footprint of the sector and promoting such use to achieve better environmental services.
- To model and promote good practices and green procurement criteria in the ICT sector by enforcing pilot actions in education centers as well as in public buildings and equipment.
- To demonstrate the added value of new devices, ICT applications and procedures available in the market to achieve the objective of reducing CO_2 emissions.
- To contrast, through three pilot demonstrative actions in the administrative, educational and urban management sectors, the effectiveness of new processes, devices and more sustainable and efficient ICT applications.
- To define and disseminate standards of control and regulation of ICT to ensure greater energy efficiency and to lower CO_2 emissions.

Author: Iván Argüelles

- To encourage all ICT users to adopt responsible behaviours when using these technologies, so as to help to reduce their energy consumption.

- To boost the citizens and small businesses initiatives to develop ideas and ICT solutions to help strengthen environmental management through the use of open data, environmental information and social networks.

2.4 The Stages of the Project

The development stages of the project have been structured as follows:

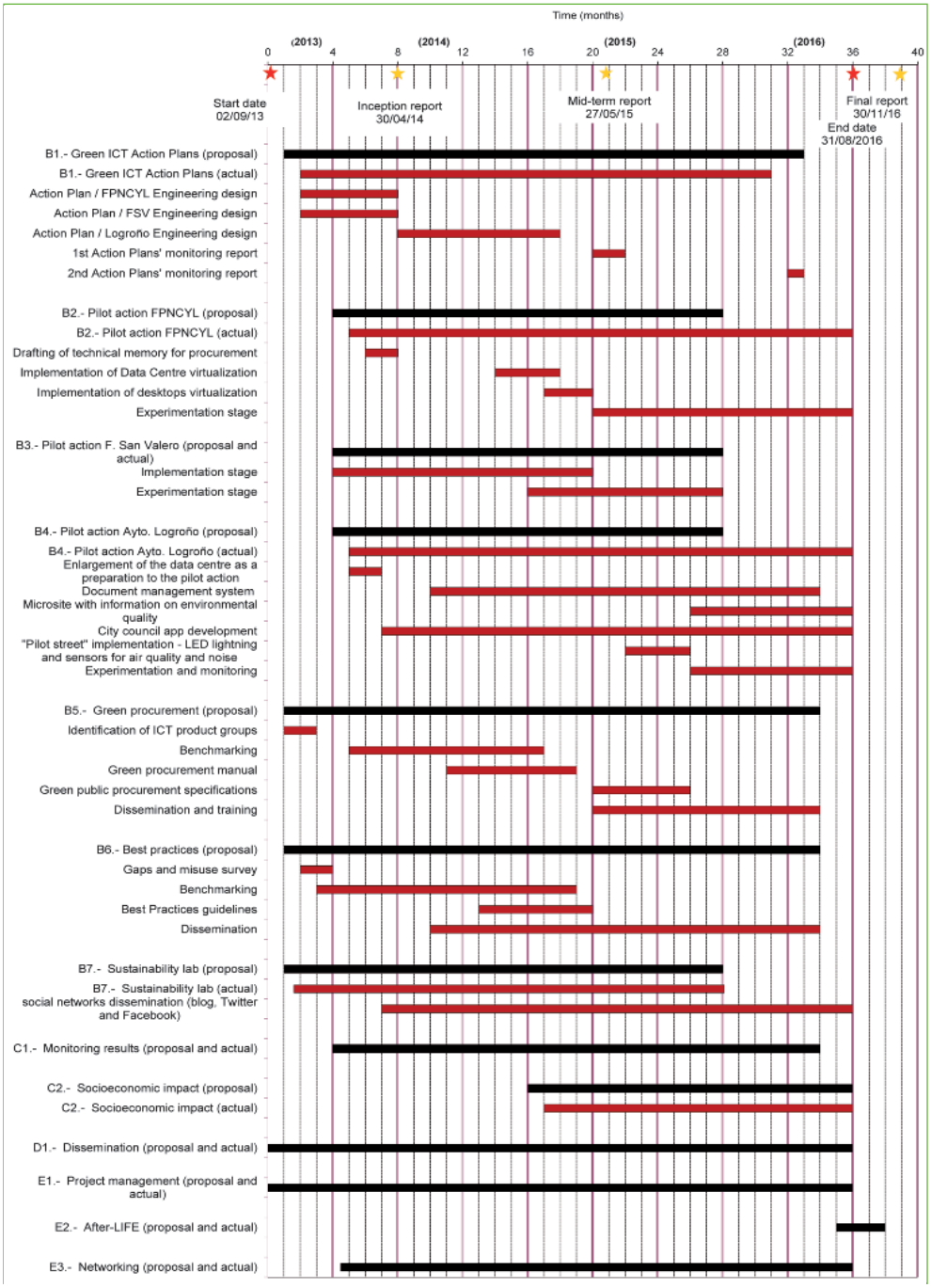
a) **Stage 1:** creation of the working structure (coordination committee, technical committee and dissemination committee) as well as consultative groups supporting the project (experts and stakeholders) (Action E1).

b) **Stage 2:** development of the preliminary work necessary for the forthcoming development of technical actions, as detailed below :
   - Inventory of ICT equipment and their CO_2 emissions (actions B1, C1).
   - Elaboration of a Green ICT Action Plan (B1).
   - Development of an engineering design of pilot actions (B1-B2-B3-B4).
   - Benchmarking B5 and B6 actions.
   - Creation of a virtual community, social networks and web channels (B7, D1).
   - Design of a monitoring system (B1-C1).
   - Survey about the social and economic impact of the project (C2).
   - Identification of projects and entities for networking (E3).

c) **Stage 3:** development of the basic contents of the different actions:
   - Implementation of Action Plans (B1).
   - Execution of Pilot Actions (B2 -B3 - B4).
   - Creation of Manuals and Guides (B5 -B6).
   - Generation of ideas, Green ICT projects (B7).
   - Dissemination materials, articles, etc. (D1).
   - Make contacts for networking (E3).

d) **Stage 4:** monitoring and dissemination of results.
   - Action Plan Monitoring Reports (B1).
   - Reports on the Socioeconomic Impact and on CO_2 Targets (C1 -C2).
   - Training, Information and Awareness-raising Actions (B1 to B6, D1).
   - Midterm and Final Reports (E1).

The work schedule of the project is summarized in the Gantt chart below (dates set as proposed in black, pink indicates actual final dates):


Time (months)
(2013)
(2014)
(2015)
(2016)
0
4
8
12
16
20
24
28
32
36
40
Start date 02/09/13
Inception report 30/04/14
Mid-term report 27/05/15
Final report 30/11/16
End date 31/08/2016
B1.- Green ICT Action Plans (proposal)
B1.- Green ICT Action Plans (actual)
Action Plan / FPNCYL Engineering design
Action Plan / FSV Engineering design
Action Plan / Logroño Engineering design
1st Action Plans' monitoring report
2nd Action Plans' monitoring report
B2.- Pilot action FPNCYL (proposal)
B2.- Pilot action FPNCYL (actual)
Drafting of technical memory for procurement
Implementation of Data Centre virtualization
Implementation of desktops virtualization
Experimentation stage
B3.- Pilot action F. San Valero (proposal and actual)
Implementation stage
Experimentation stage
B4.- Pilot action Ayto. Logroño (proposal)
B4.- Pilot action Ayto. Logroño (actual)
Enlargement of the data centre as a preparation to the pilot action
Document management system
Microsite with information on environmental quality
City council app development
"Pilot street" implementation - LED lightning and sensors for air quality and noise
Experimentation and monitoring
B5.- Green procurement (proposal)
Identification of ICT product groups
Benchmarking
Green procurement manual
Green public procurement specifications
Dissemination and training
B6.- Best practices (proposal)
Gaps and misuse survey
Benchmarking
Best Practices guidelines
Dissemination
B7.- Sustainability lab (proposal)
B7.- Sustainability lab (actual) social networks dissemination (blog, Twitter and Facebook)
C1.- Monitoring results (proposal and actual)
C2.- Socioeconomic impact (proposal)
C2.- Socioeconomic impact (actual)
D1.- Dissemination (proposal and actual)
E1.- Project management (proposal and actual)
E2.- After-LIFE (proposal and actual)
E3.- Networking (proposal and actual)

3

ACTIONS DEVELOPED BY THE ***LIFE GREEN TIC PROJECT***

3. Actions developed by the LIFE Green TIC Project.

3.1 Development of Green ICT Strategies and Action Plans

This Action (B1) was intended to demonstrate the usefulness of developing and implementing strategic and planned approaches in organizations to reduce the environmental impact and carbon footprint of the use, therein, of information and communication technologies.

To achieve this, each of the three partners, based on a common methodology, carried out different pieces of work aimed at elaborating their own Green ICT Strategies or Action Plans.

These pieces of work were accomplished as follows:

a) **Design of a common methodology or procedure for the preparation of the Green ICT Strategies or Action Plans.**

The establishment of a Green ICT policy in any organization has to start with a preliminary step, which is the completion of a thorough analysis of the equipment and services available, in terms of rationality and efficiency in their use, as well as of the alternatives for reducing energy consumption, either by optimizing the existing infrastructure, by introducing a new, more efficient, one or by a combination of both alternatives.

This analysis should result in the articulation of all the gathered information in a Green ICT Action Plan. This Plan must be adapted to the needs and financial possibilities of the organization, taking into account the cost-benefit ratio of investments to be made and the savings to be achieved, as regards not only energy, but also material resources and working time that the staff of the organization invests in maintenance, repair, programming and troubleshooting in general.

There are already experiences of various national governments, such as Australia or the United Kingdom, that have developed their own Green ICT plans and strategies for public bodies with a consolidated monitoring system.

Experiences in cities have also been developed, such as those grouped under the Green Digital Charter, co-financed by the European Commission under the 7th Framework Programme for Research and Technological Development. These cities have developed their own plans, in line with the targets set by the Green ICT Project. Unfortunately, these examples are still an exception.

The LIFE Green TIC Project has established its own methodology, through steps and minimum requirements to be followed when carrying out a Green ICT Action Plan or Strategy. This methodology has been applied and validated by each of the project partners in their own organizations.

Under this method the following contents for Green ICT Plans were defined:

- Inventory and analysis of ICT infrastructure and equipment.
- Gather of data about energy consumption and CO_2 emissions.
- Analysis of ICT policy of the organization.
- Propose Green ICT policies for the organization.
- Establish a system for monitoring energy consumption.
- Lay out Green ICT Policy Indicators.

b) Development of Green ICT Strategies or Action Plans by each of the partners.

Under the methodology and procedure mentioned above, each of the members of the LIFE project has developed its own Green ICT Action Plan or Strategy and, to do that, they have fulfilled the following steps and tasks:

- Elaboration of an inventory of ICT equipment and estimation of its energy consumption.

These inventories are intended to provide information on the size, energy efficiency, usage patterns and estimated electricity consumption of the entire ICT infrastructure of each entity. To this end, a detailed inventory of the existing ICT equipment in the organization has been carried out, considering at least the following devices:

CPU (Central Processing Unit)	UPS (Uninterruptible Power Supply)
Laptops	Servers
Tablets, Notebooks, iPads	Data Storage Cabinets
Monitors	IP Phones / Mobile Devices
Printers	Routers, Switches
Faxes	Repeaters

In conducting these inventories the following information about the above mentioned equipment, as well as about other devices that could be identified at this inventory stage, has been sought to be detailed:

- Number of devices in each category.
- Antiquity.
- Annual operating hours.
- Theoretical annual energy consumption (according to technical specifications).
- Whether the device is provided with a stand-by or total turn off system.
- Whether it has saving and energy optimization systems.
- Whether it can be completely turned off when not in use.
- Whether they have an energy efficiency labeling system such Energy Star® or any other type.
- Recyclability / presence of hazardous components.

The following table was designed to develop these inventories (see example below):

DEVICE	BRAND AND MODEL	DAILY OPERATING HOURS	OPERATIONAL CONSUMPTION (W)	SLEEP CONSUMP. (W)	OFF CONSUMP. (W)	DAILY CONSUMP. (W)	ANUAL CONSUMP. (W)	Energy Star®	ELECTRICAL CONNECTION TYPE	OBSERVATIONS
PRINTER	CANON IR-3100CN	0	1200	225	2,8	67,2	24528	NO	DIRECT UNSTABILIZED	24h. OFF Consumption
PRINTER	CANON MF4340d	24	650	9	3	852,5	311162,5	YES	DIRECT STABILIZED	1,5 hours on/day + 22,5 standby

- Analysis of the main existing ICT policies and definition of measures that make up the Green ICT Strategy or Action Plan, both in the short and the medium term, for each of the partners.

In this section, each partner has analysed patterns of operation and use of the infrastructures, ICT equipment and services of the organization, including those relevant to the implementation of a Green ICT policy. Moreover, the existing options and alternatives which are better adapted for the organization to develop a Green ICT policy have been analysed. Among the arisen issues, the following should be mentioned:

- Existence of an ICT monitoring system for energy consumption and an adequate level of detailed information (Data Centers, desks, etc.).
- Level of use of existing infrastructures and equipment on account of their potential.
- Printer use and operation policy.
- Control of switching on and off, of CPU and monitors or other devices (routers, etc.).
- Meetings Policy (videoconferences and similar).
- Recruitment, billing and document management policy.
- Telephone communications, including mobile devices.
- ICT equipment end-lifecycle policy.
- Data Center servers efficiency.
- Adequacy and operation of the Data Center cooling system.
- Adequacy of UPS devices and their operating system.
- Storage and data management policy.
- ICT procurement policy.
- Personnel policy and their involvement in ICT management, including training.
- Hosting policy.

According to the analysis carried out, each entity has established the objectives of the organization in terms of reducing energy consumption and optimizing the available equipment and the staff working time, as well as of disposing safely of the out-of-use equipment.

These objectives, together with the financial resources of the organization and a cost-benefit and Return on Investment (ROI) analysis will determine the selection of alternatives that will make up the Green ICT Action Plan of the organization.

FPNCYL and FSV's Action Plans were approved in March and January 2014 and the one designed by the Logroño City Council, in March 2015 .

The measures included in the plans are those that each partner has considered necessary, coherent and feasible to globally improve the environmental performance of its ICT infrastructure They include both measures to be developed under the LIFE Green TIC Project and others in the medium term, taking into account the available budget of each entity.

Each Plan is subject to a specific monitoring within the scope of project in order to determine the degree of compliance with its measures and their impact in reducing energy consumption and CO_2 emissions.

The measures included in the action plans of each of the partners are described as follows:

The Natural Heritage Foundation of Castilla y León

The Plan prepared by the Natural Heritage Foundation of Castilla y León includes 18 actions + 8 sub-actions. This Plan is applicable to the PRAE building in Valladolid, where the Data Center is located, and to 60 jobs, but also to the peripheral infrastructure connected with such Data Center and located throughout the region, approximately 40 centers located in rural areas within the natural protected areas network of Castilla y León. These measures are listed in the following table:

Action 1. – To incorporate all jobs into an Active Directory to ensure the CPU shutdown not only for 30% of the current equipment but for the 100%.
Action 2. – To incorporate all jobs into an **Active Directory to ensure the prohibition of changes in the CPU configuration** options for energy saving.
Action 3.1. – To incorporate or replace the existing power strips with others with a switch, raising awareness among their users about the importance of switching them off after work.
Action 3.2. – **To add a centralized control system of electronic supply** and to provide each office set to be controlled with the necessary relays.
Action 4. – To replace the existing equipment with energy-efficient devices that include **desktop virtualization.**
Action 5.1. – To review the real use, applications and data from computers that are being used by other people. Transfer them to common storage systems and review their applications to the actual jobs of their users.
Action 5.2. – To reunify the printing system by removing individual printers.
Action 6.1. – To consolidate the printing systems removing printers used by a single user.
Action 6.2. –To establish a user training policy in order to raise awareness about energy consumption caused by unnecessary printing tasks. To implement of double-side, black and white, multiple pages per sheet printing, etc.
Action 7. – To act on consumption due to standby power. This consumption can be eliminated by applying the action plans described above in 3.1 and 3.2.

Action 8. - Data Center Virtualization. This action implies a change from the current physical server infrastructure to a system of server virtualization.
Action 9.1.- FreeCooling. It would amend the current Data Center room cooling method by incorporating a *FreeCooling system.*
Action 9.2. - Solution with forced ventilation system.
Action 9.3. – To change the Data Center racks for proper cooling and heat management**.**
Action 10. - Electronic modular network: incorporation of an electronic modular network which will eliminate the current limitations of performance and capacity and will reduce the amount of power supply needed.
Action 11. - To remove unused equipment. To dispose of the equipment found unused during the inventory stage. The ERP (European Recycling Platform) guidelines, or some similar ones, will be taken as a reference.
Action 12.1. – To change the Uninterruptible Power Supply (UPS) of the current Data Center 1 for a new one.
Action 12.2. – To act on the current UPS state considering a change to sleep mode in slots in which there is no workload for the users of the building.
Action 13.1. – To centralize documentation and to establish policies aimed at eliminating external drives.
Action 13.2. – To raise users awareness on the importance of only storing the absolutely necessary data**.**
Action 14. - To generate and implement a procurement policy that requires **verification of compliance with Green standards** before purchasing decision.
Action 15. - Procurement policy that requires **verification of compliance with these standards as regards the not use or minimization of hazardous substances** before the procurement decision.
Action 16. - To generate and implement a **procurement policy that favours the renovation/expansion and prolongation of the equipment useful life** and eases recycling at the end of it.
Action 17.1. - Reuse of equipment that still has a useful life. For 90 % of current equipment, it is been taken into consideration the reuse of equipment that is no longer necessary but is still utilisable.
Action 17.2. - Collection of equipment discarded by the authorized manager.
Action 18. - To rationalise the wireless infrastructure by replacing the existing wireless equipment with other with programmable on and off hours.

The San Valero Foundation

The San Valero Group Action Plan was prepared by the staff of the entity itself through a working group in which the various training centers and areas of the Group were involved: the international area responsible for the management and coordination of the LIFE project, the ICT services transversal area, the financial area, the quality and environment area, the human resources area, the lecturers of computing at the ICT faculty and the vocational training teachers. The Plan was finally approved in January 2014 and has been monitored and discussed by the aforementioned group.

Additionally, different companies in the ICT Aragón cluster have taken part in the Action Plan. They were given the opportunity to make their own proposals and to participate in the design of measures for the development of the ICT Action Plan (ICT breakfast held on November 27, 2013 in Zaragoza, summoning the most representative companies within the sector). The Green ICT Panel of Experts from Zaragoza was established during that meeting.

Subsequent actions to those included in the initially approved Plan have been included or detailed as a result of these meetings and discussions. The updated Action Plan of the San Valero Foundation contains the following actions:

Action 1. - Review and update of the inventory of ICT equipment and devices. Renewal, applying green procurement policy, of ICT equipment. Biannual review of inventory of equipment fulfilling energy efficiency criteria.
Action 2. - Online pilot action **(virtual campus) in higher vocational training courses.** Comparative analysis of energy and paper consumption of a particular course in its online and classroom modalities.
Action 3. - Online **"virtual campus"** formative action in the **field of university undergraduate and postgraduate programmes** aimed at reducing paper and the emissions associated to its use.
Action 4. - **Reprographics and control software: ZERO PAPER POLICY.** Installation of a software that allows controlling the use of reprographic systems fulfilling Green ICT criteria.
Action 5. - To implement a software as ICT solution for multimedia collaboration. Such solutions allow online conferences, workshops, e- Learning, etc.
Action 6.- UCloud - desktop and application virtualization.
Action 7. - **On-line self-registration service.**
Action 8. - PBX phone system in software and mobile phone services.
Action 9. – Digitalisation and mailing 90% of Christmas greetings.
Action 10. - Digitalisation and publication of **institutional summaries.** 90% reduction of institutional summaries on paper by making digital versions available to the public**.**
Action 11. - Putting into operation the Dynamics AX ERP software in all entities within the San Valero Group. That is an **enterprise resource planning software to store accounting and financial documentation digitally** in order to substitute the previously used paper storage.

Action 12. - **Virtualisation of the San Valero Group personnel payroll** through ICT application, having workers direct access to pay slips without printing them.
Action 13. - Internal customer surveys made in digital format.

The Logroño City Council

The Logroño City Council has developed two types of measures, according to its objectives under the project. First, measures to enhance the effect of ICTs on the fight against climate change in different city services; and secondly, measures aimed at reducing energy consumption and CO_2 emissions in the ICT infrastructure of the local government.

Only the second type of measures are part of the LIFE project, and includes the following:

Action 1. - Remodelling the switchboard in the local Data Center.
Action 2. - Replacing CRT (Cathode Ray Tube) with LCD (Liquid Crystal Display) monitors.
Action 3. - Application of **green procurement** criteria and specifications for CPU and monitors purchase.
Action 4. - **Definition of best practices**. Advice or best practices for dissemination among the local government staff of different behaviours to be applied when using ICT.
Action 5. - ICT carbon footprint inventory in the town hall.
Action 6. - Lighting pilot project to reduce CO_2 emissions.
Action 7. - **Dissemination** of the Green ICT Project Results.

At the same time, taking into account the first type of measures proposed by the Logroño City Council was considered to be an added value for the project, as they were identified when relating the Green ICT Project Objectives to the City of Logroño Sustainable Energy Action Plan (SEAP), created within the *Covenant of Mayors* European initiative.

Thus, five specific Green ICT actions are included in the SEAP-Logroño, having each of them an individual record, being linked to the LIFE Project and incorporating its logo. The SEAP also includes a summary of the Green ICT Actions to be taken (SEAP table 54) with a description of each of them, its scope and the estimated energy and CO_2 emissions savings.

It is estimated that these five specific Green ICT actions included in the following table will save 3,463 MW per year and reduce 1,178 t CO_2 emissions.

ACTION	SCOPE	ENERGY SAVING (MWH)	EMISSIONS SAVING GHG	% EMISSION SAVINGS OF THE TOTAL CITY COUNCIL EXPENDITURE
Islallana efficient exterior lighting system	ENERGY EFFICIENCY – MUNICIPAL OFFICES	5,5	2,65	0,05%
Piqueras urbanisation and Smart control system	ENERGY EFFICIENCY – MUNICIPAL OFFICES	19,45	9,35	0,19%
Monitoring and control project to enhance energy efficiency in municipal offices	ENERGY EFFICIENCY – MUNICIPAL OFFICES	2.869,39	892,93	18,30%
SMART irrigation control system in parks and gardens of Logroño	ENERGY EFFICIENCY – MUNICIPAL OFFICES	148,00	71,19	1,45%
Installation and control of remote systems in circuit boxes for street lighting	ENERGY EFFICIENCY – STREET LIGHTING	619,12	297,79	6,10%
TOTAL		**3.463,34**	**1.178,62**	**26,09%**

c) To design the engineering of pilot actions to be developed under the LIFE project and integrated within the Strategy or Action Plan.

One of the final results of the inventory, analysis and planning stage was to help to define one of the main proposals of the Action Plans which would subsequently be developed within Pilot Actions of the LIFE Project framework.

Therefore, the degree of definition of these major proposals had to be precisely detailed at technical or engineering levels. These studies were made in April 2014 (FPNCYL), April 2015 (FSV) and February 2015 (Logroño City Council). These engineering proposals, as have been developed within the Pilot Actions of the LIFE Project framework, are specified in the relevant sections of this publication.

d) To design the CO_2 emissions monitoring system associated with pilot actions.

As a final stage of the preparation of Green ICT Action Plans, and according to the methodology described at the beginning of this section, the CO_2 monitoring system for each of the beneficiary institutions of the project has been defined.

The purpose of these monitoring systems is to obtain data on the evolution of CO_2 emissions related to ICT infrastructure and to measure the impact of the actions taken by each partner in the framework of Green ICT pilot actions and plan of action with regard to reduction of these emissions.

In order to monitor the fulfilment of objectives, an energy consumption monitoring system and a set of monitoring indicators allowing permanent evaluation of the achievements of the Green ICT policy must be established.

When monitoring energy consumption it is essential to discriminate consumption attributable to Data Centers (including cooling) from the rest of consumption, as most of it is generated in these settings. The Data Centers should also have temperature and humidity gauges.

As for the rest of consumption, it would be desirable to break down consumption corresponding to the two main blocks: desktops (CPU and monitors) and printers.

Unlike the evaluation of energy consumption made during the initial inventory stage (which was mainly based on the energy consumption detailed in the technical specifications for each device and the number of operating, stand-by and off hours estimated for each type equipment), monitoring must be based on actual measurement, by using analysers located in the Data Center switchboards or in computer equipment outlets.

The systems used to monitor the actual consumption of the ICT infrastructure in the FPNCYL and in the city of Logroño are further detailed in the Project Results section of this publication.

The basic indicators that have been proposed for such monitoring are:

- Total energy consumption of ICT equipment (kWh/year).
- Total CO_2 emissions of ICT equipment (t/year).
- Energy consumption of Data Centers (equipment) (kWh/year).
- Energy consumption of Data Centers (cooling) (kWh/year).
- Power Usage Effectiveness (PUE = Data Centers consumption/ total consumption of ICT equipment).
- Server utilization (% of potential capacity).

- Data storage utilization (% of potential capacity).
- Efficient use of equipment: total energy consumption of ICT equipment/ potential consumption according to technical specifications.
- DCiE (Data Center Infrastructure Efficiency).

3.2 Pilot Action: Virtualization in an Administrative Building

The objective of this action (B2) has been to test and demonstrate the potential that ICT infrastructure virtualization has for energy saving, as compared to conventional solutions, both in Data Centers and desktops. In first case (Data Centers) servers are virtualized, whereas in the second instance (desktops) it is the computers and monitors in each job position that are virtualized.

Virtualization is to simulate, through "virtual" machines, the existence of real physical machines (servers or PCs) with all their components and to render all necessary resources for their operation. There is usually a host software (of hypervisor or VMM type) which controls that the different virtual machines are properly addressed. A virtual machine allows to have multiple virtual computers running on the same physical computer, which means fewer hardware (real) and, consequently, energy and raw materials saving.

The scenario where the "virtualization" of ICT infrastructure pilot action has been applied is the PRAE building in Valladolid, FPNCYL's head-quarters. This foundation manages the building, including all its ICT infrastructure. The number of job positions in the building at the beginning of the project was 56, corresponding to two entities that are based there, totalling 12 servers.

In addition to this infrastructure located in the PRAE building, the Data Center also serves more than 40 peripheral centers in different provinces of the Autonomous Community of Castilla y León included in its natural protected areas network and other workplaces, often placed in remote rural areas. Therefore, the Data Center infrastructure (servers, storage disks and electronics and communication networks) is designed not only to fulfil the PRAE building needs but for all these centers.

All existing equipment in these centers is connected to the PRAE building Data Center, and its activity generates electricity consumption therein, this consumption is, therefore, included when monitoring the building. However, the energy consumption of the hardware (computers and printers) existing in each center, is part of the electricity consumption of that center and not monitored in the PRAE building consumption.

Through virtualization, the consolidation of all servers in Data Centers (Data Center 1 and 2) has been achieved, by including the 12 previously existing servers and 2 data storage cabinets, in one Data Center with 4 servers + 1 pilot server and a disks cabinet, meeting strict energy efficiency standards. Besides, part of individual computers and monitors (screens) of each workstation, has been replaced by "thin client" computers, devices without hard disk, of two types, some of them with built-in monitor (24 low consumption LED screens) and others without it (7 box).

The following tasks have been carried out when developing the pilot action for virtualizing the ICT infrastructure of the PRAE building:

• *Drafting of the Engineering Project*

The engineering project was drafted once the audit and inventory previous to the development of the Green ICT Action Plan were finished. This new project modified the initially planned technical solution, where it was proposed a virtualization model based on one Data Center and three servers. The audit and engineering project concluded that the technical solution was not possible without having to excessively oversize the Data Center, which neither would be economically feasible nor meet targets on CO_2 emission savings.

This led to redefine the solution of the Data Center, as reflected in the above mentioned "Engineering Project", in order to achieve the highest equipment efficiency, optimizing its use and capacity and reducing energy consumption and CO_2 emissions as much as possible, in addition to being flexible enough to enable future transfer of virtualization to all workplaces managed by FPNCYL and hosted in the PRAE Building Data Center.

This solution, based on the existence of a Data Center with 5 physical servers, met the need to manage a heterogeneous environment, where virtualized job positions coexist with others which are not, and where high power demand equipment, lower demanding one and homogeneous applications can also be found side by side.

Such a solution is shown in the following image:

- ***Contract of the equipment supply and its configuration***

The acquisition of the following hardware and software equipment and consumables was carried out in order to develop virtualization.

AREA	EQUIPMENT	UNITS
Data Center	Virtualization servers	4
	Pilot virtualization server	1
	Disks Storage Cabinet	1
	KVM (switch)	1
	Data Center Management Console	1
	Virtualization Switch	1
	New Electronic Network	1
	Firewall (control and security)	1
	Rack (server cabinet)	1
	UPS (power supply)	1
Job positions	All-in-one Thin Client Equipment	24
	Box Thin Client Equipment	7

Summary of the supplied software:

Software	UNITS
Hypervisor VMware License	3
Microsoft Desktop License	30
Veeam Backup Esssentials Enterprise License	2
Microsoft Windows Server Std 2012 R2 License	4

New thin client equipment in the PRAE building.

"All -in –one" model that has replaced CPU+monitor in the FPNCYL (left) and "Box" model (that only replaces CPU but keeps monitors).

New virtualized server group in the PRAE building

Tasks developed for the installation of hardware and software:

- Acquisition and installation of hardware on new rack (computer equipment cabinet).
- Installation of hypervisors (virtualization software).
- Installation of the pilot server and configuration of the virtualization servers and of their hypervisors.
- Installation of virtualization servers.
- Connection of the infrastructure to the FPNCYL's network.
- Migration of network configurations from the current server to the new computer firewall-router.
- Incorporation of the pilot server to the current active directory.
- Installation of each of the virtual machines.
- Incorporation of the existing data storage cabinet to the virtualization.
- Setting up alert systems and electronic and storage servers, adjusting the configuration in order to lower their energy consumption.
- Setting up virtual machines for tasks.
- Installation and customization of virtual machines in job positions.

3.3 Pilot Action: Virtual Campus in Educational Settings

This action, led by the San Valero Group, was aimed to demonstrate the potential for reducing CO_2 emissions by installing and testing a virtual campus for vocational training and university master courses and postgraduate programmes.

In order to achieve this, a "zero paper" policy was applied within the educational scope from the beginning of the project, replacing the traditional classroom learning system with an online one in the fields of university and vocational training.

That is the reason why all the materials commonly used in paper format have been digitised through the on-line virtual campus. Such procedure encompasses the entire training process (from the publication of courses offered, registration, formalities and the actual educational content, to the delivery of certifications).

The following measures have been taken as part of this action:

a) Virtual Campus for Official Higher Vocational Training Courses

Due to teaching schedule issues, this measure began in October 2013 as a pilot project to offer online courses within the "Filmmaking and audio-visual production" field. As online vocational training had not been yet regulated by the Aragón Regional Government, its implementation was subjected to authorization by the regional education authorities of the Government of Aragón.

During the school year 2014-2015 the online educational offer was expanded, from two to four subjects being implemented within the "Filmmaking and audio-visual production field".

43 students chose online training courses in the 2013-2014 school year and 110 students did so during 2014-2015, enabling subsequent savings on resources and energy by switching from classroom to online education.

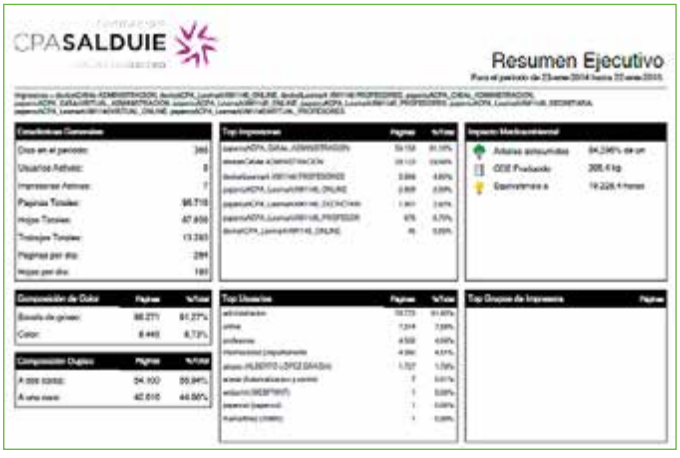
b) "Virtual Campus" for Postgraduate or University Courses

This action developed at the university level had as starting point the existence of online courses supported by delivering paper teaching and learning materials to students. This pilot action aimed at digitising 100% of these materials, achieving a significant saving of paper and eliminating the transportation, shipping and linked CO_2 emissions.

The new virtual campus, both in regard to administrative procedures (registration, etc.) and the course content management (syllabus, etc.) has been applied to 1,173 students during course year 2013/2014 and to 2,042 students during 2014/2015.

c) "PaperCut" Software for printing and copying management and control in entities under San Valero Group

The San Valero Group has implemented a service with equipment for copiers, printers and common reprographic devices containing, among its criteria, options and elements of rationalization of use, early prevention of errors and applications based on eco-sustainability and eco-efficiency (consumption, duplex printing, printing more than one page in A-4 format, etc.) managed by a software called "PaperCut". This software has been installed in all four educational entities of the group.



Once this new system for managing copies and printing policies was implemented, ICT staff within the entity was trained in order to ensure the proper use of the software. Additionally, the rest of the staff in each of the entities was trained on the correct use of printers and their new possibilities.

A picture of the executive report that the manager of each ICT area can extract from the PaperCut software at any time is shown ahead:

The person in charge of Quality and Environment requests a biannual executive summary to the ICT managers in each entity and conducts a study in order to obtain data and draw conclusions.

d) Other Actions

Other actions related to this pilot action have also been developed, such as the deployment of a multimedia collaboration software that allows reducing energy and paper consumption and therefore CO_2 emissions as well as fuel consumption due to savings on journeys to classrooms, as online courses make unnecessary the presence of students in classrooms.

The tools that have been implemented are:

- Meeting or multimedia collaboration applications (Adobe connect / Onsync).
- UCloud – Applications and desktops virtualization. Values in Annex I (ICT Inventory of equipment reduction).

3.4 Pilot Action: Environmental Management in a Smart City

The main purpose of the pilot action of the City of Logroño was focused on the installation of a network of sensors measuring parameters of air quality and noise on a main street in the center of the city. These sensors would be located on the street lighting infrastructure with LED technology to manage road traffic and street lighting in the most efficient way as regards environmental quality, health and energy saving.

The following measures have been taken to develop this action:

- ***Extension of the Data Center to support the pilot action:***

The implementation of two new servers was planned as a prior action supporting the development of the pilot action. These were acquired through a process of tender that included in its bases the green procurement criteria that had previously been identified by the City Council Computer Services.

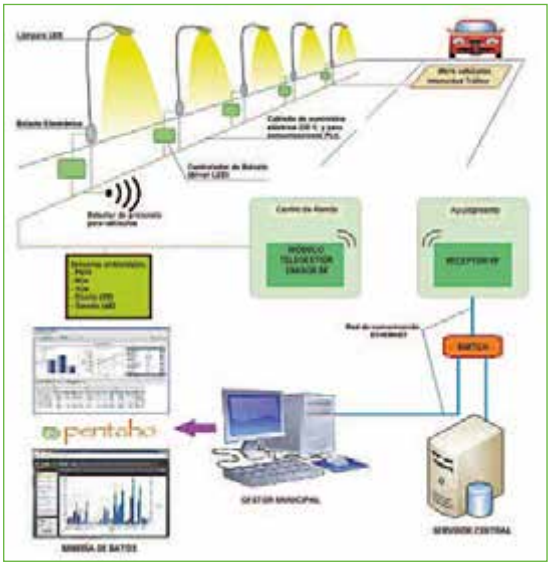
These servers support, in real time, the noise and air quality data collection system installed in the municipal lighting network. Different big data management systems were tested, in particular the "Pentaho",

as part of the municipal policy of seeking Open Source solutions. Pentaho is a set of free programs to generate business intelligence, which includes integrated data gathering, reporting, etc.

The Pentaho suite has been installed on servers to link them to the real-time data gathering made by the sensors located in a "pilot street". Additionally, a course on the utilization of Pentaho was carried out in order to train municipal employees who will have to actually use this tool.

- ***Implementation of a remote noise and air quality monitoring system in a "pilot street" with LED lighting***

The selected "pilot street" is La Paz Avenue in its section between Colón and Juan XXIII Avenues. 36 lamps were installed together with the different sensors that provide information on the following parameters: PM_{10}, NO_x, SO_2, O_3, noise (dB), traffic flow, temperature, humidity, rain and wind.



The infographic below explains the design of the pilot action:

- ***Microsite with information on environmental quality***

A microsite linked to the municipal website, www.logroño.es, has been created for citizens to access to information on environmental quality (air and noise). This can be done by clicking on a link placed next to the LIFE Green TIC Project logo in the previously mentioned home site.

The displayed parameters are: PM_{10}, NO_x, SO_2, O_3, noise (dB), temperature, humidity, rain and wind.

- ***Development of a Municipal app***

The municipal app was in operation since 2013 and provided general information about the city and 100% open data. Under the LIFE Green TIC project, parameters of air quality, noise, temperature and weather information about the city have been gradually included in it.

- ***Experimentation Stage***

Once the entire infrastructure was set up and the procedures of data gathering and processing validated, the experimental stage started in order to assess the impact that the different lighting and traffic flow management measures in the pilot street had on air quality and noise levels. Among other issues, the following were analysed during this experimental stage:

- **Effect that reducing lighting by half had on energy consumption**. This was the first scenery for multivariate alteration. Even though this is a measure that has a direct and immediate impact in energy saving, it was considered necessary to verify that it does not negatively affect other issues, such as road safety, etc.

- **Impact of the use of motion detectors on street lighting**. This stage was aimed at analysing the actual impact that street lighting activation by motion detectors had on energy consumption. The use of automation sensors in homes and buildings has already proven to save energy, but their use in street lighting is a new experience.
- **Influence of calm traffic regulation (30 km/h) on the air quality and noise parameters**. The average speed in the city center is set to 50 km/h, being recommended to reduce it to 30 km/h in certain areas due to road safety and other reasons. The project has assessed the impact of calm traffic measures on the environmental quality of the city.

3.5 Green ICT Procurement

Green procurement is a voluntary procedure whereby entities define environmental criteria including energy saving and efficiency when acquiring or contracting goods and services. It is essential to establish objective, upgradable and verifiable criteria that can be applied by the contracting bodies or departments when purchasing or outsourcing such goods and services.

The LIFE Green TIC Project was intended to contribute to identify and disseminate these criteria for those goods and services related to Information and Communication Technologies (ICT).

In order to achieve this aim, the scope of application of these criteria was defined at an early stage. All ICT equipment that might be subject to a green procurement policy was identified and it was also verified whether there were internationally recognised standards for determining the technical specifications and setting objective award criteria to be applied when contracting that equipment.

The following objective verification systems were analysed:

- International Telecommunication Union (ITU) standards.
- Energy Star® requirements.
- Ecological labelling (EU Ecolabel, Nordic Swan, Blue Angel, etc.).
- EPEAT.
- TCO Certified.
- Voluntary Declarations (ECMA)
- Other systems such as: The SNIA Emerald™ Power Efficiency or 80plus standard, Telecommunications Energy Efficiency Ratio (TEER) , Energy Efficient Ethernet (EEE) or ASHRAE Thermal Guidelines for Data Processing Environments.

Some equipment manufacturers or ICT service providers also have their own green certification systems (self-declarations), whose standards have been used as reference for research but cannot be considered as an objective verification element, since they depend on specifications from each manufacturer and have not been verified by third parties.

Since the early stages, the LIFE Project technical team has gathered information and documentation regarding green procurement of ICT equipment and devices. It included applicable legislation, standards, eco-labelling programmes, sustainable or green procurement and outsourcing guides, literature on analysis and evaluation of such systems and on their (legal, technical, etc.) use options, examples of application, best practices, and call for tenders, etc. All these preparation tasks had led to the creation of a *Green ICT Procurement Manual*, as well as tender specifications standard templates for the purchase of computers, servers and printers.

The following tasks were carried out:

a) Identification of the ICT Product Group.

The ICT are the set of resources required to search, process, store and provide or transmit information, including all equipment necessary to do so.

Given this broad concept, for the selection of ICT products, their classification was made taking into account the product subgroups for which different verification systems have set standards or criteria that may be associated with green procurement, and that encompass types of more or less homogeneous products according to their main features. These categories are the following:

Computers and the like	Personal computers, including CPU, Thin Client and laptops Monitors Keyboards Peripherals External power sources Tablets Graphics Processing Units (GPU) Workstations
Imaging and printing equipment	Printers (ink and laser) Multifunction equipment Copiers Fax Scanner
Data storage equipment	Memory cards Storage disks External hard drives Backup systems Networks Storage devices

Data Centers	Servers HVAC equipment. UPS
Electronic network	Layer 2 access switches Layer 3 / layer 2 core switches Edge routers / Ethernet service routers Multipurpose routers
Audio-visual equipment	Televisions Projectors Sound equipment DVD / video recorders Microphones and speakers Digital photo frames Digital signage Video conference equipment Interactive whiteboards
Measuring Equipment	Energy meter boxes Sensors for temperature, flow, voltage, current, pressure, humidity, etc. Software for data collection and analysis Smart power distribution units Transducers
Telephony	Mobile phones Mobile chargers Switchboards Peripherals (headsets, batteries, hands free) POE devices

b) Analysis of comparative experiences on green procurement criteria and on ecological or energy-efficient labelling for ICT products.

A benchmarking document was elaborated on the experiences of green procurement and call for national and international tenders that are considered to be most useful in line with project objectives. The information has been structured in three main blocks bearing in mind that it could also be used as a reference document in the development of subsequent tasks within this action:

- A first block where all the applicable European and Spanish legislation is compiled, together with the existing strategies and methodologies and the keys for the legal implementation of green or sustainable criteria in ICT procurement for public authorities, including the already existing verification systems (standards, eco-labelling programs, etc.).
- A second block where references to all documents dealing with guidelines and other tools for implementing green or sustainable criteria in the ICT procurement or tender are included, as existing in the EU, in the pioneer countries within this field, in some Spanish Regional

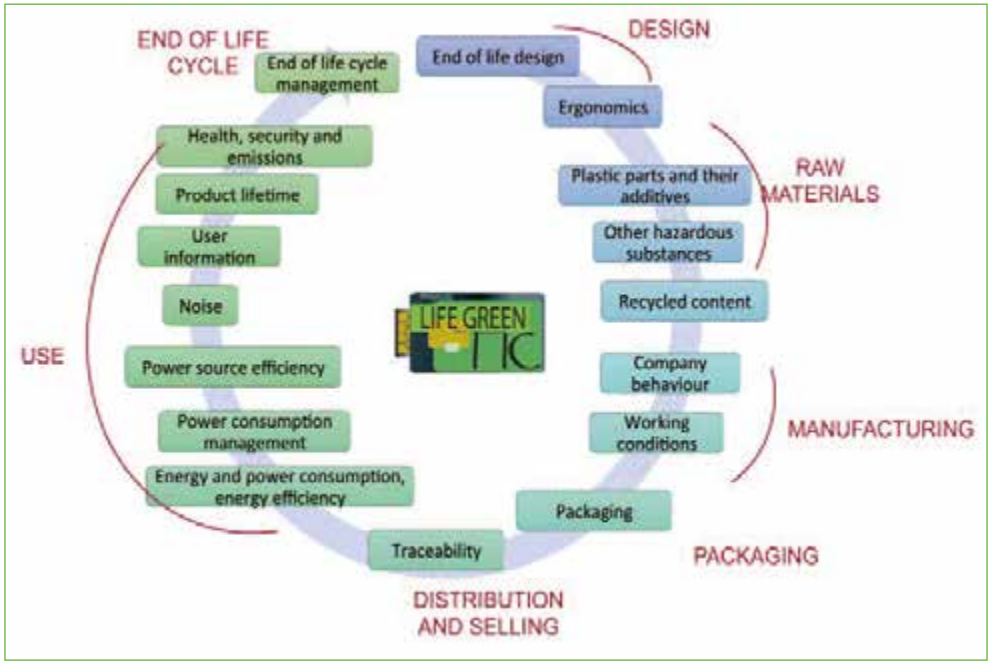
Governments and in international organizations and companies related to the ICT sector. The necessary information (web links, bibliographic references) for easy location of information is given whenever possible.

- A third block made up of the compilation and a brief explanation, of experiences, projects and examples of best practices in implementing green criteria to procurement and tender, that the project team has learnt and that are considered essential to this subject matter.

c) Development of a Green Procurement Manual for ICT Products.

A Green Procurement Manual for ICT Products has been developed based on the information gathered and the previous work done. This manual is a document with the necessary information to be taken into account by any person or entity intending to access to green or sustainability criteria when purchasing ICT equipment. It has the following structure:

- **Fundamental concepts**: the life cycle of products, eco-labelling and energy efficiency labelling schemes, applicable legislation, etc. In addition and, as part of work done when creating the guide, a set of benchmarks covering all phases of an ICT product s lifecycle have been established, as it can be seen in the following diagram:



- **Green procurement criteria for ICT product groups**: the green or sustainability criteria to be taken into account when acquiring an ICT product or group of products have been explained, as so have been the eco-labelling or energy efficiency labelling schemes that enable the possibility of verifying their compliance. The work has sought the balance between technical information and clarity

and has used some tools to make the information more understandable. Some of them are the tables summarizing criteria according to product, group of products and labelling scheme. The table related to desktop computers and similar is included below as an example:

1- Desktop computers, integrated desktop computers, thin clients/all-in-one computers, workstations	ENERGY STAR	EU ECOLABEL	TCO CERTIFIED	NORDIC ECOLABEL	BLUE ANGEL ECOLABEL
CRITERIOS DE SOSTENIBILIDAD					
ENERGY EFFICIENCY	√	√	√	√	√
POWER CONSUMPTION MANAGEMENT	√	√			
POWER SOURCE EFFICIENCY	√	√	√	√	
RESOURCE USE					
NOISE		√	√	√	√
USER INFORMATION	√	√		√	√
PRODUCT LIFETIME		√	√	√	√
HEALTH, SECURITY AND EMISSIONS			√	√	
END OF LIFE CYCLE MANAGEMENT			√	√	
END OF LIFE DESIGN		√	√	√	√
ERGONOMICS			√	√	
PLASTIC PARTS AND THEIR ADDITIVES		√	√	√	√
OTHER HAZARDOUS SUBSTANCES		√	√	√	√
RECYCLED CONTENT		√	√		
COMPANY BEHAVIOUR			√		
WORKING CONDITIONS			√	√	
PACKAGING		√	√	√	
TRACEABILITY				√	

The Green Procurement Manual for ICT Products was subjected to on-line public consultation through the project s website and social networks, as well as by delivering it to significant entities within the sector, including the project s consultation groups.

d) Tender Specifications Standard Templates for Green ICT Procurement.

Complementing the Green Procurement Manual, tender specifications standard templates have been created for three ICT product categories, with the aim of facilitating the inclusion of green clauses in common call-for-tenders procedures or in those having greater impact on environment and energy consumption, particularly computers, servers and printers.

e) Training Workshops on Green ICT Procurement.

In the months of February and March 2016 some training workshops were organized. These were addressed to public employees, ICT companies and people in charge of ICT in schools and were intended to make them aware of the application of green criteria in the procurement of ICT equipment.

In these workshops, held in Valladolid, Zaragoza, Madrid and Logroño, both the Manual and the tender specifications standard templates were presented to 133 attendees. Another workshop attended by 44 people was also organized within the framework of a Networking action with the Energy Agency of the Murcia City Council.

f) Practical Application of Green ICT Procurement Criteria by the partners.

As a complement to the above actions, the knowledge acquired has been applied by each of the project partners in the procurement of equipment planned for developing the pilot actions under the LIFE Green TIC Project, as detailed below:

The Natural Heritage Foundation of Castilla y León:

This partner established green criteria and specifications as part of the technical report draft for contracting the supply and implementation of IT equipment for virtualization (pilot action). For instance, in paragraph 2.8. of the technical report it was stated:

Energy efficiency:

- *The servers used in virtualization must fulfil the best possible features as regards energy efficiency and they must comply with or even improve the project s theoretical estimates on energy consumption (summaries of these will be included here).*
- *The power supply must have an efficiency of over 85% for a load of 10% and above 90% for a load of 20%, 50% and 100 %.*
- *The processor s frequency and voltage scaling will be dynamic.*

Manufacturing materials:

- *The maximum lead content of the materials will be less than 0.1%*
- *The maximum cadmium content of the materials will be less than 0.01%*

San Valero Foundation

The incorporation of San Valero Foundation to the Expert Group on Cross-sectional Environment Area guarantees the principle of "Green Procurement" throughout the whole project as well as its inclusion into the procurement policy of the San Valero Group on a permanent basis.

The ongoing review of Green ICT Action Plan includes green procurement criteria to be followed by the staff in charge of ICT procurement, environmental policy SCR, the financial department and the managers of each of the Group entities.

Additionally, these green procurement criteria have been disseminated among all staff in order to raise awareness and to apply it when making any investment on ICT.

The Logroño City Council

The Council defined a first set of green procurement criteria and applied them as a practical experience to the purchase of two servers that are part of its Pilot Action B4 (March 2014), serving as a reference for future studies, such as:

- Energy Star® (power supply efficiency, ability to limit the server s maximum power consumption, variable speed fan, available low-power states, and dynamic CPU frequency and voltage scaling).
- Manufacturing materials (by means of an Eco-Declaration).
- Design and lifecycle (ease of recycling, parts availability, modular expansion possibilities).

3.6 Best Environmental Practices in the Use of ICT

The objective of this action has been the identification and dissemination of best practices for energy savings in the use of ICT, mainly aimed at reducing the carbon footprint of such use. The following work has been developed in the context of this action:

a) Good practices for more sustainable use of ICT

During the first months of the project, good practices for sustainable use of ICT was identified, that is to say, those attitudes, habits and possibilities related to the use of ICT that seek to minimize the possible environmental and social negative impact of ICT.

The actions detailed below were carried out in this line:

- ***Review of literature, database and expertise on best practices in the use of ICT***

As a preliminary step, a comprehensive literature review was conducted. The existing referential guides and documents published by every kind of institutions and entities having the objective of promoting sustainable use of ICT were examined. This work was carried out by the end of the year 2013. Nevertheless, the gathering of information continued throughout the whole project.

Among others, we have identified the following guidelines, documents and references, many of them from projects funded by the EU, including Spanish initiatives, initiatives from other EU states and third countries, from both public and private organizations, and from ICT companies:

- EFFORTS Project. SAVE European Programme. Best Practices Manual for the use of office equipment (Institute for Diversification and Saving of Energy – IDAE by its Spanish acronym).
- Equalmultiplica Project (CTIC Foundation - Technology Center of Asturias).
- PymeVerde –GreenSMEs– Project: Sustainability and Environmental Management in Technological SMEs.
- Guide for Energy Saving in the Office (WWF).

- Best practices for reducing GHG emissions in ICT companies (ASCENTIC).
- Green Office Guide. Government of Australia.
- Green ICT Guide. GeSCI.
- Best practices from GreenITWeek.
- Environmental Protection Agency (EPA) Best Practices.
- Code of Practices for Green ICT (CEPIS).
- Best Practices in Green Data Centers (ITU).
- Specific recommendations from equipment and devices manufacturers.
- GREENIT.NET.
- ENERTIC Reference Guides.
- ETICS – CONETIC.
- NICE Project - The Green Digital Charter.

• *Development of a questionnaire about errors and bad practices*

With the basic information previously gathered, the Natural Heritage Foundation of Castilla y León team designed a questionnaire to identify the most common errors, as well as best practices in the use of ICT in order to provide a more reliable picture of reality and help to complete this work of identifying the best practices in this matter.

The survey classified the possible best practices and errors in two large blocks, differentiating (at this stage) between ICT managers and users. Within each of these blocks a series of questions about behavioural habits, ICT infrastructure design, management, etc., were set and grouped according to specific equipment or functions (such as data storage and user awareness and equipment such as printers, Data Centers, computers, mobile phones, etc.).

Once identified the most common errors and bad practices in the use of ICT equipment and devices, the team decided that it was more coherent to just focus on users.

• *Elaboration of a Best Practices Guide for ICT Users*

The results of the previous work have contributed to the development of a "Best Environmental Practices Guide for ICT Users", which contains various recommendations for them to make a more intelligent and responsible use of different equipment and devices, reducing energy consumption, prolonging their lifecycle and, consequently, reducing their carbon footprint.

60 good practices have been identified and are of application for the categories below:

- Computers and monitors (13)
- Smarthphones, Tablets and the like (23)
- Printing and Imaging Equipment (15)
- Information management, emails, etc. (9)

Example on monitors:

Monitors	
Recommended Practice	**Justification**
To decrease the brightness of the monitor screen	To reduce the screen brightness reduces energy consumption. It is estimated that 15-20% of energy can be saved by adjusting the screen brightness to medium. Laptops tend to reduce brightness when working with the battery instead of plugged in, up to 40% of energy can be saved this way. Another complementary option to brightness reduction is choosing images with dark colours as desktop wallpaper. It is estimated that a dark page on display consumes 25 % less energy.

- ***Informative Infographics***

In order to strengthen the dissemination of best practices, four infographics summarizing the messages and main recommendations stated in the Best Practices Guide have been developed, as this is considered to be a highly effective tool for spreading information through social networking.

These infographics correspond to each of the four sections of this guide and have been disseminated through the project s blog, Twitter account and Facebook profile.

They have also been made available to any entity that wishes to use them to raise awareness of these issues among their employees or partners. These infographics were distributed by the Castilla y León Regional Government to more than 18,000 public employees, having this action the greatest impact regarding dissemination.

b) Success stories and experiences of using ICT for environmental management and the fight against climate change.

Secondly (albeit both tasks were temporarily carried out in a parallel way), "success stories" of using ICT for environmental management and the fight against climate change were identified and a catalogue compiling some of the most representative objectives of the LIFE Green TIC Project was created.

To this end, a campaign disseminating the tasks was carried out and ICT and environmental companies and entities as well as other European Projects (especially LIFE Projects) were contacted with the aim of publicizing and sharing their activities related to Green ICT. A section on "Ideas and Best Practices" was enabled within the Project s Blog "MiHuellaTIC" (My ICT Footprint) as a platform for dissemination of this information and to shape the aforementioned catalogue.

In addition to searching online, numerous entities were directly contacted in order to gather further information about their best practices, some of the interviews conducted were later published in the blog.

These best practices are being disseminated through the project s social networks (MiHuellaTIC blog and the Green TIC Facebook profile), there is also a specific section of the blog where all these Green ICT success stories, projects and experiences can be looked up.

65 success stories have been identified, 40 of which are published in the project s blog, including descriptive information about them. 7 of these projects belong to the LIFE Programme.

3.7 Participation and ICT environmental management Lab

This action aimed at creating a "laboratory" based on the use of social networks to promote ideas and open solutions for entrepreneurs, students and ICT users. These ideas will contribute to the improvement of management, information and participation within the environmental field through the following:

- Use of participatory methodology: designing a participatory tool for all stakeholders based on the use of ICT (blog and social networkd in this case) within the scope of co-creation and validation of innovative solutions.
- Promotion of ideas of entrepreneurs that can help to generate new environmental ICT products and services.
- Support for entrepreneurs in the exchange of experience and implementation of ideas.

The specific tasks below have been develop as part of this action:

a) Creation of laboratory spaces in social networks

Three specific tools having an impact in social networks (Internet) have been used to give support to participation in the laboratory: creating a blog, a Facebook profile and a Twitter account.

To identify this laboratory and all the above mentioned tools, the identifying term "**My ICT Footprint**" ("**Mi Huella TIC**" in Spanish) was coined in reference to the main objective of the project, reducing the carbon footprint of the use of ICT.

All this information can be found in the following websites:

- Blog: http://mihuellatic.lifegreentic.eu/
- Facebook: www.facebook.com/MiHuellaTIC
- Twitter: @lifegreentic

b) Creation and implementation of the Green ICT virtual community.

In order to publicize the created laboratory and to educate a "Green ICT" community, different initiatives were developed following the Project s Work Plan and adapting to other activities and milestones of the LIFE project:

- ***My ICT Footprint Photo Contest***

In a first stage a photo contest was launched through social networks. 73 photos from 46 different participants were received. The presentation and dissemination of this competition during April and May 2014 generated traffic in social networks and gave place to a progressive increase in the number of the Project s followers and users that has continued to grow.

At the same time, the contest provided the project partners with a bank of original and good quality images that are representative of the Green ICT idea. These images are also proving to be very useful for illustrating documents and communication and dissemination materials (such as press releases, web news, etc.).

(Finalist pictures. Authors from left to right and from top to bottom: Adolfo Domínguez, prr2427, Francisco Luis, Tomas Castro, Francisco Luis)

- ***Viralization on social networks of the LIFE Green TIC Project***

Once the photo contest finished, the social networks' community had already been created. The next stage of the work was promoting close coordination between the laboratory and the different tasks developed through other actions under the LIFE Project, with the aim of encouraging the participation of this community in the different events organized, the consolidation of the laboratory and the steady increase of the number of followers.

Participation has been significant in the following events: Green Week 2014, National Environmental Congress (CONAMA, by its Spanish acronym), MATELEC Fair, Smart Cities Congress, Environmental Education and Communication Congress, the Hack4Good day, etc.

The social media followers resulting from these activities are:

- Monthly visits to blog: 550
- Followers on Facebook : 538
- Followers on Twitter : 950

In addition to these figures, the activity generated through social media has also been important, as numerous post have been published in the blog and social networks, being their content very well received by users and followers.

c) Generation of Green ICT ideas, projects and actions by the Virtual Community.

After more than a year of publications, posts and dissemination of activities related to the project, the Laboratory completed its development with a final event called "Green ICT Competition - Entrepreneurs" an action that, from the very beginning, was considered essential to accomplish one of the main objectives of the laboratory: to get ideas and proposals from young students and entrepreneurs to achieve a more efficient use of ICT and to put ICT at the service of environmental management and information.

The rules of the competition were made public when it was launched on 5th February 2015. Three possible participation categories were established:

- Projects, executed or planned technical proposals, such as innovative ICT tools (software, applications, web pages, apps, etc.) or research on the impact of ICT on climate change and its economic effects.
- Actions, such as campaigns or commitments to run a campaign, whether already carried out or planned, for instance, campaigns or plans for Green ICT action in education, business, etc. Disseminating or information activities on Green ICT and the relation between environment and ICT, elements for publicizing, etc.
- Ideas stating innovative proposals to reduce the ecological footprint of ICTs or how to use them to improve the environment.

These projects, ideas or actions could be approached from three perspectives:

- Those aimed at reducing the ICT ecological footprint by extending the equipment, devices and batteries working life and contributing to their reuse or recycling in order to reduce energy consumption or the consumption of certain raw materials for manufacturing devices, etc. These ideas could refer to both the design, the production, the use and the end of the ICT devices life cycle.
- Those that allow combat the adverse environmental impacts (such as climate change) through ICT solutions: services, software or applications that help reduce the ecological footprint or carbon footprint in sectors such as construction, transportation, industry, agriculture, tourism , administration, working methods and consumption.
- Those that allow the use of ICT as tools for managing environmental information so that citizens, students or educational community have easier access to it and, as a result, their degree of participation in the environmental protection improves. Services, software or applications that help to achieve these objectives were searched for.

A jury was formed by one representative from each of the project partners (The Natural Heritage Foundation of Castilla y León, the San Valero Foundation and the Logroño City Council) plus a representative of the Spanish Association of Computer Technicians (ATI by its Spanish acronym). The project coordinator was the president of that jury.

The criteria for evaluating the submitted proposals were: quality, originality, definition of the proposal (clarity and detail), range of Green ICT criteria applied, way of addressing the actual environmental problem, impact in terms of potential beneficiaries or recipients, impact on reduction of emissions, degree of transfer of the proposal and potential for commercial development (if any) .

The following figures summarize the results of participation in the competition:

- 40 participating teams.
- About 150 young people (under 30 years), forming part of such teams.
- Different origins within the national territory: Castilla y León, Madrid, Aragón and Cataluña.
- 98 proposals, 18 of which were projects, 13 actions and 67 shared ideas (the competition allowed participation in three different categories depending on the scope of the proposal).

Once each proposal had been assessed by the jury, 5 finalists in each category were chosen. This process ended on 15th May 2015. All the finalists were summoned to present their proposal in a final event held in the afternoon of the 27th May in the headquarters of the Natural Heritage Foundation of Castilla y León, in the PRAE building in Valladolid.

This proposals were then presented to companies and technology centers belonging to the fields of ICT and environment. A networking was establish between them, trying to connect education-business and administration in search of experiences and alliances for possible development of proposals.

The event was attended by authorities from the University of Valladolid, the General Director of Telecommunications of the Castilla y León Regional Government and the Association of Information and Communication Technologies' Companies of Castilla y León, as well as the finalists of the competition and the project partners.

Two moments of the final event held in Valladolid on 27th May 2015
(Left: networking companies-teams; right: awards ceremony).

The winners of the competition were:

- **Best Project**: the Blueberry Car Connect by the Greenficient team of the University of Valladolid was awarded 3,000€ to the

best project. It is a driving monitoring system that allows to control parameters and compete with other users in a more efficient, less intensive in emissions, driving.

- **Best action**: "Tu Guiño TIC" action by the CRITIC team (young entrepreneurs from Salamanca) was awarded 1,500€ to their educational campaign, consisting of numerous activities and materials, that seeks to publicize the Green ICT concepts to students.
- **Best idea**: Eco-Footprint Scan (Eco-Huella Scan in Spanish) an app for mobile devices by the Eco-Huella team was awarded 500€ to the best idea according to the jury. This application would allow to visualize information on the environmental behaviour of any product by scanning its code bar or other codes, helping to promote green procurement in every sector. The Mooby idea by the Greenficient team was awarded a second prize of 500€ to the best idea according to social networks followers, the Audience Award. This idea proposed to develop a social GPS app that would boost ecological and collaborative mobility, providing actual data on the environmental impact of the user s means of transport.

Participants have demonstrated that the integration of green criteria in the use of ICT and the use of ICT to reduce the carbon footprint of human activity is possible even though most citizens are not very aware of it, proving that there is a huge amount of work to be done in that field.

However, as a result of this competition, there are many students, entrepreneurs, companies, technology centers and other entities that have had their first contact with the Green ICT concepts and that will be, from now on, part of the Green ICT community and directly involved in the dissemination of these concepts.

4

THE PROJECT RESULTS

4 The Project Results

As it has already been mentioned, the main objective of the project was to demonstrate the potential that a responsible and intelligent use of ICT has for reducing CO_2 emissions.

From this perspective, the project results have been measured primarily in terms of impact on energy and raw materials saving as a result of better use of information and communications technologies and its equivalence in reducing CO_2 emissions and mitigating climate change.

To analyse these results, specific methodologies for monitoring the impact of the actions developed within the LIFE Green TIC project were defined, especially in the context of pilot actions and Green ICT action plans developed by each project partner.

Thus, the impact of the project has been monitored through the application of the following parameters by each partner depending on the type of actions that each of them has carried out.

- Electricity consumption of the ICT infrastructure.
- Paper consumption when applying paper-less, e-administration and virtual campus policies.
- Fuel consumption saving per displacements avoided by the virtual campus

The methodology for monitoring impacts and results of the project actions in reducing CO_2 emissions has been adapted to each type of action developed, establishing two different systems:

1. A methodology based on actual measurements of energy and paper consumption, mainly applied to actions in ICT infrastructure and in the offices of the Natural Heritage Foundation of Castilla y León and of the Logroño City Council.
2. A methodology based on the assessment of the lifecycle of a student in a school classroom versus the lifecycle of a student in a virtual campus. This has been specifically applied to the pilot action developed by the San Valero Foundation.

Following the implementation of the different actions in the framework of the LIFE Green TIC project and the applying of these methodologies, the results in the table below have been reached:

Emissions reduction (t CO_2 eq)	FPNCYL	Logroño	FSV	Total
electricity	-13,00	-11,93	-62,23	-87,16
paper	-0,19	-39,00	-73,50	-112,69
fuel-oil			-18,22	-18,22
total per partner	-13,19	-50,93	-153,94	-218,06
TOTAL LIFE Green TIC project			-218,06	

Indicators of results, project LIFE 12/ENV/ES/000222 GREEN TIC							
consumption indicator	Units	baseline	year 1	year 2	year 1 saving	year 2 saving	Total savings
ICT electricity FPNCYL	kWh/year	59.120,00	40.620,00	40.480,00	-18.500,00	-18.640,00	-37.140,00
ICT electricity Logroño	kWh/year	290.879,00	290.879,00	280.000,00	0,00	-10.879,00	-10.879,00
ICT electricity FSV	kWh/year	1.044.479,00	995.154,00	980.134,00	-49.325,00	-64.345,00	-113.670,00
LED electricity Logroño	kWh/year	116.027,00	116.027,00	92.813,00	0,00	-23.214,00	-23.214,00
FSV's classrooms - electricity	kWh/year	48.979,00	30.959,00	2.881,00	-18.020,00	-46.098,00	-64.118,00
direct paper FPNCYL	t/year	0,51	0,46	0,46	-0,05	-0,05	-0,11
direct paper Logroño	t/year	34,00	24,00	24,00	-10,00	-10,00	-20,00
direct paper FSV	t/year	9,67	7,69	7,55	-1,98	-2,12	-4,10
indirect paper FSV	t/year	13,95	6,04	0,03	-7,91	-13,92	-21,83
fuel-oil FSV	l/year	5.600,00	4.208,00	2.082,00	-1.392,00	-3.518,00	-4.910,00

CO_2 emissions	Units	baseline	year 1	year 2	year 1 saving	year 2 saving	Total savings
ICT electricity FPNCYL	t CO_2 eq	20,69	14,22	14,17	-6,48	-6,52	-13,00
ICT electricity Logroño	t CO_2 eq	101,81	101,81	98,00	0,00	-3,81	-3,81
ICT electricity FSV	t CO_2 eq	365,57	348,30	343,05	-17,26	-22,52	-39,78
LED electricity Logroño	t CO_2 eq	40,61	40,61	32,48	0,00	-8,12	-8,12
FSV's classrooms - electricity	t CO_2 eq	17,14	10,84	1,01	-6,31	-16,13	-22,44
direct paper FPNCYL	t CO_2 eq	0,93	0,83	0,83	-0,10	-0,10	-0,19
direct paper Logroño	t CO_2 eq	66,30	46,80	46,80	-19,50	-19,50	-39,00
direct paper FSV	t CO_2 eq	18,86	15,00	14,72	-3,86	-4,13	-8,00
indirect paper FSV	t CO_2 eq	41,85	18,12	0,08	-23,73	-41,77	-65,50
fuel-oil FSV	t CO_2 eq	20,78	15,61	7,72	-5,16	-13,05	-18,22
Total reduction CO_2	t CO_2 eq	694,53	612,13	558,86	-82,40	-135,67	-218,06

The application of these methodologies in each of the partners of the project has been developed as detailed below:

4.1 Monitoring and Results in the Natural Heritage Foundation of Castilla y León

In order to calculate the baseline year, data on energy consumption of the ICT infrastructure in the PRAE building were taken into consideration. These data were available through the existing general monitoring system, which had a scanner in the UPS electrical panel. These data were compared with other measurements done using portable equipment installed in 24-hour minimum periods, as well as with consumption estimates made during the audit and inventory stages, based on the technical specifications of the equipment, its use in different modes (on, stand-by, off) and the estimated operating time measures in each mode.

The existing consumption records of the UPS electrical panel were analysed by adding data values that were unmonitored, as they were not connected to the previously mentioned panel. This was carried out by using estimates of consumption of the Data Center air conditioning system, consumption data of printers that were not connected to the UPS panel, and the UPS equipment's own losses.

Energy consumption of ICT infrastructure (baseline year 2014): 59,120 kWh.

OUTPUT INDICATORS - ACTION PLAN IMPLEMENTATION IN FPNCYL

SCOPE: PRAE (Headquarters of Fundación Patrimonio Natural de Castilla y León)

DATE		ELECTRIC CONSUMPTION (kWh)				PUE (Power Usage Effectiven	CO_2 emissions due to total ICT energy consumption (kg CO_2/kWh)
YEAR	MONTH	TOTAL ICT infrastructure	DATA CENTRES		DESKTOPS	CPD consumption/Total ICT devices consumption	
			SERVERS	COOLING			
2014	JANUARY	5.584	1.683	220	3.381	1,309025322	1.954,30
	FEBRUARY	4.606	1.658	210	2.438	1,307621782	1.612,06
	MARCH	4.660	1.606	220	2.534	1,323785803	1.631,00
	APRIL	4.216	1.574	212	2.130	1,325285896	1.475,60
	MAY	4.361	1.603	183	2.275	1,301116656	1.526,24
	JUNE	4.854	1.571	180	2.803	1,305595162	1.698,93
	JULY	5.030	1.575	206	2.949	1,321365079	1.760,55
	AUGUST	4.885	1.532	170	2.883	1,306873368	1.709,80
	SEPTEMBER	4.866	1.495	154	2.917	1,30348495	1.703,00
	OCTOBER	5.308	1.530	151	3.327	1,29454902	1.857,68
	NOVEMBER	5.346	1.570	226	3.250	1,335025478	1.871,10
	DECEMBER	5.405	1.620	235	3.250	1,330246914	1.891,75
	TOTAL 2014	59.120	19.017	2.366	34.137	1,313748154	20.692,00

Monitoring:

During preliminary study of the ICT infrastructure in the PRAE building, made in order to implement the Green ICT Action Plan (Action B1), the limitations of the existing system were revealed. These limitations brought about difficulties for proper monitoring of electricity consumption and for getting appropriate parameters to measure the energy saving results obtained with the implementation of the pilot action.

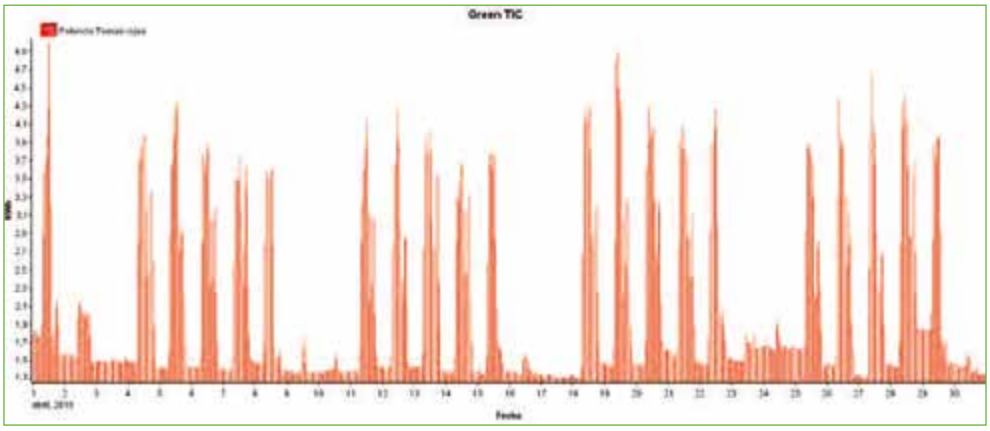
Among these limitations, the following can be mentioned:

- The system could not automatically obtain basic indicators for the monitoring of the project (CO_2 emissions and Power Usage Effectiveness-PUE).
- Various elements of the Data Center were not monitored or manual counters were reading them (air conditioning on Data Center 1, loss of UPS, servers on Data Center 2, etc.). Its automated connection recommended a software change.

The Action Plan (B1) concluded the need for further reform of the on-line monitoring system to provide more information on the energy efficiency measures implemented. Therefore, a new Scada Circutor software was hired, the electrical panel was reconfigured and EDS and analysers were installed.

This new system corrected the deficiencies of the existing one mentioned above, integrating all the necessary parameters and automatically calculating the Power Usage Effectiveness (PUE) of the Data Center and the CO_2 emissions.

New meters, some information processors (EDS-Circutor web server) and a software managing the entire system (Scada) have been installed. This allows the consultation of online data in real time and the generation of graphs and reports for each section of ICT consumption within the building.



Energy consumption of the virtualized ICT infrastructure (2015):

OUTPUT INDICATORS - ACTION PLAN IMPLEMENTATION IN FPNCYL

SCOPE: PRAE (Headquarters of Fundación Patrimonio Natural de Castilla y León)

DATE		ELECTRIC CONSUMPTION (kWh)				PUE (Power Usage Effectiven	CO_2 emissions due to total ICT energy consumption (kg CO_2/kWh)
YEAR	MONTH	TOTAL ICT infrastructure	DATA CENTRES		DESKTOPS	CPD consumption/Total ICT devices consumption	
			SERVERS	COOLING			
2015	JANUARY	3.950	1.200	300	2.200	1,206896552	1.382,50
	FEBRUARY	3.950	1.200	300	2.200	1,206896552	1.382,50
	MARCH	3.952	1.082	278	2.306	1,202901198	1.383,06
	APRIL	3.926	1.073	274	2.175	1,185503419	1.374,10
	MAY	3.580	1.096	278	1.772	1,181699346	1.253,00
	JUNE	3.405	1.158	306	1.510	1,192573946	1.191,75
	JULY	3.699	1.287	515	1.406	1,289651294	1.294,65
	AUGUST	3.393	1.201	472	1.279	1,287454324	1.187,55
	SEPTEMBER	3.592	1.170	241	1.579	1,136004515	1.257,20
	OCTOBER	3.783	1.233	239	1.634	1,12513089	1.324,05
	NOVEMBER	3.486	1.135	340	1.313	1,185488271	1.220,10
	DECEMBER	3.420	1.193	336	1.177	1,176192973	1.197,00
	TOTAL 2015	44.136	14.028	3.879	20.551	1,196821321	15.447,46

With the data available after the implementation of the virtualized infrastructure (pilot action) both in the Data Center and the deskstops, and the adoption of additional measures of the Action Plan (Green ICT Strategy), the following energy savings have been achieved:

Action	Energy Saving (*)	CO_2 Emissions reduction (tonnes) (*)
Virtualization of Data Center	4.989 kWh	1,75 t
Desktop Virtualization	5.800 kWh	2,03 t
Printers	3.000 kWh	1,05 t
Green ICT Action Plan	4.786 kWh	1,68 t
Total	**18.575 kWh**	**6,51 t**

(*) An*nual saving*

The total annual savings due to the LIFE Green TIC project implementation have reached 18,575 kWh once all actions are finished. Nevertheless, during the project development, part of the achieved savings have been neutralized as a result of the UPS system performance loss as well as an increase of 3,520 kWh in its consumption. All these was caused by the proximity of the UPS batteries' end of life.

4.2 Monitoring and results in San Valero Foundation

In the case of the San Valero Foundation, given the specificity of its pilot action, a particular methodology for monitoring results has been defined and adapted to the two main axes of the action itself: the virtual campus and the implementation of a zero paper policy.

The first target when performing this monitoring was to establish the baseline of consumption for different parameters (paper, electricity, oil) and also of their CO_2 emissions. Additionally, other variables were analysed, such as those related to the impact that changing from classroom to on-line learning had on transport and, hence, on environment.

Monitoring of Virtual Campus

This is about analysing the impact and results that the virtualization of education within the university field and the change from classroom to online training in the schools and colleges of the San Valero Group had on reducing energy and paper consumption and its consequent reduction in CO_2 emissions.

The methodology for monitoring the results of changing from classroom to online education has followed the stages explained below:

- Contrast of processes involved in classroom education with those related to online education within the school or college.
- Definition of the common indicators resulting from the incorporation of ICT actions.
- Comparative analysis of indicators at unit level and volume of processing whole processes or threads.
- Calculation of savings and resulting impacts by applying coefficients to oil consumption, energy consumption and saving paper at a unit level in order to establish a reliable comparison.

The methodology developed specifically for the project evaluates the lifecycle of education when switching from classroom to online and, in particular, its effect on the processes detailed below:

- Process of student recruitment and course catalogue advertising.
- Advisory and commercial tasks (service received from staff).
- Management and registration tasks.
- Teaching and tutoring tasks.
- Students care service and student course completion tasks.

The following parameters have been taken into account when monitoring the digitization of virtual campus in the university:

- Comparison of the processes of printing and mailing materials with the process of digitizing them.
- Definition of the common indicators resulting from the incorporation of ICT.
- Comparative analysis of indicators at unit level and volume of processing whole processes or threads.
- Calculation of savings and resulting impacts by saving paper and reducing CO_2 emissions.

Therefore, the following items have been monitored:

- Printing orders in administration.
- Registration forms.
- Printing of educational syllabuses.
- Shipment (transport).

As regards the results of its implementation, "Virtual Campus" is monitored through a global planning management system (Intranet Enterprise Resource Planning–ERP).

The complexity of the lifecycle assessment carried out, determined factors such as the indirect emissions generated by the student when printing himself digital materials at home, or the increased use of computer equipment by students at home, to be considered when presenting the final results. In order to take these issues into account, a survey was done to participating students.

The energy and paper consumption was calculated during two school years (2014/2015 and 2015/2016), affecting a different number of students:

School year	Vocational Training Number of Students	University Number of Students
2013/2014	43	1.179
2014/2015	110	2.042

Calculation of energy consumption and CO_2 emissions for classroom education and paper-based management during the academic year 2014-2015 and savings achieved by implementing on-line education/virtual campus.

a) For the switch of Higher Vocational Training Courses from classroom to online:

AREA	PROCESS	Indicator type	TOTAL CLASSROOM EDUCATION (2014/2015) number of students	Total average paper consumption (kg)	Total average fuel-oil consumption (l)	Total average energy consumption (kWh)	Total costs (euros)
Publicity	leaflets, documents	paper savings	110	0,54780		-	132,00 €
Publicity	offline events	CO_2 emissions	110	0,548	23,084	-	3.681,70 €
Publicity	open doors day	CO_2 emissions	110	0,548	41,336	-	7.001,00 €
commercial	centre's visit	CO_2 emissions	110	-	7,755	-	6.908,00 €
commercial	brochures, posters	paper savings	110	0,55	-	-	2.425,50 €
commercial	pre-registration form	paper savings	110	1,10	-	-	1.342,00 €
commercial	aditional documents	paper savings	110	-	-	-	0,00 €
administration	student documents required	paper savings	110	-	-	-	572,00 €
administration	registration form	paper savings	110	2,19	-	-	572,00 €
administration	certificates	paper savings	110	0,50	-	-	723,80 €
administration	registration process	paper savings	110	1,10	-	-	616,00 €
Teaching	books and syllabus	paper savings	120	657,38	-	-	3.500,00 €
Teaching	classrooms and equipment	Energy consumption	110	-	-	48979,25	8.585,80 €
Teaching	classes / tutorials	CO_2 emissions	110	-	3974,685	-	162.925,17 €
Teaching	calls	CO_2 emissions	110	-	0,000	-	5.725,01 €
Teaching	exams	CO_2 emissions	110	26,299	93,530	-	5.725,01 €
Teaching	evaluation and diplomas	paper savings	120	1,10	-	-	880,00 €
Students assistance	academic records	paper savings	110	0,55	-	-	414,15 €
	GLOBAL TOTAL (110 students)			692,44	4.140,36	48.979,25	212.136,78 €
				Kg	Litres	kWh	Euros

	ALUMNOS	Kg	Litres	Kw/h	Euros
AHORRO TOTAL	110	668,15	3957,57	46.098,13	110.890,93 €
	For 110 students switching from classroom to online education				

b) In the case of University Education:

AREA	PROCESS	Indicator type	TOTAL ONLINE EDUCATION (2014/2015) number of students	Total average paper consumption (kg)	Total average fuel-oil consumption (l)	Total average energy consumption (kWh)	Total costs (euros)
Publicity	leaflets, documents	paper savings	110	0,00000	-	-	0,00 €
Publicity	offline events	CO_2 emissions	110	-	0,00000	-	0,00 €
Publicity	open doors day	CO_2 emissions	110	-	0,00000	-	0,00 €
commercial	centre's visit	CO_2 emissions	110	-	0,00000	-	0,00 €
commercial	brochures, posters	paper savings	110	0,00000	-	-	0,00 €
commercial	pre-registration form	paper savings	110	0,00000	-	-	337,98 €
commercial	aditional documents	paper savings	110	0,00000	-	-	337,98 €
administration	student documents required	paper savings	110	0,00000	-	-	304,15 €
administration	registration form	paper savings	110	0,00000	-	-	304,15 €
administration	certificates	paper savings	110	0,00000	-	-	20,28 €
administration	registration process	paper savings	110	0,00000	-	-	570,28 €
Teaching	books and syllabus	paper savings	110	0,00000	-	-	443,30 €
Teaching	classrooms and equipment	Energy consumption	110	-	-	2681,13	505,05 €
Teaching	classes / tutorials	CO_2 emissions	110	-	1981,38140	-	71.210,15 €
Teaching	calls	CO_2 emissions	110	-	0,00000	-	220,00 €
Teaching	exams	CO_2 emissions	110	26,29440	101,60930	-	26.840,01 €
Teaching	evaluation and diplomas	paper savings	110	0,00000	-	-	110,00 €
Students assistance	academic records	paper savings	110	0,00000	-	-	27,50 €
	GLOBAL TOTAL (110 students)			26,29	2.082,99	2.681,13	101.235,81 €
				Kg	Litres	Kw/h	Euros

PAPER SILLABUS IN UCAV						
AREA	PROCESS	INDICATOR TYPE	students	total average paper consumption (kg)	Total average fuel-oil consumption (l)	Total costs (euros)
Administration	printing orders	paper saving	2042	20,34	-	8.096,53 €
Administration	registration forms	paper saving	2042	152,54	-	35.316,39 €
Printing	syllabuses printing	paper saving	2042	13.087,99	-	128.771,67 €
Shipment	courier service	CO_2 emissions	2042	-	872,65	12.252,00 €
GLOBAL TOTALS:				13.260,87 Kg	872,65 Litres	184.436,59 € Euros

	STUDENTS	Kg paper	Fuel-oil litres	Euros
AHORRO TOTAL:	2042	13.260,87	872,65	184.436,59 €
For 2042 students with digital syllabuses				

4.3 Monitoring and results in the Logroño City Council

The following procedure has been designed to monitor the energy consumption of the ICT infrastructure in the Logroño City Council:

- Air conditioning and lighting consumption of the Data Center are obtained by direct measurement with a network analyser placed in the server room (isolated room). The consumption of air conditioning and lighting for the rest of the computing department, is estimated to be 1.5 times the air conditioning consumption of the server room.
- The consumption of the ICT equipment (desktop of informatics department) in the Data Center is obtained by direct measurement of a number of devices and subsequent extrapolation number.
- The servers' consumption is obtained by subtracting the consumption of personnel equipment (desktop of informatics department) of the Data Center to the total consumption of ICT equipment in the building.

Energy Consumption Analysers in Logroño City Council

Thus, data are available for 2015, the year monitoring was started. In the case of network analysers, actual measured data are available from the month of February 2015. In the case of single-phase meters (individual consumption in ICT equipment), there are real data measured from the month of April. There are no measurements made of individual equipment during the months of January and February 2015, so the valuation of consumption has been made by using estimates depending on the working days of the month in question, according to the data obtained from the measurement of a single working period. The data for 2015 are shown in the table (consumption expressed in kWh):

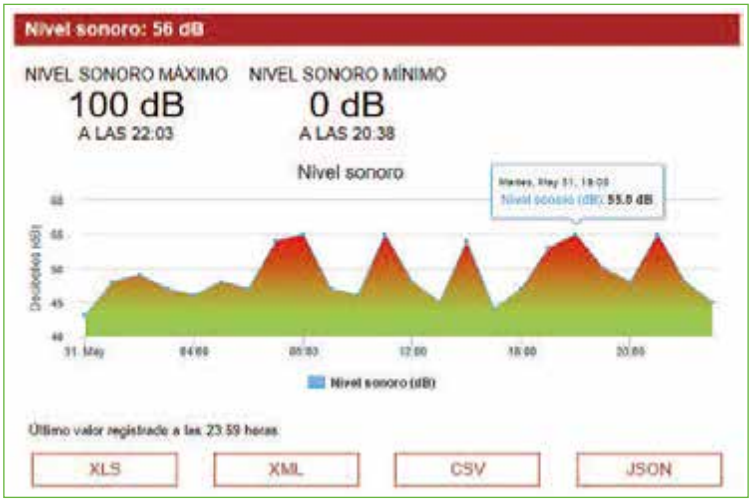
DATE		ELECTRIC CONSUMPTION (kWh)				PUE (Power Usage Effect)	CO_2 emissions due to total ICT energy consumption (kg CO_2/kWh)
YEAR	MONTH	TOTAL ICT infrastructure	DATA CENTRES		DESKTOPS	CPD consumption/ Total ICT devices consumption	
			SERVERS	COOLING			
2015	JANUARY	13.790	13.542	3.568	248	1,259	3.310
	FEBRUARY	13.068	12.737	3.190	331	1,244	3.136
	MARCH	13.261	12.897	3.818	364	1,288	3.183
	APRIL	14.878	14.564	3.388	314	1,228	3.571
	MAY	16.178	15.807	3.524	370	1,218	3.883
	JUNE	15.025	14.770	3.203	256	1,213	3.606
	JULY	16.577	16.256	2.330	321	1,141	3.978
	AUGUST	16.260	15.962	2.196	298	1,135	3.902
	SEPTEMBER	15.511	15.208	2.755	303	1,178	3.723
	OCTOBER	16.280	15.895	2.820	385	1,173	3.907
	NOVEMBER	15.119	14.747	2.525	372	1,167	3.629
	DECEMBER	14.328	14.089	1.960	238	1,137	3.439
	TOTAL 2015	180.273	176.473	35.275	3.799	1,196	43.265

The energy consumption of different months may not reflect the saving expected from the measures implemented in the LIFE project due to the following reasons:

- The consumption of ICT equipment depends on whether or not the day is a working day (holidays included). Taking into account the fact that each month has a different amount of working days and holidays, monthly consumption will be different and, therefore, the PUE will also vary.
- The PUE calculation involves counting the consumption of air conditioning. This consumption varies month to month since, according to the time of the year, the temperature of the cold source (outside) is different, so consumption will vary.
- Likewise, any modifications in the servers programme will significantly change their consumption. The IT department may decide to temporarily leave certain unit out of service. These variations change every month.

Therefore, the fact that a month has higher consumption than previous ones, does not mean saving measures have not been applied, but is justified by the variation of the programme working zone (working day/holiday), and by the time of the year (weather changes). In order to measure the real impact of the actions taken it is necessary to wait to have total annual data.

As part of its pilot action, the Logroño city council has implemented a remote monitoring system for the environmental quality management which is integrated in a new LED lighting system (with motion detectors that allow to adapt light intensity to traffic and people's presence). The system, among other functions, collects and supplies real time information on various parameters. It will obtain records of the environmental parameters (particles (PM_{10}) nitrogen oxides (NO_X), tropospheric ozone (O_3), sulphur dioxide (SO_2), noise level, traffic volume, temperature, humidity, rain and wind) that will suffice to analyse the environmental impact of traffic in the urban environment.



Data of these parameters available allow pointing out conclusions on correlations expected in the system and the reliability of measures and control. For instance, both acoustic level and energy consumed by lighting increase or decrease according to the volume of vehicles as expected. Furthermore, environmental quality parameters such as PM_{10} or NO_x, and specially SO_2 and O_3, have a direct relationship with traffic intensity.

Besides, thanks to the lamp changing (sodium vapour to LED) and to the implementation of different management scenarios, reductions in the power installed and the energy consumed have been confirmed. In fact, there has been a 75% energy saving corresponding to more than 23,000 kWh per year which means 8,120 CO_2 kg avoided.

5

DISSEMINATION AND NETWORKING

5 Dissemination and Networking

The activities carried out under the project and referred to in its dissemination strategy have been aimed at achieving the following objectives:

- To disseminate the project results.
- To increase the information and public awareness of the carbon footprint and environmental impacts of the use of ICT.
- To promote the implementation of Green ICT policies and criteria in public bodies, the education sector and businesses, especially SMEs.

All partners have globally contributed to the dissemination of the project results in each of the actions. Furthermore, as there is specialization of each of the partners (being this the main added value of the partnership) an enhanced dissemination addressed to specific stakeholders has been carried out, as follows:

- FPNCYL: to ICT professional sectors, Department of the Environment and Regional Government of Castilla y León.
- San Valero Foundation: to the education community, professional ICT sectors, Department of the Environment and Regional Public Administration of Aragón (specifically through the Climate Change and Environmental Education Service).
- Logroño City Council: to *smart cities* and local authorities in general.

Partnerships with third parties who have contributed to the dissemination of results and project activities have also been established.

The dissemination activities developed are summarized below:

5.1 Tools for disseminating the Project

The dissemination of project results and communication with the main target groups or potential beneficiaries are fundamental issues on LIFE projects. That is the reason why a series of tools and materials to enable ongoing dissemination have been launched, specifically the following:

The Project s Website: www.lifegreentic.eu

It is the institutional home of the project on the Internet, where its aims and activities are defined and all project products can be viewed and downloaded as documents. Although the main language is Spanish, much of the content can also be found in English. The website is the channel used to encourage participation through surveys or letters of commitment.

In this website, access is given to photos and videos of the Project, news or major events and activities carried out and links of interest to other entities with which networking initiatives have been developed can be accessed through it.

MihuellaTIC Blog

The Project s Blog http://mihuellatic.lifegreentic.eu has been the key to start participation in the ICT lab, providing ideas for environmental sustainability.

Social collaboration has been promoted through this tool, as well as participation in the photo contest "MiHuellaTIC" and the competition "Green TIC-Emprende".

The blog has also been the tool for collecting and disseminating successful cases of implementation of Green ICT practices by other entities outside the LIFE project, sharing their experiences and participating in the creation of a Green ICT virtual community in Spanish.

Other Social Networking Sites

The **Facebook** profile www.facebook.com/MiHuellaTIC and the **Twitter** account @lifegreentic were created to provide additional support to the rest of the communication channels and activities developed to disseminate the project.

Project Brochure

A project brochure has been edited by the reprography service of the Logroño City Council. This brochure is a three-part document measuring 14 cm (horizontal) x 10.5 cm (vertical). This booklet contains the logos of the LIFE Green TIC Project, data about its partners, information on actions developed under it, expected results and a list of all the websites and social networks related to it, as well as general information on the EU LIFE Programme.

3,000 copies have been published in Spanish and distributed in major event such as the National Environmental Congress, the MATELEC trade show, etc. 500 copies were also published in English and, among other events, they were mainly used in the Green Week and in the meeting with the Representatives of European Regions in Brussels.

Dashboard / noticeboard

The LIFE project partners have installed posters and information points about the project objectives in different strategic locations in their facilities and centers.

The Natural Heritage Foundation of Castilla y León has a large information sign (210 cm x 140 cm) placed in the hall of the PRAE building, this building is home to the FPNCYL s headquarters and to the Environmental Resources Center of Castilla y León, receiving more than 30,000 visitors annually.

The San Valero Foundation has installed an information foam panel at its offices, and a sign in the Secondary Education and Vocational Training School.

The Logroño City Council has placed informative roll-up posters about the LIFE Green TIC project in the courtyard of the Town Hall. They are woven vinyl canvases measuring 2 metres high x 1 metre wide.

Roll-up / Poster

In order to strengthen the presence of the project in different acts, events, conferences, etc., a roll-up canvas displaying the same content as the dashboard has been created. It allows easy placement and removal in any meeting room. It has also been published in a poster format.

Two posters were placed on the designated area of the National Environmental Congress (November 2014). They were PVC posters so that they could be reused in other displays related to the project. Actually, they had previously been used at the MATELEC trade show and they were later used in other events such as those related to the "Green TIC – Emprende" competition.

Merchandising

A USB flash drive was specifically designed and customized with the LIFE Programme and Life Green TIC logos in order to back up the dissemination of the project and to reward active participation in it, as well as to deliver documentation to the project s stakeholders (signature of commitment letter, finalists of the "Green TIC – Emprende" competition, meetings of expert groups, etc.).

In line with the objectives of the project and its green purchasing policy, a product fulfilling the environmental criteria was sought. The selected product was made out of wood with a FSC (Forest Stewardship Council) certification as coming from sustainably managed forests, RoHS compliance and certified as Carbon Neutral. 500 items were purchased and used for the first time in the National Environmental Congress.

Videos of the Project

In the initial stages of the project an informative video on its actions and its objectives was produced and primarily used to be projected at the stand of the National Environmental Congress (CONAMA). A final video of the project was also developed summarizing the main results thereof and the actions undertaken.

Both videos are available online at the project website:

www.lifegreentic.eu/es/videos

5.2 Specific Actions for Disseminating the Project

The specific actions carried out in recent years to disseminate the project can be grouped into the following categories:

Congresses, Fairs and Conferences:

The project partners have maintained an active presence in national and international forums for the dissemination of the project among the stakeholders and potential beneficiaries of its results. The following can be highlighted among them:

- ***Forum of the International Telecommunication Union:***

The Mayor of Logroño, Concepción Gamarra, participated in the Forum on technology that the International Telecommunication Union (ITU) and Telefónica held in Madrid on 18 September 2013. This third edition was also called the Green Standards Week and it was the setting chosen to present some of the actions to be developed under the LIFE Green TIC Project.

- ***Presence at the ARAGÓN OPEN DATA event. February 6th, 2014***

The San Valero Foundation participated on February 6th, 2014 in the Aragón Open Data event, organized in Zaragoza by the Government of Aragón. Representatives of the FSV could then contact with representatives from different entities within the ICT sector and had the opportunity to inform them about the LIFE Green TIC Project.

- ***Presentation at the III Smart Energy Congress of enerTIC. Madrid 23rd April 2014***

The Mayor of Logroño, Concepción Gamarra, opened in Madrid the III Smart Energy Congress of enerTIC and presented, in this forum of energy efficiency experts, one of the projects that the city is developing and that has make it a national reference within this field.

- ***Green Week - Brussels from 3rd to 5th June 2014***

The LIFE Green TIC project was selected to participate in the LIFE section of the Green Week in Brussels in 2014 under the slogan "Circular Economy". For this purpose, an information form justifying the relationship between the Green ICT Project and circular economy was filled in. The event took place at The Egg Conference Center.

- ***Workshop on Energy Efficiency and Climate Change***

Coinciding with the Green Week, the LIFE project organized in 4th June 2014 an informative event on the Permanent Representation of Spain in Brussels. Delegations from Regions of the European Union and entities related to energy efficiency and the environment were invited to attend.

The Conference was entitled "Workshop on Energy Efficiency and Climate Change" and was attended by 47 participants, including 20 representatives of Spanish regional governments and representatives of regions from Germany (2), Denmark (2), France (2), Italy (2), Czech Republic (1) and Croatia (1).

- ***MATELEC - International Exhibition of Solutions for the Electrical and Electronics Industry –Madrid 28th October 2014***

As the Natural Heritage Foundation of Castilla y León had a stand in MATELEC to present other projects, information on the LIFE Green TIC Project was included there, such as informative posters, distribution of leaflets and presence in social networks.

The main objective was to make the experts of electrical and electronics industry aware of the amount of energy consumed by electronic sensors and devices, as well as to inform about the LIFE project.

- ***Presence at the event ICT FORUM ARAGÓN 2014. 20th November 2014***

The San Valero Foundation participated in the Event ICT Forum Aragón, where it could contact entities from the ICT sector and inform them about the LIFE Project.

- ***National Environmental Congress (CONAMA). Madrid, 24th to 27th November 2014***

This Congress, celebrated every two years, is the main event of debate and knowledge about environment held in Spain, therefore the participation of the LIFE Green TIC Project was considered to be strategic to inform about it, to raise people s awareness about the carbon and the ICT ecological footprints and, certainly, to disseminate the project as a whole. It lasted four days and had an average of 2,450 visitors a day.

Participation in CONAMA included:

- A public information stand of 12 m^2.
- The presentation of a written communication.
- The placement of a poster in the poster area of the Congress.
- The presentation of the LIFE Green TIC Project in a dynamic room about LIFE Projects on the 25th of November.
- The launch of a Green ICT Letter of Commitment for organizations and users.

- ***The First National Congress of Smart Cities. 24th March 2015***

This Congress was organized by the Spanish Network of Smart Cities and the Tecma-Red Group in the Conde Duque Cultural Center of Madrid. It was attended by more than 300 delegates and had wide impact on social media.

LIFE Green TIC sent a written presentation to the Congress. This presentation was one of the 20 selected for oral presentation to the plenary out of a total of more than 120 submissions. It was published in the Communications Book of the Congress, both on paper and online versions:

www.esmartcity.es/biblioteca/libro-de-comunicaciones-i-congreso-ciudades-inteligentes

The intervention in the Plenary was video recorded and is available on-line:

www.esmartcity.es/videoteca/jesus-diez-patrimonio-natural-cyl-i-congreso-ciudades-inteligentes

And also the presentation:

https://www.esmartcity.es/biblioteca/ponencia-jesus-diez-fundacion-patrimonio-natural-cyl-en-congreso-ci

- ***National Congress of Communication and Environmental Education (COMEA, by its Spanish Acronym), Valladolid 4th April 2015***

The National Congress of Environmental Education and Communication, which was trending topic, #comea, aimed to be a meeting point and discussion on the role of media in environmental education and lay the foundations on which companies, institutions and other stakeholders, can manage and disseminate their values and projects on these issues.

- ***Hack for Good - # H4G at the University of Valladolid 16th April 2015***

This event "HackForGood" is a hackathon focused on social innovation, new ideas, services or applications that help to solve social problems by satisfying existing needs, as well as creating new communities and partnerships between public, private and third sector institutions, etc. It takes place annually and simultaneously in different Spanish cities and has primarily computing and telecommunication students among its participants.

- ***nternational Conference on Critical Raw Materials – International Research Center in Critical Raw Materials for Advanced Industrial Technologies (ICCRAM). Burgos***

The LIFE Green TIC Project was presented in the parallel sessions about recycling and circular economy which took place on 25th June 2015 in the city of Burgos under the Conference on Critical Raw Materials organized by the International Research Center in Critical Raw Materials for Advanced Industrial Technologies (ICCRAM) of the University of Burgos.

- ***Local CONAMA***

Coinciding with the celebration of the Greencities and Sustainability Forum in the city of Malaga on 7th and 8th October 2015, a special session was also organized by the National Congress on Local Environment. A poster of the LIFE Green TIC Project was sent to the Congress and exposed there.

- ***Green ICT Procurement and Best Practices Educational Sessions***

As part of the dissemination activities of the project results, the consortium of the LIFE Green TIC Project planned a series of educational sessions on green ICT procurement and best practices for energy saving in ICT. They took place between 18th February and 31st March 2016 in the cities of Valladolid, Zaragoza, Madrid and Logroño and were attended by over 130 people.

- ***Conference with the Local Energy Agency of Murcia City Council***

In cooperation with the Local Energy Agency of Murcia City Council, a conference on green ICT procurement and best practices for energy saving in ICT was held on 4th May 2016 and attended by 40 people.

5.3 Articles and Communications in Specialised Publications:

The project has also sought specific channels of dissemination of technical and specialised content in order to reach the target audience and stakeholders directly related to it.

Therefore, communications and articles have been published in the following media:

a) CyLDigital Magazine:

This is a digital magazine published every four months by the Directorate General of Telecommunications of Castilla y León. It has more than 3,500 subscribers. Permanent cooperation was established between the LIFE Green TIC Project and this publication, as it has been specially shown in three occasions:

- CYLDigital number 11 - February 2014. This time cooperation with the LIFE Green TIC Project resulted in the publication of a special issue dedicated to Green ICT, "A Greener World through Technology." In this issue an article presenting the LIFE Green TIC Project, its objectives and expected results was included.
- CylDigital number 14 - November 2014. In this issue the initiative of the LIFE project aimed at creating a network of organizations committed to Green ICT was presented.
- CylDigital number 18 – June 2016. In this issue a dissemination article on the "Best Environmental Practices Guide for Energy Saving for ICT Users" developed under the LIFE Green TIC Project was included.

b) esmarcity.es Website.

This is the main Spanish web related to smart cities. In addition to the own site contents, it is distributed to several thousand subscribers through a digital newsletter. This site organizes, together with the Spanish Network of Smart Cities, an annual nationwide congress.

The technical communication "Reducing the Carbon Footprint of the Smart Cities", presented at the First National Congress of Smart Cities by the LIFE Green TIC Project, was published in this website. The oral presentation of this technical communication made in the Plenary is also posted there.

Furthermore, the Green ICT Procurement Manual published by the LIFE Green TIC Project is also available in this website.

c) CONAMA Communication.

The technical communication that was presented in the National Environmental Congress (CONAMA) held in November 2014 was published on the CONAMA Foundation website.

Such communication entitled "Reducing the Carbon Footprint of Information and Communication Technologies" was included in the Communications Book of the Congress.

d) Journal of Equipment and Municipal Services.

An informative article "Logroño Smart City" was published in the "Journal of Equipment and Municipal Services", a magazine on urbanism and environment, during the second quarter of 2014. It is the leading journal published by Spanish Local Authorities.

The actions and projects carried out by the Logroño City Council within the Smart Cities framework are explained in this article. It deals with issues such as: energy efficiency, sustainable mobility, environment, ICT, etc.

e) Publishing in the "Corporate Commitment" digital magazine by CSR (Corporate Social Responsibility).

This is the digital magazine of the Commitment and Transparency Foundation, where an article on the Green ICT and Project LIFE as a CSR approach to the fight against climate change was published on 26th June 2015.

5.4 Networking

The development of *networking* activities has been directed towards the following objectives:

- To seek synergies with other projects dealing with similar topics whose results could enrich the work done by the LIFE Green TIC Project and vice versa, that the work done under this project could serve as a benchmark for developing other projects.
- To identify success stories in order to include them in the catalogue of best practices in the use of ICT for environmental management and to fight climate change.
- To incorporate the implementation of green ICT policies to other entities.

The following tasks have been carried out to achieve these objectives:

- Search for related projects: search engines and databases of different European programmes and initiatives have been used to do so (LIFE, CIP-ecoinnovation, Long-life Learning Programme - ADAM database, 7th Framework Programme, European Social Fund, etc.). More than 30 related projects were identified.
- Email and telephone contact: direct contact has been established with projects that were considered to be more eligible for establishing potential synergies. At the same time, numerous Spanish LIFE Projects have been contacted in order to invite them to share best practices to be included in the catalogue of best practices in the green use of ICT and to sign up for the Charter of Entities Committed to Green ICT.
- Exchange of information and documentation: this exchange of information has been guided from the LIFE Green TIC Project to other entities to provide them with the documents already produced

under the project (Best Environmental Practices Guidelines for ICT Users and Green Procurement Manual for ICT Products).

The following actions have brought added value to the LIFE Green TIC Project:

- The Green Digital Charter.

An initiative from Eurocities funded under the 7th Framework Programme through which the SEAPs (Sustainable Energy Action Plans) compatibility documents of the Covenant of Mayors have been analysed together with the ICT emissions inventories.

The organization also facilitated access to the on-line NICE tool for tracking and monitoring ICT emissions and dumping that information to the SEAPs. This information has proved to be useful for the development of the Action Plan of the Logroño City Council, as it is also a signatory entity of the Covenant of Mayors.

Moreover, in the framework of projects and cities integrated in the Green Digital Charter, the city of Linköping (Sweden) was contacted. This city provided a software (EasyArp) for the inventory of energy consumption and CO_2 emissions of an ICT infrastructure. The Logroño City Council tested this and, while recognizing its simplicity and usefulness, it was found that the system used by the City Council offered much more complete information, hence validating the methodology used by the LIFE Green TIC Project.

- Interreg SUDOE FI4VDI Project - Development of a network of federated infrastructures to generate virtualization services for desktops.

Coordination meeting with the Spanish partner "Foundation of Supercomputing Center of Castile and León" (FCSCL, by its Spanish acronym) in León. This cooperation has led to better guide the Pilot Action B2 developed by Natural Heritage Foundation of Castilla y León (Spain) on virtualizing Data Centers.

- Green ProcA (Green Public Procurement in Action).

Project funded by the Intelligent Energy Europe (IEE) Programme, primarily aims to develop tools to support green procurement as an instrument to be applied by the signatory local authorities of the Covenant of Majors, within the framework of development of their Action Plans on Sustainable Energy. This project is a continuation of two previous ones called Buy Smart and Buy Smart+. Contacts established through that project have enabled to use and disseminate tools for analysing the lifecycle costs of ICT products. These tools are included in the Green Procurement Manual for ICT Products and in the tender specifications standard templates of the Life Green TIC Project.

- Spanish Association of Computer Technicians (ATI, by its Spanish acronym) http://www.ati.es/.

Through this collaboration documents have been exchanged in order to back up and disseminate best practices and criteria for green purchasing, which has enabled to bring the results of the LIFE Green TIC Project working group to the Council of European Professional Informatics Societies (CEPIS) http://www.cepis.org/.

ATI has intensely worked in the "Green TIC Competition - Emprende" (B7) and has also been a member of its jury. CEPIS has shared its Green ICT Best Practices Guide and the results of the research made on the situation of Green ICT in companies and organizations, conducted by surveying institutions of the European Union.

- Collaboration with other European projects has started:
  - Is IT Green (www.isitgreen.eu) (Lifelong Learning Programme): there has been an exchange of materials resulting from both projects. Best practices developed by the LIFE Green TIC Project were sent and documents concerning e-skills for Green Information Technologies were received from the other project. All of this will be taken into account in the dissemination and on the Socioeconomic Impact Action (C2).
  - Erasmus Mundus Green IT (emundusgreenit.uvigo.es): talks have started to make available certain LIFE Green TIC products to the international consortium and thus contribute to the international transfer of the results of this project.
- LIFE entities that have signed their commitment letter:
  - CARTIF Foundation.
  - Galician Technology Institute (ITG, by its Spanish acronym).
- EU LIFE Projects and other projects that have provided Green ICT success stories:
  - ROEM+ (LIFE11 ENV/ES/590) - www.roemplus-life.eu
  - SANePLAN (LIFE12 ENV/ES/000687) - www.saneplan-life.eu
  - ShoeBAT (LIFE 12 ENV/ES/0002443) - www.life-shoebat.eu
  - EPLACE (CIP) www.eplaceproject.eu
  - Smartspaces (CIP) smartspaces.energiamurcia.es
  - TEDS4BEE (CIP) www.teds4bee.eu
  - Wetnet (CIP) www.wetnet.it/es

6

THE TRANSFER POTENTIAL OF THE PROJECT

6. The Transfer Potential of the Project

The findings and products obtained by the LIFE Green TIC Project have a high transfer and replicability potential and could be integrated in different EU policies, especially in the following:

- ***Energy and climate change policy***

  Energy consumption in the ICT sector has not been yet considered a specific field of action within the strategy for fighting against climate change, neither at a European level nor in national, regional or local plans.

  Even though there are some initiatives developed by the Joint Research Center of the EU and by some Member States, they should be widespread in order to promote the development of Green ICT strategies and actions plans. The approach of energy saving in the Digital Agenda, the use of efficient equipment, as well as best practices among users should be in the roadmaps for mitigating climate change.

  The energy consumption of the ICT sector should become part of the agendas and national plans to combat climate change, from the perspective of both encourage the manufacture of more energy efficient equipment and from the users perspective, whether large companies and public administrations or individual users, considering them as a diffuse sector.

  The dissemination of best practices manuals for users and of green procurement criteria for ICT equipment and devices, such as those developed by the LIFE Green TIC Project, are measures that could be included in national plans to combat climate change.

- ***Environmental Policy and Efficient Use of Resources***

  The LIFE Green TIC project has helped to give greater visibility to the environmental problem of CO_2 emissions caused by the increased use of information and communication technologies. The problem does not only concern energy consumption and CO_2 emissions but also poses other indirect problems such as the augmented use of valuable and scarce raw materials or the large-scale production of hazardous waste. Nevertheless, the main purpose of the project is the impact of ICT on climate change.

  One of the main obstacles identified when developing the project is the lack of visibility of this environmental problem as, despite its growing volume, the energy consumption of the ICT infrastructure, equipment and devices normally goes unnoticed for users such as companies and organizations. Therefore, giving visibility to this problem has been one of the project s priorities.

  The best practices for energy saving in the use of ICT and other measures identified in the development of Green ICT strategies proposed by the LIFE project are helping to optimize ICT equipment, to reduce the number of necessary devices and to extend their useful life, as they

imply a decrease in energy consumption. All these aspects are directly linked to greater efficiency in the use of resources, lower consumption of raw materials and a lower rate of waste generation, improving the life cycle of ICT products.

- ***Cohesion Policy***

  The authorities managing the various Operational Programmes could include the Green ICT perspective in the project selection criteria as related to the priorities of the Digital Society, R+D+I and improving business competitiveness.

  Thus, the following could be prioritized and encouraged:

  - Innovation in the development of ICT products and services, making them more energy efficient or eliminating stand-by power consumption.
  - Application of green procurement criteria for all ICT equipment and devices to be financed by European Regional Development Fund.
  - Advice and finance companies to implement Green ICT strategies in their organizations, in order to improve their competitiveness, under the European Regional Development Fund.
  - Include modules to raise awareness on the efficient use of ICT in the training and employment support activities financed by the European Social Fund.
  - Development of specific training activities on Green ICT financed by the European Social Fund.

  The implementation of Green ICT strategies, including green procurement and best practices, by companies and public bodies will have a positive economic effect, as it will improve their competitiveness by enhancing the performance of their IT infrastructure while reducing power consumption.

- ***Employment Policy***

  One of the main barriers identified by the LIFE Project for the implementation of Green ICT policies is the limited amount of professionals with the right skills to apply these techniques.

  The development of training standards and "green" skills for professionals in the ICT sector is, therefore, considered necessary, so digital economy will rely less on carbon industry and its professionals will be trained for the transition to a green economy with low use of natural resources.

  From the social point of view, the project results can help to encourage the inclusion of Green ICT competencies and knowledge in e-skills training programs, educating new IT professionals for a model of green economy and improving, hence, their employment opportunities.

  Second, the project can be transferred by fostering, among professionals and companies in the ICT sector, the provision of new Green ICT services or the improvement of the ones currently provided, by promoting the labour market in the sector of telecommunication and computer companies.

The potential transfer of the project could be measured through the following long-term indicators of its impact:

- Total reduction of electricity consumption in the ICT sector.
- Total reduction of CO_2 emissions in the ICT sector.

- Number of entities implementing Green ICT strategies.
- Number of entities applying green procurement criteria for ICT products.
- Number of cities monitoring ICT consumption and adopting measures within the framework of their plans to combat climate change.
- Number of ICT measures included in the national, regional and local plans to combat climate change.
- Number of schools that implement virtual campuses.
- Number of entities that implement virtualization processes.

Finally, some specific examples of transfer of the project that have already been carried out can be mentioned. Different organizations, especially Regional Energy Agencies, Technology Centers, Educational Centers and Public Authorities have shown interest in the project s results.

- Transfer Case 1: ICT Energy Efficiency Network "EFFICIENTIC"

  Creating a Partnership to promote a regional cooperation project on energy efficiency in ICT. This cooperation has resulted in the drafting of a project that has been submitted to the INTERREG programme SUDOE, with institutions in Spain, Portugal and France. The project aims at capitalising the experience of monitoring energy consumption, ICT energy audits and Green ICT strategies by applying it to 30 pilot projects in 3 countries, as well as the development of e-learning training materials for professionals and students in the ICT sector.

- Transfer Case 2: Dissemination of Best Practices

  The Regional Government of Castilla and León, through the Directorate General of Telecommunications, has used the educational materials developed under the LIFE Green TIC Project, namely infographics summarizing the Good Practices Guide for Energy Saving for ICT Users, to distribute them online to more than 18,000 public employees. At the same time, a training webinar about the contents of this Guide was organized through the online training platform.

- Transfer Case 3: Green ICT Procurement Day

  The Local Energy Agency of the Murcia City Council, asked the LIFE Green TIC consortium to organise a training day on green ICT procurement and good energy saving practices for regional stakeholders (regional and local government, business and professionals in the sector, universities, etc.). This event took place in the city of Murcia on 4th May 2016.

7

CONCLUSIONS AND LESSONS LEARNED

7. Conclusions and Lesons Learned

The development of the LIFE Green TIC Project during three years has led to a series of conclusions and recommendations that should serve to promote the replicability and transfer of results to other entities, taking as a premise the basic conclusion of the project: that the power consumption of information and communication technology is a growing environmental issue that must be taken into account by organizations and companies seeking a low-carbon economy model.

In a more detailed analysis of these conclusions and lessons learned, they can be classified in those of a specific nature related to the development of the different actions, and other general ones related to the socioeconomic impacts, as well as to the social and professional perception of the implementation of green ICT policies.

7.1 Conclusions Drawn from the Specific Project Actions

In this field the lessons learned in four key areas will be considered:

- The virtualization of data centers and desktops.
- The sensorization of the environmental management of the city.
- The application of ICT to education.
- The implementation of printing policies in offices.

7.1.1 Lessons Learned in Virtualization of Data Centers and Desktops

After the pilot action of virtualization developed in the PRAE building by the Natural Heritage Foundation of Castilla y León, the main conclusion drawn has been the potential of virtual environments, as compared to conventional or physical ones, for saving energy and ICT equipment.

Reducing the number of physical machines, both servers in data centers and computers at desktops, has a direct impact on reducing energy consumption (less equipment-less consumption). It also has an indirect impact as, when less equipment is necessary, energy consumption associated with the manufacturing processes becomes lower, therefore, the overall impact of virtualization turns out to be even more favourable.

In the case of the PRAE building, savings achieved due to the virtualization of the Data Center have been 30%, although the initially thought saving to be reached was 85%, which is about 5,000 kWh per year.

The main reason for this minor impact has been the change of the initially proposed technological design due to the complexity and heterogeneity of the needs of different desktops. As the virtualization of all the equipment could not be possible, to size the Data Center with a greater number of servers than the initially proposed (5 instead of 3) became necessary. Another factor that has affected the sizing of the Data Center has been the installation of a new VoIP phone system, as the virtualized infrastructure had to bear all its electronics.

Virtualized desktops have achieved the goal of 90% energy saving as compared to conventional ones (although when considering this impact in absolute terms, it has to be taken into account that only 50% of the full amount of desktops have been virtualized).

The following conclusions have been drawn from the virtualization experience in the PRAE building:

- From an operational point of view, the virtualization processes are simpler and more efficient when applied to very standardized and homogeneous environments, i.e. where users of ICT infrastructure use identical software and applications, because in heterogeneous environments migration and configuration processes require more tasks, take longer, and imply a higher risk of incidence.
- In the case of the PRAE building, the environment is heterogeneous and virtualized desktops share infrastructure with others that are not. There are workstations that need two monitors instead of just one and more than 40 work centers share the same network electronics. The sizing of the virtualized Data Center had to be larger and more complex. Thus, despite having achieved very significant energy savings, the maximum saving potential of this technology has not been reached. However, the performance achieved in both data centers and desktops in terms of energy efficiency justify switching from a conventional infrastructure to a virtualized one in medium and large organizations.
- Personnel management in organizations during virtualization processes is an important factor in order to ensure the success of these systems, since one of the main barriers to the establishment of virtualized environments is their fear for paralyzing their activity or losing information during migration processes.
- It is necessary to strengthen the dialogue between IT departments and other departments in order to optimize changes in technology solutions from the early design stages to the implementation of virtualization. Staff and external assistance companies often seek the best technological solutions for the company without involving staff from the rest of the departments when designing their implementation, hindering the progress of work and multiplying incidences and eventualities.

7.1.2. The Sensorization of the Environmental Management of the City

The Logroño City Council has developed a pilot project aimed at analysing the use of sensors and other devices to improve the environmental management of the city and the energy consumption of street lighting, as well as drawing conclusions, such as Big Data management, that can relate areas such as air quality, noise, traffic and street lighting.

The main findings of this project were:

- Sensors and other ICT devices are the workhorses of Smart Cities, as they provide valuable information and data for managing the city, especially to improve its environmental quality.
- More important than the possibility of having data is its useful management and processing for decision taking. The challenge of Smart Cities is not to accumulate data, but to manage them properly.
- The management and environmental information can be significantly improved through sensors and ICT devices. In the case of air quality and noise monitored in the pilot action developed in Logroño the information gathered by these means allowed managers to act precisely in order to reduce specific pollution problems that were not shown by existing networks of air quality and noise control, which only measure immission levels but do not attend to detail.

7.1.3 The application of ICT in education

After the "virtual campus" pilot action was carried out by the San Valero Foundation in schools managed by the Group, the results obtained from the actions implemented and validated at the demonstration experimental stage in the field of education exceed by far the objectives set in the approved proposal.

The main conclusion is, therefore, the high potential for reducing CO_2 emissions that online education and digital document management has, as compared to classroom education and paper-based document management.

In the case of San Valero Group, the real situation of existing students in both of the pilot virtual campus sub-actions has been taken into account when using the calculation method, as well as its contrast with a real scenario in classroom tuition. This, together with the large number of students involved in the pilot actions (110 in vocational training and 2,042 in university education), has led to very high absolute values of oil consumption reduction in trips from places of residence to schools and its consequent equivalence in the decrease of CO_2 emissions.

In addition, the following conclusions have been drawn:

- The potential transfer of the model and its results is very high at different levels of the specific field of education, both nationally and in the context of the European Union. In this sense, financial savings of the application of ICT in the educational field have also been quantified in order to provide arguments on the environmental cost/benefit to support the change to a cutting–edge educational modality that has also great interest to support the European strategy on climate change.
- The potential for reducing greenhouse gas emissions in the specific field of education is also very high regarding the "zero paper" approach, with many applications implying a fast payback and an excellent cost/environmental benefit ratio.
- The multiplier effect of exploiting the ICT potential and associated CO_2 reduction formulas in the field of education has a very high added value, as teachers and students can be trained on behaviours and activities related to respect for the environment.
- When introducing new ICT applications and tools, their rapid technological evolution should be borne in mind as linked to levels of rapid obsolescence of technologies or devices.

- It is also worth bearing in mind the potential levels of resistance to changing applications and methodologies posed by educational or professional staff who may be unfamiliar with this type of tools.

7.1.4 The implementation of office printing policies

One area of common action in the three entities forming the LIFE Green TIC consortium is the implementation of different green ICT policies for saving paper and energy consumption in printing and imaging equipment.

The partners have addressed this issue through different measures among which the following ones are included:

- Consolidation of the number of printers, by reducing the number of individual ones and replacing them with multifunction devices shared between different departments.
- Dissemination of best practices among users in order to reduce the number of prints and paper copies.
- Application of a management software for monitoring and controlling resource consumption in the printing and imaging equipment.
- Setting energy and paper saving in printing and imaging equipment.
- Green procurement of printing and imaging equipment.

Significant savings of both paper and energy resources have been achieved thanks to the implementation of these measures by the three project partners. The main conclusion drawn when monitoring consumption is that, although printing and imaging efficiency policies have a direct impact con energy consumption, their greatest impact occurs in resource consumption (paper and toner) and, indirectly, when analysing CO_2 emissions from manufacturing raw materials, which are very relevant in the case of paper.

The results achieved by each entity were as follows:

Paper-Less Policies Saving Results		FPNCYL	FSV	Logroño Council
Before Implementation	Paper consumption in Kg	**514 kg**	**9.670 kg**	**34.481 kg**
	Kg CO_2 eq	**925 Kg CO_2 eq.**	**18.860 kg CO_2 eq.**	**66.300 kg CO_2 eq.**
After Implementation	Paper consumption in Kg	**459 kg**	**7.692 kg**	**23.704 kg**
	Kg CO_2 eq	**825 kg CO_2 eq.** **Reductión: 0,1 t CO_2**	**15.076 kg CO_2 eq.** **Reductión: 3,86 t CO_2**	**46.080 kg CO_2 eq.** **Reductión: 19,5 t CO_2**

Lessons learned:

- The policy of reducing the number of individual printers and their replacement by centralized multifunction devices contributes significantly both to energy and paper saving. Increasing the distance from desktops to printing stations is a determining factor in the volume of prints or copies that are made.
- Setting printers and printing options for each computer has a significant impact on paper and energy saving, especially regarding the configuration policy of setting default B&W instead of colour printing and double sided instead of single sided printing.
- The management software for printers and copiers has a significant impact on saving paper, as it monitors the number of copies made by each department or each person, which is a conditioning factor in workers. This software also allows to assign different printing roles depending on the characteristics of each job.
- Green procurement of printing equipment is very important to reduce energy and paper consumption. Special attention must be paid to compliance of equipment with standards of Energy Star® type and to its energy saving configuration options. Suppliers must also be asked to tailor such configurations to the actual needs of the entity.
- Information and dissemination of good practices among workers is not a complementary but an essential action to the above mentioned, since the success of many of the actions taken depends on the correct use that staff makes of equipment and devices.

7.2 Socioeconomic Impact of Green ICT

The perception that society in general and the target audience of the LIFE Green TIC Project (ICT and education professionals, managers of ICT infrastructure, IT departments of public administrations and companies, etc.) have regarding energy and CO_2 emissions saving from ICT equipment and devices is essential to assess the potential replicability of the lessons learned from the project.

In order to assess the acceptability and social impact of Green ICT actions and policies, the project has followed the methodology explained below:

- Launch of a survey with a specific questionnaire adapted to the three targeted groups (students, government employees, and companies) and distributed to them through e- mailing and specialized newsletters. This survey was supplemented by a short online survey posted at the website of the project and publicized through the project s own social networks (Twitter and Facebook).
- Do a benchmarking research on experiences, related studies, potential for job creation, Green ICT training offer and needs and introduction of these approaches and policies in organizations.

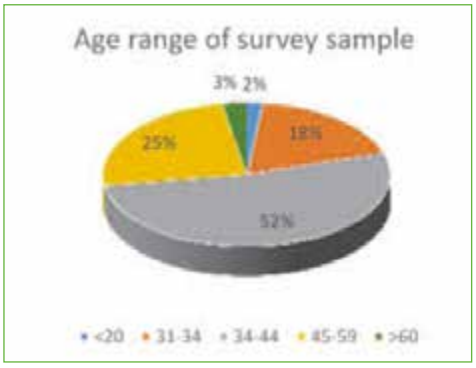
The main conclusions drawn and lessons learned from this LIFE Project on the social and economic impact of Green ICT are:

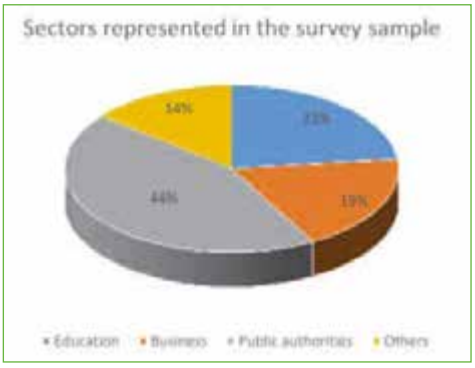
- Most public and private organizations do not perceive that the energy consumption of the ICT infrastructure is a problem and, as a general rule, this consumption is not monitored separately from other electricity consumption in buildings.

- ICT service providers or the staff in IT departments do not generally provide information or services on Green ICT policies that help to reduce energy consumption, as their main concern is safety and availability.
- The Green ICT skills and knowledge are not part of the formal education in Spain and the non-formal education offer is quite scarce in this field. However, it is relatively easy to find education and training offers related to the facilitating effect of ICT, i.e. ICT services or products for environmental management, but not related to procedures, techniques and services to reduce ICT energy consumption.
- Training ICT professionals in procedures, techniques and more energy efficient ICT services is not just a job opportunity for them, especially for young people, but it is also considered a factor of competitiveness to improve career prospects for ICT professionals who are already on the labour market.
- Many of the organizations would be willing to develop policies and implement Green ICT measures to reduce the energy consumption of their ICT infrastructure, although they consider it difficult to find trained professionals to do so. They find it easier to apply green procurement criteria, provided this does not involve an overrun on their budget.
- The return on investment in Green ICT solutions or products raises doubts within organizations, especially considering how quickly these technologies evolve and their rapid obsolescence.

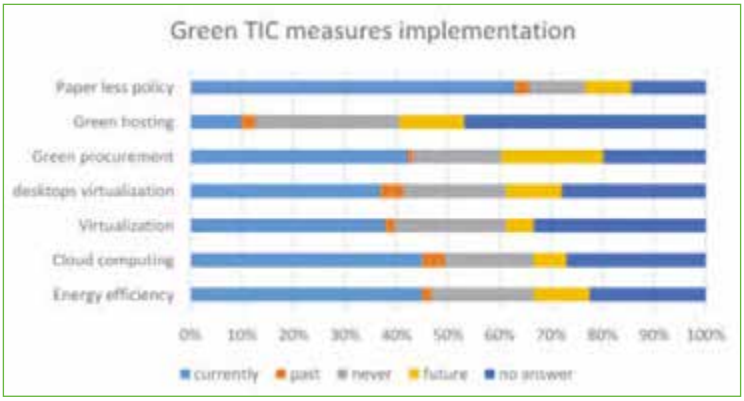
These conclusions have been obtained by consulting specific groups of experts set by each of the project partners in their respective territories, as well as through a series of surveys made to 114 stakeholders of the key sectors of the project, by means of a specific written questionnaire, and 125 online surveys to followers of the project on social networks, through the website www.lifegreentic.eu

The profile of the sample of the stakeholders survey is a person between 35 and 45 years old (52%) and preferably belonging to the public sector (44%). However, there has been representation of other profiles, as shown in the graphs:

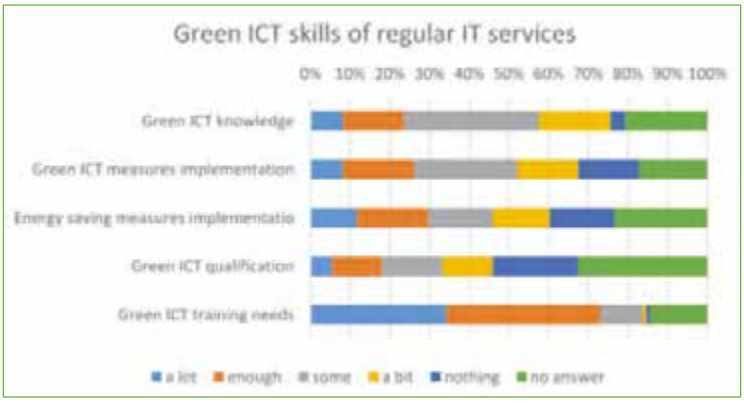




Less than half of the people surveyed recognized to have implemented Green ICT measures in their entities, except in the areas of printing and imaging equipment resource saving, which is the policy that has more implementation (73 %). The policy that has the least implementation (14%) is that of contracting hosting services where suppliers guarantee the energy efficiency of their data center.

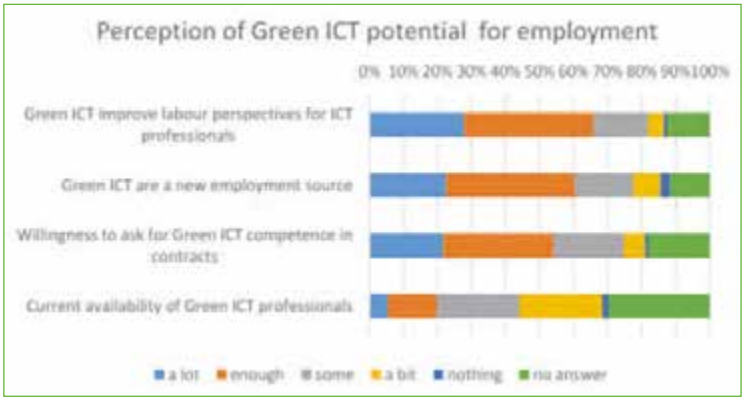


A majority of respondents (81%) think it is very necessary that the IT departments and the usual IT service providers improve their skills on Green ICT policies, services and products. This is consistent with the fact that only 30% report that their suppliers or IT departments have implemented Green ICT or energy saving measures.



As regards the prospects for Green ICT job offers, a large majority of respondents (82%) believe that training on Green ICT will improve the professional prospects of IT providers and will offer young people and computing students a new source of employment (78%).

Over 60% of respondents would be willing to request Green ICT solvency to their suppliers when contracting their services, but the main problem that about 60% perceive is that currently there is no availability of skilled professionals within this field.



Finally, it has to be mentioned that the main barriers identified for the development of Green policies is the lack of information by organizations, their managers and staff on the implications of these policies and their potential for energy savings (90%) , doubts about the return on Green ICT investment (82%) and the shortage of skilled professionals (80%).

8

A PROJECT IN PICTURES

8. A PROJECT IN PICTURES

8.1 Places where pilot actions were developed

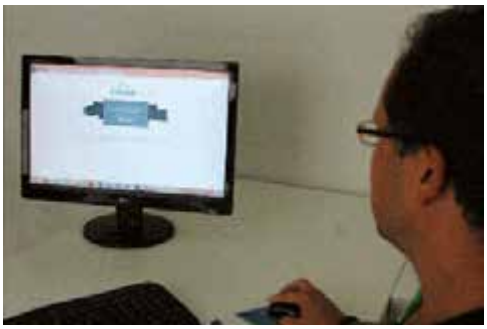
Pilot Action in the PRAE Building (Valladolid)

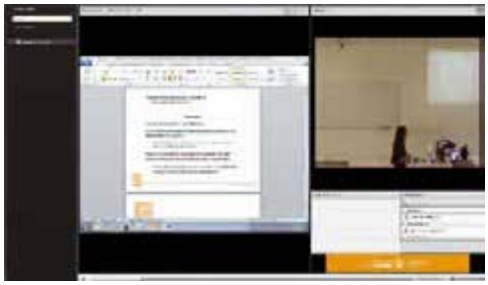







Pilot Action in the Educational Community of the San Valero Group (Aragón).





Pilot Action in the City of Logroño





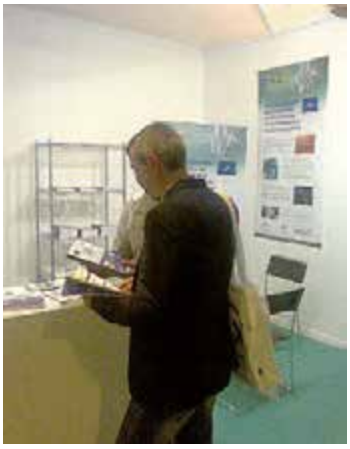
8.2 Participation in Congresses, Fairs and Conferences

Green Week, Brussels 4th to 7th June 2014.

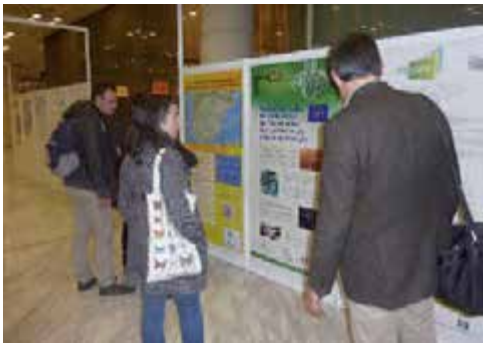
Presentation to European regions in Brussels. 4th June 2014..

Smart Cities Congress (Madrid, March 2015).

MATELEC Electronics Fair trade. Madrid, October 2014.



National Environmental Congress (Madrid, November 2014).




ECONOMÍA BAJA
EN CARBONO


LIFE GREEN TIC
Life

8.3 Dissemination Reviews

GESTIÓN SOSTENIBLE DE LAS TIC

La Fundación Patrimonio Natural lidera el proyecto LIFE GREEN TIC para fomentar la reducción de los consumos energéticos en el uso de las TIC

Proyecto Life 'Green Tic': el compromiso de reducir emisiones

LOGROÑO

El proyecto LIFE GREEN TIC invita a desterrar gestos con "incidencia importante en el consumo"

Gamarra quiere que Logroño sea una ciudad "líder en Europa en compra verde"

noticiascastillayleon.com

El 'Life Green TIC' reducirá un 50% el consumo energético asociado a la utilización de las tecnologías

8.4 Meetings of the partnership and visits to places where pilot actions were developed

Valladolid (23rd October 2013).

Logroño (4th February 2014).

Zaragoza (2nd January 2015)

Logroño (11th February 2016)

8.5 Training Workshops and networking


LIFE GREEN
TIC


Proyecto
LIFE GREEN
TIC