LIFE Project Number

<LIFE12 ENV/ES/222>

FINAL Report

Covering the project activities from 02/09/2013 to 31/08/2016

Reporting Date

<30/11/2016>

LIFE+ PROJECT NAME or Acronym

< Green TIC – Reducing CO_2 footprint of information and communication technologies>

Project Data

Project location	Castilla y León, Aragón, La Rioja (Spain)
Project start date:	<02/09/2013>
Project end date:	<31/08/2016> **Extension date:** <dd/mm/yyyy >
Total Project duration (in months)	<36> months (including **Extension of** <XX> **months**)
Total budget	1.455.240 €
Total eligible budget	1.319.240 €
EU contribution:	659.120 €
(%) of total costs	45,29 %
(%) of eligible costs	49,96 %

Beneficiary Data

Name Beneficiary	Fundación Patrimonio Natural de Castilla y León
Contact person	Mr Jesús Ángel Díez Vázquez
Postal address	Cañada Real, 306, E-47008 Valladolid (Spain)
Visit address	Cañada Real, 306, E-47008 Valladolid (Spain) Violeta Parra, 9 – 50015 – Zaragoza (Spain) Avda de la Paz,11 – 26071 – Logroño (Spain)
Telephone	+34 983345850 +34 983450358
Fax:	+34 983345844
E-mail	jesus.diez@patrimonionatural.org
Project Website	www.lifegreentic.eu

1. List of contents

2. 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.

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

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, in education centres as well as in public bodies.
- 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.
- 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 Green ICT ideas.

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

1) Stage 1: creation of the working structure (coordination committee, technical committee and dissemination committee) as well as advisory groups supporting the project (experts and stakeholders) (Action E1).
2) 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).

3) Stage 3: development of the basic contents of the different actions:
   - Implementation of Green ICT Action Plans (B1).
   - Implementation 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).

4) 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).
   - Mid-term and final reports (E1).

To contribute to the Green TIC project objectives, the following actions were implemented from September 2013 to August 2016:

B1. Development of Green ICT Action Plans.

B5. Definition of Green Procurement Guidelines for ICT equipment.

B6. Development of a Best Practices Manual for energy saving in ICT.

B7. Social participation in the design of ICT solutions for environmental sustainability through a Living Lab.

C1. Monitoring

C2. Socioeconomic assessment

D1. Dissemination

E3. Networking

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

B2. Pilot Action 1: virtualization in the Environmental Resources Centre of Castilla y León in Valladolid (PRAE building).

B3. Pilot Action 2: Virtual Campus at the University of San Jorge and at San Valero Vocational Training Centre (Zaragoza).

B4. Pilot Action 3: smart urban environmental management of the city of Logroño.

Throughout these 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. As a whole, the project's actions have helped to achieve an annual emissions reduction of 218 tonnes of CO_2 equivalent.

The main objective of the project was to reduce 50% of energy consumption by each of the partners through the implementation of Pilot Actions, Green ICT Plans, Green Procurement and Best Practices.

The most important energy saving is the one reached in the FSV virtual campus (95%), whereas virtualization of Data Centre and desktops helped to reach 31% savings in FPNCYL and the Smart Street LED Lightning 75% in Ayto. Logroño.

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 face-to-face to online education. At the University, FSV has reduced its 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 annual 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, and changing conventional street lightning by LED technology. Emissions reduction in the smart street have reached 75%. On the other hand, emissions reduction in paper and in ICT infrastructure has been lower. Taking into account all the consumptions, the average reduction of the project is 20%.

Finally, the application of virtualization policies done in the PRAE building by FPNCYL, both in its Data Centre and in its 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 tonnes within two years of implementation of the pilot action.

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. 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.

A summary of the main results that have been reached in the LIFE Green TIC project framework is shown in the table below:

Actions	Main results
B1 Development of Green ICT Strategies and Action Plans	• Common methodology for the preparation of the Green TIC Strategies and Action Plans. • 3 Green TIC Strategies / Action Plans (one per partner), adapted to the specific implementation sector: ICT equipment inventory, data bases of technical details and consumptions, tasks to be performed by every partner. • Monitoring systems for CO_2 emissions associated with pilot actions.
B2 Pilot action 1: virtualization in an administrative building	• Green ICT engineering project specific for PRAE building (Valladolid). • Contract of supply and configuration of the necessary equipment for the development of the Green ICT solutions. • Monitoring database of the pilot action. • Avoided emissions: 8 t CO_2
B3 Pilot action 2: virtual campus virtual in educational settings (vocational training and University – FSV)	• Specific Green ICT engineering project. • Virtual campus for official higher vocational training courses. • Virtual campus for postgraduate or university courses. • *PaperCut* software for printing and copying management and control in entities under San Valero group. • Implementation of tools: meeting or multimedia collaboration applications; desktops and applications virtualization. • Monitoring data base of the pilot action results. • Avoided emissions: 97 t CO_2
B4 Pilot action 3: environmental management in a Smart City (Logroño)	• Specific Green ICT engineering project. • Extension of the data centre to support the pilot action. • Implementation of a remote noise and air quality monitoring system in a "pilot street" with LED lighting. • Microsite with information on environmental quality. • Environmental quality information integrated into the municipal app. • Monitoring data base of the pilot action results. • Avoided emissions: 47,12 t CO_2

Actions	Main results
B5 Green Criteria for ICT procurement	• List of ICT devices that form the ICT product group open to green procurement criteria. • Benchmarking: bibliographic review and analysis of experiences on the international use of green criteria for ICT procurement. Best practices collection. • Analysis of available verification systems for the green procurement of ICT devices. • Guidelines for the green procurement of ICT products. • 3 tender specifications standard templates or guidelines documents for the green public procurement of computers, imaging equipment and servers. • 5 training days on green procurement of ICT. • Partners experience: implementation of the green criteria to the procurement of partner's ICT equipment.
B6 Best practices in the smart use of ICT	• Review of literature, database and expertise on best practices in the use of ICT. • Questionnaire on errors and bad practices – data base with results. • Best practices guide for ICT users. • 4 informative infographics. • Collection and dissemination of best practices and success stories.
B7 Sustainability Lab	• "MiHuellaTIC" (my ICT footprint) blog. • Tools for dissemination through social networks: Twitter account and Facebook profile. Creation of a Green TIC virtual community, active in social networks. • My ICT Footprint photo contest. • Generation of Green ICT solutions through participation: 67 ideas, 18 projects and 13 actions collected and disseminated as part of the "GreenTIC-Emprende" competition (40 participating teams – about 150 young people (under 30 years) with different origins within the national territory). Four awards to winners. • Networking meeting between finalists of the "GreenTIC-Emprende" competition and companies / technological centres from ICT and environment sectors.

The partnership of the project has 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.
- FSV: 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).
- Ayto. Logroño: to *smart cities* and local authorities in general.

These are the main results of dissemination actions:

- Number of website users: more than 19.000
- Number of followers in social networks (Facebook and Twitter): 1.500
- Number of attendees to the training actions: 231
- Number of members of the advisory groups: 43
- Target audience (number of individuals) of mass media (press, radio and TV) activities: 5.000.000
- Number of congresses, conferences and events in which the Project has been present: 13
- Number of articles published in specialized publications plus papers: 14
- Target group (number of individuals) of the actions meant for general audience. 46.000

The project has analysed the perception that society in general and the target audience of LIFE Green TIC project in particular have, regarding energy and CO_2 emissions saving from ICT equipment.

For that purpose, 114 stakeholders belonging to key sectors of the project, answered to the written questionnaire, and other 125 online surveys were fulfilled by followers of the project on social networks, through the website www.lifegreentic.eu

The main conclusions drawn and lessons learned from this survey 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.
- 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 in 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.

A "Commitment Charter" was designed as a tool to disseminate and to help spread the knowledge and implementation of measures that contribute to reduce the carbon footprint attributed to the use of ICT. This specific initiative has the aim of increasing the socio-economic impact of the LIFE Green TIC project. As a result of this campaign 74 organisations signed their own "Green TIC Commitment Charter" and among them 5 City Councils, 1 Provincial Government, 5 company clusters (ICT, energy efficiency and environmental sectors), 5 technological centres, 4 local or regional energy agencies and 3 educational groups.

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

- Energy and climate change policy,
- Environmental and resource efficient use policies,
- Cohesion policy,
- Employment policy.

The transferability potential of the project has showed up in its final stage. The partnership got in touch with several organisations, among which local and regional energy agencies of Spain, Portugal, Austria and France, to capitalise on the results and deliverables of the LIFE project and to actively deal with a scope of energy saving in which they had never worked before.

Lastly, from the budgetary point of view, the project has reached a 95% implementation rate in relation to the costs approved by the European Commission, mainly due to a lower justification of eligible costs in the "equipment" and "consumables" categories of expenditure.

3. Introduction

Background, problem and objectives

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 LIFE Green TIC project was 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.

Expected longer term results

The findings and products obtained by the LIFE Green TIC project have a high transferability 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.

  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 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 life cycle, 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.

- Employment and skills policy

  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 programmes, educating new IT professionals for a model of green economy and improving, hence, their employment opportunities.

4. Administrative part

4.1 Description of the management system

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

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

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).

Stage 3: development of the basic contents of the different actions:

- Implementation of Green TIC Action Plans (B1).
- Implementation 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).

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).
- Mid-term 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)

Coordinating beneficiary, associated beneficiaries and project organisation

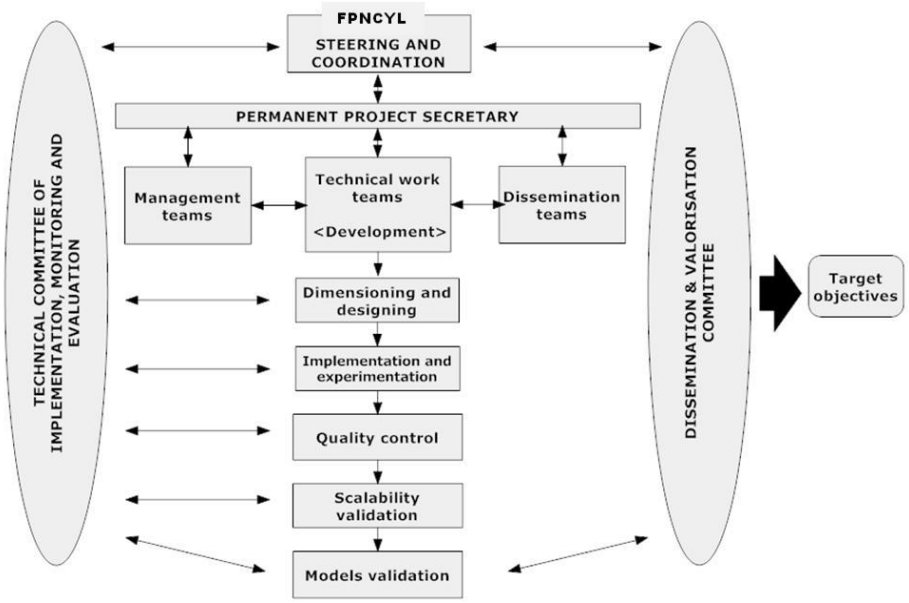
The consortium that developed the LIFE Green TIC Project was formed by three entities representing three sectors or areas with high potential for application of information and communication technologies, both in management and development of their daily activities, as well as regarding environmental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

The Natural Heritage Foundation of Castilla y León (FPNCYL) acted as promoter and coordinating beneficiary of the project. It 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 centres and desktops). As a public body linked to the Ministry of Public Works 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 (FSV), based in Aragón, 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. Its main actions in the framework of the project have been the development of the Virtual Campus pilot action and the implementation of online courses and paperless policies in education, both at its Vocational Training Centre and at the University of San Jorge.

The Logroño City Council (Ayto. Logroño) has added its experience as *Smart City* to the project, as it 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.



The staff was structured in committees set for the project (coordination and management, technical and dissemination). The following table contains the persons who form them:

Committees	FPNCYL	Ayto. Logroño	FSV
Management	**Jesús Díez** (project coordinator / manager)	**Rafael Álvarez** (coordinator) **Diego Hernáiz** (administrative coordination	**César Romero** (project manager) **Nieves Zubález** (coordinator)
Technical	**Soledad Gómez** (sustainability and administrative control specialist) **Marta Cano** (sustainability specialist) **Alejandro Espeso** (IT specialist)	**Rafael Fernández** (IT) **Pedro de Grado** (Environment) **Julio Cesar** and **Rafael Álvarez** (lighting)	**Mercedes García** (management/coordination assistant) **Luis Miguel Carrasco** and **Mª José Cavero** (quality and environment) **Fernando Berbegal**, **Javier Lasheras**, **Jorge Moneo**, **Javier Esteban** (IT) **Vanesa Mercader**, **Jesús Cobos**, **José Manuel Lorenzo** (financial)
Communication	**Javier Valenzuela**	**Raquel García**	**Cristina Mesa** **Marta Ferrer** **Alejandro Aisa** **José Montoya**

Four partnership meetings have been organised in Valladolid (kick-off), Logroño (2nd and 4th monitoring committees) and Zaragoza (3rd monitoring committee). All partners have participated in the results of all activities of the project, except pilot actions B2 (FPNCYL), B3 (FSV), B4 (Ayto. Logroño). For the monitoring action, FSV has developed a different methodology, adapted to the Virtual Campus pilot action.

No substantial changes to the Grant Agreement were requested. The only changes that have taken place are the following:

- Reporting schedule
- Deliverables list

Both changes were suggested by the European Commission and were included in the Inception Report. The Commission accepted those changes in the letter with reference number Ares(2014) 2298964 - 10/07/2014.

Besides, a request was sent to the Commission to include as part of the category of expenditure "Other costs" the payment of "GreenTIC-Emprende" competition prizes in the framework of Action B7: *Sustainability Lab*. This payment was authorised by the Commission with a maximum amount of 5.000€ in the letter with reference number Ares(2015)673106 - 17/02/2015.

The Partnership Agreements were referred to the European Commission together with the Inception Report.

4.2 Evaluation of the management system

The project management progressed generally at a good pace, with some logic digressions that were produced in the introduction of pilot actions with more technological content.

Some delays have to be mentioned in the project start-up on the part of Ayto. Logroño, due to the special administrative and financing control procedures that are applicable to Public Local Authorities. These procedures had an influence in the signing of the Partnership Agreement or in the appointment of staff allocated to the project. Nevertheless, there were some difficulties in the internal coordination,

because of the involvement of different departments of the City Council, as a European Projects Coordination Department does not exist.

At the same time, during the first months of the project, FPNCYL valued that the workload for the IT responsible and for the environmental sustainability specialist was very high; compromising their work on other tasks commended in their job contracts. Therefore, a new person of the entity staff joined the project in order to help them.

Furthermore, the necessity of modifying the deliverables of the project was considered in the Inception Report because some of them were not strictly deliverables but milestones or products and, on the other hand, they corresponded to the previous phases of a final document. That is why they were integrated in a single document.

Likewise, it was considered appropriate that the number of reports for the European Commission be simplified taking into account the duration of the project. A foreseen progress report was removed.

Contact with the European Commission took place in the following occasions:

- Signing of the Grant Agreement
- First monitoring visit (February 2014) – Letter Ref. Ares(2014)437184 - 21/02/2014
- Inception Report – Letter Ref. Ares(2014)2298964 - 10/07/2014
- Second monitoring visit (January 2015) – Letter Ref. Ares(2015)673106 - 17/02/2015

Contact with the monitoring team was carried out through the person commended to the project by means of the external assistance of the European Commission NEEMO (Irune Osés). The contact, both by e-mail and by phone, was fluent. Several consultations took place during the elaboration of the reports as well as the preparation of the monitoring visit.

5. Technical part

5.1. Technical progress, per task

Action B1 - 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 (ICT).

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:

Task B1.0: <u>Design of a common methodology or procedure for the preparation of the Green ICT Strategies or Action Plans.</u>

The setting-up of a Green ICT policy in any organization has to start with a preliminary step. This is the completion of a thorough analysis of the equipment and services available, in terms of rationality and efficiency in their use, together with an analysis 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 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.

Taking into account previous experiences such as the Australian or British Green ICT strategies and the plans developed under the Green Digital Charter, the LIFE Green TIC project has developed its own guidelines with 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.

The document explaining the whole task and the methodology (finished in November 2013) was provided with the Inception Report (deliverable B1.1), is available in the project website and it was disseminated via social networks. It features the stages and minimum contents necessary for the elaboration of Green ICT Action Plans and the different ICT product groups that should be analysed. Here are the minimum contents defined under this methodology:

- Inventory and analysis of ICT infrastructure and equipment.
- Gathering of data on energy consumption and CO_2 emissions.
- Analysis of the organization's ICT policy.
- Green ICT policies proposal for the organization.
- Monitoring system for the energy consumption.
- Lay out of Green ICT Policy Indicators.

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

Task B1.1 Elaboration of an ICT equipment inventory and estimation of their energy consumption.

FPNCYL and FSV carried out their inventories between December 2013 and February 2014 and these were attached to the Inception Report as part of deliverables B1.2 and B1.3 respectively. The inventory of Ayto. Logroño was carried out in February 2015 and was attached together with deliverable B1.4.

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. More precisely the inventory included at least the following devices…

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

… and the following information concerning these devices and others identified during the inventory stage:

- 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 functions.
- Whether it can be completely turned off when not in use.
- Whether they have an energy efficiency labelling system such as Energy Star® or any other type.
- Recyclability / presence of hazardous components.

The following table was designed to develop these inventories (it includes two examples):

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

B1.2 Development of an Action Plan for the implementation of Green ICT by each partner

An analysis of the main existing ICT policies and definition of measures that make up the Green ICT Strategy or Action Plan (in both the short and the medium term) for each partner was developed.

Action Plans of FPNCYL and FSV were approved in March and January 2014 respectively and were attached to the Inception Report (deliverables B1.2 and B1.3). The Action Plan of Logroño City Council was carried out in March 2015 (deliverable B1.4) and was attached to the Mid-term Report.

As part of the task, each partner has analysed patterns of operation and use of the ICT infrastructures, equipment and services of the organization, including those relevant to the

implementation of a Green ICT policy. Moreover, an analysis of the existing options and alternatives to determine which are better adapted for the organization was carried out. This helped to develop Green ICT policies for every partner. 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 Centres, 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 Centre servers work load.
- Adequacy and operation of the CPD 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 project scope in order to determine the degree of compliance with its measures and their impact in reducing energy consumption and CO_2 emissions. This monitoring is shown in two specific reports: deliverable B1.8 (available from June 2015 except for FSV data, which were already attached to Mid-term report) and deliverable B1.9 (available from early June 2016).

Measures included in every partner's action plans are summarised in the following subtasks description:

SubTask B1.2.1 The Natural Heritage Foundation of Castilla y León Action Plan

The Plan prepared by FPNCYL includes 18 actions and 8 sub-actions. This Plan is applicable to the PRAE building in Valladolid, where the Data Centre is located, and to 60 desktops, but also to the peripheral infrastructure connected with such Data Centre and located throughout the region, approximately 40 centres located in rural areas within the natural protected areas network of Castilla y León.

The Plan was elaborated with the support of an external technical assistance (between November 2013 and March 2014), as it was planned in the Grant Agreement. The external assistance carried out the technical proposals of the plan and its assessment in terms of opportunities and profitability, as well as the engineering design for the pilot action B2, included as one of the actions in the Plan. The measures that form the Plan are listed in the following table:

Action 1. – To incorporate all desktops 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 desktops 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 systemby removing individual printers.
Action 6.1. – To consolidate the printing systems removing printers used by a single person.
Action 6.2. –To establish a user training policy in order to raise awareness about energy consumption caused by unnecessary printing tasks. To implement 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 Centre 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 Centre room cooling method by incorporating a *FreeCooling system*.
Action 9.2. - Solution with forced ventilation system.
Action 9.3. – To change the Data Centre 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 Centre 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 IT users awareness on the importance of only storing the 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.

SubTask B1.2.2 The San Valero Foundation Action Plan

The FSV Action Plan was prepared by the staff of the entity itself through a working group in which the various training centres 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, and the educators (lecturers of computing at the ICT faculty and 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 Advisory group (panel of experts) from Zaragoza was established during that meeting.

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

Action 1. - Review and update of the inventory of ICT equipment and devices. Renewal and applying green procurement to ICT equipment. Biyearly review of equipment inventory 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.

FSV elaborated the Action Plan monitoring report (deliverable B1.8) that has been attached as an annex to both the Mid-term and Final reports.

SubTask B1.2.3 Logroño City Council Action Plan

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, were detailed in deliverable B1.4 and are listed below:

Action 1. - Remodelling the switchboard in the local Data Centre.
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, the taking into account of the first type of measures proposed by Ayto. Logroño 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 Green TIC 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 will save 3.463 MW/year and will reduce 1.178 tonnes of CO_2 emissions (see Green ICT actions overview in the Logroño-PAES for more detail).

To give visibility to the links between PAES and LIFE Green TIC project, both logos are combined in the website of the Logroño City Council. See link

Task B1.3 To design the engineering of pilot actions to be developed under the LIFE project and tender documents for each Partner.

The definition of the engineering for the pilot actions implementation was a result of the inventory, analysis and planning stage. These proposals have to be precisely detailed at technical-engineer levels. The studies were carried out in April 2014 (FPNCYL), April 2015 (FSV) and February 2015 (Ayto. Logroño). These engineering proposals are detailed in the sections of this report were pilot actions are described.

The engineering projects have also integrated and defined the components forming the Green ICT systems for the pilot actions of each partner (virtualization, virtual campus and Smart Street).

Task B1.4 To define environmental indicators and design the CO_2 emissions monitoring system.

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 the ICT infrastructure and to measure the impact of the actions taken by each partner in the framework of Green ICT pilot actions and plans 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 was established.

When monitoring energy consumption, it is essential to discriminate consumption attributable to Data Centres (including cooling) from the rest of consumption, as most of it is generated in these settings. The Data Centres 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.

Monitoring must be based on actual measurement (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). These data are obtained by using analysers located in the Data Centre switchboards or in computer equipment outlets.

The basic indicators that have been used 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 Centres (equipment) (kWh/year).
- Energy consumption of Data Centres (cooling) (kWh/year).
- Power Usage Effectiveness (PUE = Data Centre consumption/ total ICT consumption).
- DCiE (Data Centre Infrastructure Efficiency).

The description of the adopted monitoring system is detailed in Action C1 "Quality control and monitoring" of this report.

Task B1.5 Monitoring Action Plans

The Green ICT action plans designed for every partner to be implemented in their organisations, have been monitored on a continuous basis. The purpose has been the assessment of results and lessons learned from the implementation of every proposed measure. This follow-up has been the main subject of various deliverables, more specifically B1.8 "Action Plan Monitoring" (completed in June 2015) and B1.9 "Final Action Plan Monitoring" (finished in August 2016). Every one of them includes concrete sections for every partner.

Main conclusions arising from the monitoring of the Green ICT action plans are, first of all, that a wide range of measures can be implemented to optimize ICT use, to reduce energy consumption, to enlarge life cycle and to better manage the electronic waste by means of a proactive management. Secondly, when talking about ICT, life cycles are short; technology (both for hardware and for software) evolves very quickly as does the need of new services. For all these reasons, it is necessary to make alive Green ICT Action Plans, that is to say, documents that are constantly reviewed and updated to have room for new, more environmental friendly solutions for new challenges and needs.

Analysis of contingencies / deviations from objectives, deliverables and milestones of this action:

Contingency	Solution / Comments	Impact on project´s objectives
Eight-month delay in the elaboration of the Ayto. Logroño Action Plan	The roles of staff assigned to the project were re-established, appointing a new coordinator. The monitoring plan schedule was increased in 3 months.	Although the Plan was not drawn up until 20/02/2015, some measures were already been implemented, such as the ICT equipment inventory, adopting good practices for paper management or applying green procurement criteria. The

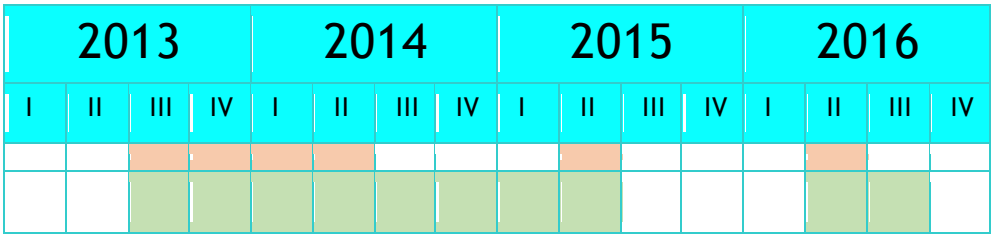
		Plan has been successfully and fully implemented.
Eight-month delay of the pilot action engineering project	The engineering project was drafted by Council own staff.	The tendering process of the Smart Street Pilot Action was delayed .

Perspectives for continuing the action and complementary actions outside LIFE

The action plans drafted by every partner, set out an integrated Green TIC strategy including both actions to be developed within the project and outside LIFE. At the same time, these plans are designed as living documents, being constantly reviewed and updated, and this way of working will continue after the LIFE project has ended. The energy monitoring will stay in place after LIFE and this will facilitate the revision and incorporation of new measures to the Action Plan.

Complementary actions / investment outside LIFE	Renewal of the UPS in the FPNCYL Data Centre
	Free-cooling installation and new air-cooling equipment in the FPNCYL Data Centre
	Monitors renewal in Ayto. Logroño desktops

The following table compares the initial time schedule (sepia colour) and the actual one (in green):



Task / Milestone	DELIVERABLES	Months	Schedule Proposed	Final schedule	Delay Months
B1.1 ICT inventory and audit	B.1.1: Action Plans methodology	02	01/11/2013	30/11/2013	01
B1.2 Action Plans drafting	**B.1.2:** FPNCYL Action Plan	04	20/12/2013	20/02/2014	02
	B.1.3: FSV Action Plan	03	20/12/2013	20/01/2014	01
	B.1.4: Ayto. Logroño Action Plan	10	30/06/2014	20/02/2015	08
B1.3 Pilot actions engineering	**B.1.5:** FPNCYL engineering design	02	30/06/2014	30/04/2014	--
	B.1.6: FSV engineering design	03	30/06/2014	30/04/2014	--
	B.1.7: Logroño engineering design	04	30/06/2014	25/02/2015	08
B1.4 indicators and emissions monitoring system	(see Action C1)	06			--
B1.5 Monitoring Action Plans	**B.1.8:** 1st Action Plan Monitoring	01	30/05/2015	30/06/2015	01
	B.1.9: 2nd Action Plan Monitoring	01	30/05/2016	30/08/2016	03

Action B2. Virtualization in an administrative building (Pilot action)

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 Centres and desktops. In first case (Data Centres) 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. Usually a host software (of hypervisor or VMM type) controls that the different virtual machines are properly addressed. A virtual machine allows having 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 headquarters. This Foundation manages the building, including its entire ICT infrastructure. The number of desktop 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 Centre also serves more than 40 peripheral centres in different provinces of Castilla y León included in its natural protected areas. Therefore, the Data Centre infrastructure (servers, storage disks and electronics and communication networks) is designed not only to fulfil the PRAE building needs: all existing equipment in these centres is connected to the PRAE building Data Centre, and its activity generates electricity consumption therein, this consumption is, therefore, included when monitoring the building.

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

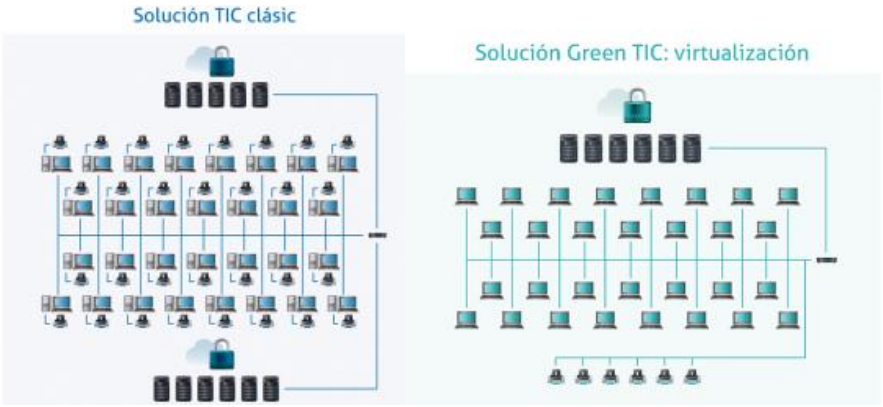
The following tasks have been carried out when developing the pilot action for virtualizing the ICT infrastructure of the PRAE building:

Task B2.0 <u>Drafting of the engineering project</u>

This stage was developed between March and April 2014 within the framework of the action B1 giving rise to the deliverable B1.5-– *Engineering Design of Pilot Action-FPNCYL*. The final version of the engineering project followed the proposal defined in the Green ICT Action Plan (Action B1) once all the technical options and their profitability were assessed, in terms of economic cost and energy saving. This version modified the initially planned technical solution, where it was proposed a virtualization model based on one Data Centre and three servers. The audit and engineering project concluded that the technical solution was not possible without having to excessively oversize the Data Centre, which neither would be economically feasible nor meet targets on CO_2 emission savings.

This led to redefine the solution of the Data Centre, as reflected in the above mentioned "Engineering Project". The aim was 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, the solution was meant to be flexible enough to enable future transfer of virtualization to all desktops managed by FPNCYL and hosted in the PRAE Building Data Centre.

This solution, based on the existence of a Data Centre with five physical servers, met the need to manage a heterogeneous environment, where virtualized desktops coexist with others that are not, and where high power demand equipment, lower demanding ones and homogeneous applications can also be found side by side. Such a solution is shown in the following image:



Once the engineering project was defined, the tender procedure for the equipment contracting was conducted. Regarding the rules of public procurement, an open tender procedure without variants was followed. The bidding was disclosed at the FPNCYL contractor's portal (website of the entity), on 26th August 2014. The allocation was carried out 21st October and the contract was signed 5th November with SOSECAL for an amount of 143.699,64 € (VAT inclusive).

According to the initial schedule, bidding was planned to be carried out in May 2014, to begin the work in July. However, a long work leave of the project IT responsible (Alejandro Espeso) produced a work overload in his labour insertion. This, together with the complexity of the preparation of a technical memory for the bidding, suggested, in order to recover the delay experienced in the pilot action, to contract a specific technical assistance (Guillermo de la Fuente) both for the elaboration of the technical memory and the implementation control of new equipment and the virtualization infrastructure.

Task B2.1 Virtualization of Data Centre

This task started on the 7th November 2014 with the virtualization of the Data Centre and was finished in December, to be followed by the virtualization of desktops once the other had ended up.

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

AREA	EQUIPMENT	UNITS
Data Centre	Virtualization servers	4
	Pilot virtualization server	1
	Disks Storage Cabinet	1
	KVM (switch)	1
	Data Centre Management Console	1
	Virtualization Switch	1
	New Electronic Network	1
	Firewall (control and security)	1
	Rack (server cabinet)	1
	UPS (power supply)	1
Supplied software	Hypervisor VMware License	3
	Veeam Backup Esssentials Enterprise License	2
	Microsoft Windows Server Std 2012 R2 License	4

The following image shows the new virtualized server group in the PRAE building:

Tasks developed for the installation of hardware and software at Data Centre:

- Acquisition and installation of hardware on new rack (computer equipment cabinet).
- Installation of hypervisors (virtualization software).
- Installation of the piloting server and configuration of the new 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
- Incorporation of the pilot server to the current active directory.
- 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.

Task B2.2 Virtualization of desktops

The works for desktops virtualization began 29th December 2014 and were concluded after the different system start-up tasks by 30th April 2015.

- 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 desktops virtualization:

AREA	EQUIPMENT	UNITS
Desktops	All-in-one Thin Client Equipment	24
	Box Thin Client Equipment	7
Software supplied	Microsoft Desktop License	30

The following images show the new thin client equipment in the PRAE building: the "all-in-one" model (left) replacing CPU + display and the "box" model (right) that only replaces CPU but keeps monitors:

Tasks developed for the installation of hardware and software during desktops virtualization:

- Acquisition and installation of thin clients all-in-one and boxes
- Connection of the infrastructure to the FPNCYL's network.
- Installation and customization of virtual machines in desktops.

Task B2.3 Experimentation

Once the installation and configuration of all the equipment was over (with a delay of five months in relation with what was signed in the contract with the external technical assistance and with several configuration problems) the experimentation stage was initiated. In reality, several tests were done in different moments, resulting in bad performance and the need to re-configure.

Seen the lack of significant improvement in the system performance, an external audit was hired to check the configuration state. These works were developed between July and August 2015 and shed light on the numerous mistakes and *mala praxis* in relation with the configuration of the whole virtualized environment both in the data centre and in desktops. Due to the difficulty or impossibility of fixing it through partial improvements following the same working method, it was recommended as the only way out to re-configure the whole virtualization solution from the beginning.

A different company was hired for the re-configuration, starting to work on October 2015. The duration of the task was one month and the performance was finally optimal.

As a result of this new experimentation phase, two new deliverables were drafted explaining the new situation and work done. This are deliverables B2.4.2 – *Virtualization installation manual* (updated version) and B2.5 – *Virtualization tests* (final version).

Analysis of contingencies and deviations from objectives, deliverables and milestones:

Contingency	Solution / Comments	Impact on project´s objectives
The engineering project concluded that the technical solution foreseen at the proposal (3 servers) was not possible without having to excessively oversize the Data Centre	A new engineering solution was designed, based on the existence of a Data Centre with 5 physical servers.	Final energy savings will be lower than the previously planned ones
7-month delay in the implementation of pilot action caused by a long work leave of the IT personnel (Alejandro Espeso)	Contracting a specific technical assistance (Guillermo de la Fuente) to support the tender and the technical processes (implementation of the virtualization system)	During the actual monitoring period (March 2015 – August 2016), enough data collected to enable the analysis of changes in consumptions and to draw conclusions.

Bad performance of the virtualization solution: after a two-month experimentation process, important configuration problems and system operational fails were proved	External technical audit done on the installation, concluding that the configuration of the virtualized system had incurred in fatal errors. The only option was the configuration ex-novo. Cancellation of the contract with the technical assistance. Hire of a new technical assistance. Enlargement of the monitoring period (6 months).	These contingencies did not significantly affect the objectives of the project because registered data were enough to visualize a consumption stable pattern. It also enabled to notice load peaks, analyse them and to solve the causes where appropriate. The comparison with the consumption baseline previous to the implementation of the pilot action also enabled to adjust the new system.

During the actual monitoring period already mentioned (March 2015 – August 2016), enough data were collected to analyse the changes in consumptions and to draw conclusions with a view to Green TIC project. This is possible mainly because ICT consumptions do not have wide variations during the different months of the year.

Monitoring indicators allow to find conclusions even on a monthly data analysis. In the case of PUE (power usage efficiency) indicator, experts recommend to have at least one year measurements, and this was fulfilled within the remaining monitoring period. The delays on the system implementation did not have an impact in the objectives of the project concerning the monitoring and, therefore, a priori it was not necessary to request an extension.

The experimental period (May to December 2015) was considered enough to obtain conclusions about the real impact of Data Centre and desktops virtualization on energy and CO_2 emissions savings. In any case, to make up the experimental months lost, the period was expanded other six additional months (from January to August 2016) so finally the experimenting period covered 18 months. This guaranteed results as solid as it was previously planned.

Perspectives for continuing the action and complementary actions outside LIFE

The virtualization experience will be transferred and capitalized by FPNCYL and the Visitor's Centres in Natural Parks. These Centres are managed by FPNCYL and are located in remote rural areas, most of them Natura 2000 areas. IT infrastructure in these centres is connected to PRAE's Data Centre servers and communication equipment. They just need the virtualization of desktops that will be explored in the following months.

Complementary actions / investment outside LIFE	Installation of a network monitoring software to optimize the load and balance between virtualized servers (PRTG)
	Installation of a Network Attached Storage (NAS) to support Veeam Backup data storage system

The virtualization process (Pilot Action) was registered in deliverables B2.1; B2.2; B2.3 and B2.4 that were the test reports of the Data Centre, its virtualization and the virtualization of desktops, in addition to the system Manual. Prepared at the end of March 2015, it implies a seven-month delay according to the time schedule established in the Inception Report. This delay caused a reduction of the electricity consumption monitoring period, although the data registered until the end of the project (experimental phase) was sufficiently representative.

Lessons learnt

The first lesson learnt is that the virtualization processes are more simple and useful, from the operative point of view, in very standardized environments. In other words, it is easier where ICT infrastructure users need similar programmes and applications, because in some heterogeneous environments, migration and configuration processes demand more tasks and imply a longer period, existing a higher risk of incidents.

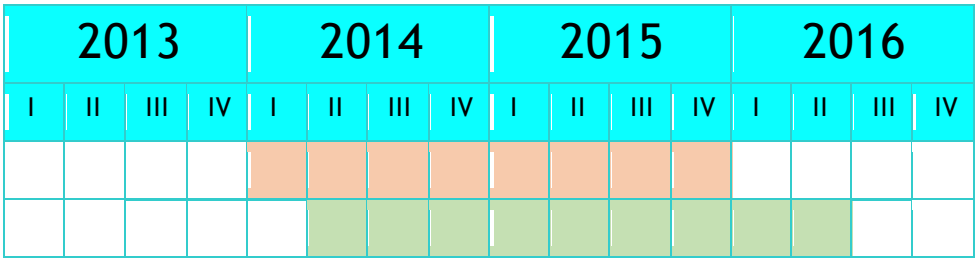
This is one of the main barriers for the implementation of virtualized environments, because of the fear on the part of organizations of paralyzing its activity or loosing information during migration processes.

Nevertheless, in both cases, energy efficiency is reason enough to change from a conventional infrastructure to a virtualized one in medium and large organizations.

Other unplanned factors or contingencies that complicated the implementation, emerged during the virtualization in PRAE:

- Certain workers use special applications and programmes that require physical resources, which cannot be provided by a medium size virtualized environment. This was solved by designing a combined system where some desktops are virtualized and others are not.
- The type of applications and programmes used in seven desktops (specially billing and accounting department) required the use of two monitors or large size monitors, for efficiency and health reasons. The solution was to remove only the physical computer (CPU), maintaining the existing monitors. For this purpose, it was necessary to use two different models of "thin client", the all-in-one model (with LED monitor incorporated) and the "box" model, without monitor.

The following table compares the initial time schedule (sepia colour) and the actual one (in green):



Task / Milestone	DELIVERABLES	Months	Schedule Proposed	Schedule final	Delay (Months)
B2.1 Virtualization of Data Centre	B.2.1: Data Centre Test	02	05/05/2014	05/01/2015	07
	B.2.2: Data Centre virtualization test	04	15/07/2014	20/02/2015	07
B2.2 Virtualization of Desktops	B.2.3: Desktop virtualization Test	03	30/08/2014	30/03/2015	07
B2.3 Experimentation	B.2.4: Virtualization Manual	01	30/08/2014	30/03/2015	07
	(B2.4.2 Updated final version)	01	New version not foreseen	15/12/2015	----
	B.2.5 Final Virtualization Test	02	Not foreseen	30/08/2016	----

Action B3: Virtual Campus in educational settings (Pilot Action)

This action, led by the San Valero Foundation (FSV), was aimed for the demonstration of the CO_2 emissions reduction potential 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).

A deliverable (B3.1 - *Implementation report of the Pilot Action – FSV*) was provided together with the mid-term report and is annexed to this final report. Deliverables C1.1 and C1.2 (monitoring reports for FSV) show that the objectives fixed for CO_2 emission, energy and paper savings were reached without any problem.

As part of this action, several tasks have been developed:

Task B3.0 Drafting of the engineering project

With the aim of developing the Virtual Campus of FSV, both the engineering project and the Action Plan were designed in parallel. This work was commissioned to the company Hiberus as an external assistance.

Intranet and extranet models for the virtual campus and the e-learning platform design were the tasks to be done and all that is detailed in the deliverable B1.6 – *Engineering design of the FSV Pilot Action*.

Task B3.1 Implementation of the Virtual Campus in a higher vocational training centre

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 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.

Task B3.2 Implementation of the 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 school year 2013-2014 and to 2.042 students during 2014-2015.

Task B3.3 Zero Paper policy: printing and copying management and control in San Valero Group and other measures

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 A4 format, etc.) managed by a software called "PaperCut". This software was installed in all four educational entities of the Group by an external assistance (ACESA). They were also in charge of testing the proper function of the system in every entity.

Once this new system for managing copies and printing policies was implemented, ICT staff within the entity was trained (by the external assistance) 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.

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

Task B3.4 Experimentation: other groupware tools

Other actions related to this pilot action have also been developed, such as the display 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.

The Pilot Action in its dual modality (vocational training and university education) was developed according to the schedule. There was a slight delay of five months in the elaboration of the Deliverable *B3.1- First implementation report*, due to methodological difficulties of results monitoring.

Conclusions and Lessons Learnt:

- Results achieved by FSV in the implementation of its pilot action (demonstrative use of ICT applications to the educational field) widely outpace the objectives stated in the grant agreement.

  This proofs the high potential of emissions reduction that can have measures like eliminating students' trips to the classroom (online training) or substituting administrative documents and paper syllabuses by digital ones. These results are reinforced by the large approval of students (the number of participating students has been higher than expected, 110 vocational training students and 2.042 university students).
- Both the methodologies developed and the results reached can be highly useful in several fields and applications with a fast profitability and an excellent ratio "environmental cost-benefit".
- On the other hand, there are certain issues that must by closely analysed. One of them has been considered of interest in the framework of the survey that students participating in the virtual campus have done; it is the possibility of an increase in energy consumed by ICT equipment used and in paper used indirectly that students could make when profiting from the digital materials at their disposal. This close analysis has led to the conclusion that, according to the average of real connection time to the virtual campus platform, a correction factor of 5% of the total CO_2 emissions must be applied. It can also be claimed that only 3,5% of students end up printing the digital contents.
- It should be pointed out the easy adaptation of students to the ICT applications and to the new educational virtualized environments.

Analysis of contingencies and deviations from objectives, deliverables and milestones of this action:

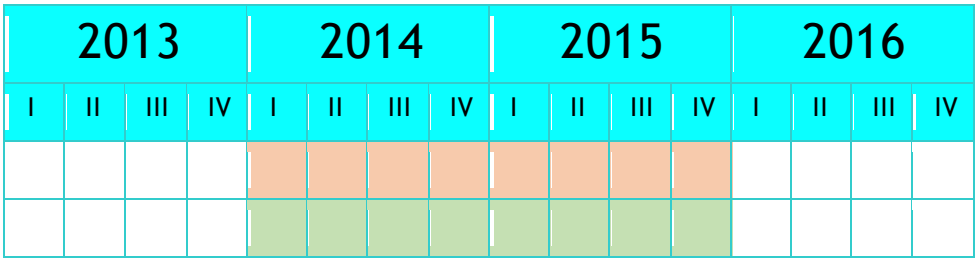
Contingency	Solution / Comments	Impact on project´s objectives
5-months delay in drafting the monitoring report	Definition of an own monitoring methodology, adapted to the virtual campus actions and to the academic time schedule	Better monitoring procedure for the virtual campus. It was necessary to blend the 4 foreseen deliverables into only 2.
The LIFE project virtual campus was integrated in a virtualization global solution of the San Valero Group	The investment needed for the "virtual campus" display was 3 times higher than the budget available in the LIFE project for the task. It was difficult to differentiate the specific cost allotted to the LIFE pilot action. Given all the above, the cost was charge to San Valero Group's own resources.	The foreseen objectives have been better reached by integrating the pilot action in a global virtual system highly complementary with actions outside LIFE project. Therefore, the budget implementation (equipment and consumables) has been lower than expected).

Perspectives for continuing the action and complementary actions outside LIFE

The LIFE Green TIC project virtual campus will keep on developing over the following years, incorporating a growing number of students to the system.

Complementary actions / investment outside LIFE	Virtualization global development of the San Valero Group. Its final economic investment tripled the Green TIC pilot action foreseen cost.

The following table compares the initial time schedule (sepia colour) and the actual one (in green):



Task / Milestone	DELIVERABLES	Months	Schedule Proposed	Schedule final	Delay Months
B3.1 Virtual Campus - VET	**B.3.1** Pilot Action Implementation Report	07	30/11/2014	10/05/2015	05
B3.2 Virtual Campus - University					
B3.3 Zero Paper Policy					
Experimentation phase completed	**B.3.2** Pilot Action Experimentation Report	10	15/11/2015	15/11/2015	------

Action B4: Environmental management in a Smart City (Pilot Action)

The pilot action of Ayto. Logroño focused on the installation of a network of sensors measuring parameters of air quality and noise on a main street in the centre of the city. These sensors are 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:

Task B4.0 Drafting of the engineering project

To start with, it was necessary to design an engineering project related to the monitoring system implemented in La Paz Avenue of Logroño. It includes both the monitoring through the LED lighting system and the Data Centre to support data collection (new IT equipment needed).

- Engineering design of the "pilot street"

The engineering project of the "pilot street" was made in February 2015 by Logroño City Council staff. This engineering proposal has integrated and defined the component parts of the Green ICT systems for the pilot action (Smart Street). The project is included as Deliverable B1.7 – *Engineering design for the Pilot Action – Ayto. Logroño.*

- Extension of the Data Centre to support the pilot action:

The implementation of two new servers was planned as a prior action supporting the development of the pilot action. The servers were acquired through a tender process including in its rules the green procurement criteria that had previously been identified by the City Council computer services within the framework of the green procurement analysis carried out in action B5.

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 programmes to generate business intelligence, which include 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, the organization of a course on the use of Pentaho enable to train the municipal employees that will have to use this tool.

Task B4.1 Dematerialization: documental management system and Zero-Paper policy

This action was aimed for paper consumption reduction in the municipal facilities. The chosen tool to reach this objective was a documental management virtualization system. The implementation began in the Communication department of the city council because its high use of paper.

Nevertheless, after analysing the cost-benefits ratio and applying this solution to other municipal facilities, the action was reoriented towards a good practices policy in paper use in the administration. It was estimated that the benefits of best practices policies are much faster and profitable that the incorporation of more expensive systems (such as documents management software, purchasing new multifunction -printing and image- equipment...). This decision affected deliverable B4.1 that changed its name into "Good practices manual in the use of paper in municipal facilities".

The documental management system was not budgeted in the LIFE project. Therefore, its substitution for a best practices policy did not mean a change or lack of budget. The same objectives were achieved following a different path (best practices), one that entails less investment.

In the proposal, it was stated that 17 tonnes of paper would be saved as a result of the planned actions. Finally, the project has reached a direct paper consumption saving of 20 tonnes (estimating the same consumption average for August - December 2016). Even more, the use of recycled paper has been set

out, reaching 50% of the purchased paper. This increases CO_2 emissions savings far over the objectives set out in the proposal. A total of 39 t CO_2 have been saved with the development of all these tasks, when the proposal objective was 30,5 t CO_2.

In order to calculate the CO_2 emissions of paper consumption it was agreed to use the same conversion factors as in the Aragón Climate Change and Energy Strategy (EACCEL): 3 kg CO_2 eq/ kg paper (virgin) and 1,8 kg CO_2 eq/ kg paper (recycled).

Therefore, even though technical changes were introduced in the task implementation, the objectives have been reached using a mixed system (documents management system foreseen in the LIFE proposal + control and awareness raising among workers and dissemination of good practices). There has been no extra cost for the LIFE project.

Task B4.2 Microsite for environmental quality information

- *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.

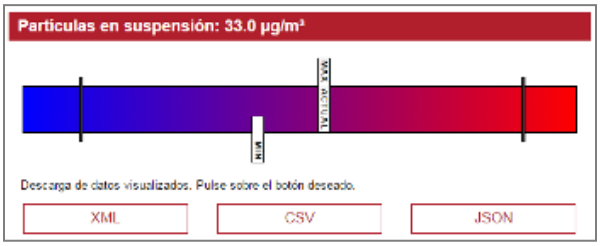
A 5.000€ contract was budgeted for a technical assistance that has modified the existing website and has created the microsite.

- 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.

This enlargement of the app functions does not have associated costs within the LIFE project. Nevertheless, it was included as a task of the project.

Besides, the required changes in the Logroño.es app have been done in order to add environmental information (MAR system) and lighting information (Luix system), thus complementing the weather information (MET system) already displayed.



The new functions are displayed in applications servers belonging to the Logroño City Council and are shown to citizens through the link lifegreentic.

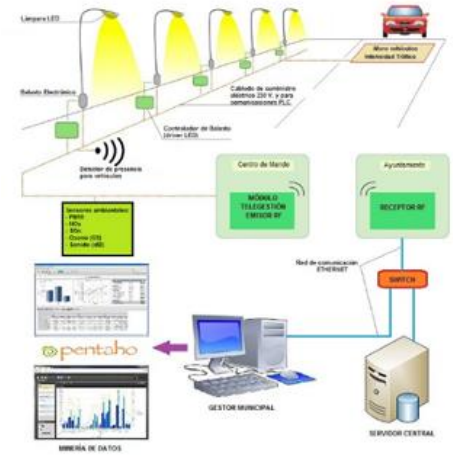
Task B4.3 Smart Street: monitoring noise and air quality through LED lighting

- 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. Thirty-six lamps were installed together with the different sensors that will provide information on the following parameters: PM_{10}, NO_x, SO_2, O_3, noise (dB), traffic flow, temperature, humidity, rain and wind.

This solution is described in the deliverable B4.7- *Remote control system operating report - Ayto Logroño*. Municipal own staff has been in charge of the technical study of the installation project (deliverable B1.7) and therefore there was no need to hire an external assistance. The search, filed and analysis of all this documentation was carried out by the project team own staff.

The infographic below shows the design of the pilot action and the LED lamps:



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 centre 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. Despite road safety and energy consumption parameters were improved, lower speed means worse (but affordable) air quality.

Conclusions and lessons learnt:

- One of the main benefits, in light of the project results, is the possibility of transferring the smart and eco-efficient lightning model to other areas of Logroño or to different municipalities. Not only does it get an important energy saving (thanks to the LED technology and to the light control through motion detectors), but it also helps to coordinate these aspects with the management of vehicles traffic and pedestrians flow.
- The sensors network and data management obtained, shows effective correlation between the above-mentioned flows and energy consumption, and also between them and the environmental pollution. Municipal managers could profit from these key tools offered by the project when dealing with environmental management.
- The scenarios tested by Ayto. Logroño demonstrate that reducing traffic or pedestrian flow intensity, the energy consumption of street lamps with motion detectors decreases:
    - In scenario 1 (decrease light intensity to 70%), the environmental variables stay passive and unchanging and noise level is affected in a significant way. This is possibly explained by the fact that lower light intensity means lower long distance visibility and therefore, lower speed of vehicles circulating to increase road security.

- In scenario 2 (adaptation of light intensity to the presence of vehicles and pedestrians with or without motion detectors), an influence on energy consumption can be observed depending on the presence/absence of motion detectors for vehicles or people.
- In scenario 3 (speed reduction), it can be confirmed that the average speed reduction has an influence on a lower air quality and higher noise levels. This can be explained by revved up engines when using low gears. This would be an ideal scenario for the use of electric vehicles.

Analysis of contingencies and deviations from objectives, deliverables and milestones:

Contingency	Solution / Comments	Impact on project´s objectives
High cost of displaying a documents management and copying/ printing control system	The foreseen document management system was only implemented in the communication department. To reach the paper saving targets an awareness strategy was developed with the staff	The paper saving target and the zero paper policy have been fully achieved with similar results to those expected. As a consequence, the deliverable *Report on the implementation of a documents management system* was replaced by the new B4.1 – *Manual on paper use good practices*.
Twelve-month delay in the implementation of the Smart Street	The experimentation scenarios have been accelerated in the last 8 months of project. For a more detailed description of the experimentation phase, a new deliverable (not foreseen in the proposal) has been added to this final report, B4.8 – *Experimentation report of Ayto. Logroño pilot action*	The reduction in the monitoring period of this part of the pilot action B4 had no significant effects in the final result of getting technical conclusions about the links and synergies of an integrated management of street lighting, road traffic, air quality and noise. This is due to the kind of parameters that are monitored: once the system is implemented and data of the new situation are collected and assessed, valid conclusions can be drawn. The period of 8-month monitoring (from January until end of August 2016) covers all possible weather, street lighting, traffic and pedestrians situations (cold weather, hot weather, working days, weekends, summer holiday period…). Even though all the scenarios are monitored, it has been seen that variation in the parameters is not significant and therefore, a period of 8 months has been sufficient to reach the objectives without losing relevant information. The accelerated tests made possible the necessary sensors calibration and data registration to state their validity and representation. The delays impact was minimised and the validity of conclusions guaranteed. All management scenarios previously proposed have been developed and valid and comparable conclusions have been drawn.
Information on environmental quality parameters was only available to citizens once the Smart Street was implemented	An external assistance was hired to accelerate the microsite creation, website and app adaptation and to coordinate their display with the data collection system. This information plays an important role in the after-LIFE plan.	Temperature and humidity data were available from early project stages. But lighting, air quality and noise data were only available the last months of the project, thus having a lower social impact than expected.

Perspectives for continuing the action and complementary actions outside LIFE

The Smart Street developed in the framework of the LIFE Green TIC project will keep on registering environmental data on air quality and noise, information that will still be available automatically for citizens via website and app.

New tests will be developed in that street with the aim of finding solutions to improve energy saving, air quality and noise levels in the city that could be applied to other streets or areas.

The zero paper policy will be maintained in all departments of the Logroño City Council.

Complementary actions / investment outside LIFE	Purchase of devices to measure detailed ICT electricity consumption

All deliverables have been attached to this report, including those delayed and not attached to the mid-term report (microsite reports B4.2 and B4.5). In order to have a more detailed description of the experimentation phase a new deliverable has been attached to the Final Report (not foreseen at the proposal: B4.8 – *Experimentation report of Ayto. Logroño pilot action*.

It should be recalled that the objective of this action was to show the potential of ICT for urban sustainability and the environmental governance in the city, and this was achieved through:

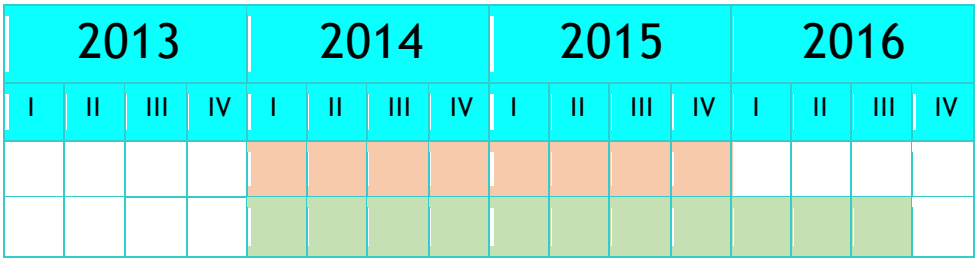
1- The increase of on-line information available for citizens on environmental parameters: temperature (available at an early step of the project), air quality and noise (available after the display of sensors and data management system in early 2016).
2- Data obtained from the sensors and the remote management system in the "Smart Street" have contributed to energy and CO_2 emissions savings.

A monitoring of 8 months (January – August 2016) has been considered representative enough. This period of data collection and analysis is relevant enough to take technical decisions as seasonal or meteorological variations would not substantially alter the weight of the conclusions obtained. Data validity is proved as the expected system correlations have been verified and measures control has been found reliable.

Data and graphics of the correlations between environmental parameters were analysed using the statistical software R-Proyect. It can be verified that both noise level and lighting energy consumption increase or decrease according to traffic level.

As part of the testing period, calibration and verification of collected data validity were included. The system was stabilized, the sensibility of instruments and sensors was checked, adjustments and calibrations were done, all in order to give the maximum coherence to data collection and interpretation. It can be stated that data are coherent and allow getting reliable conclusions that can be applied to similar cases in other cities.

The following table compares the initial time schedule (sepia colour) and the actual one (in green) – implementation and experimentation phase:



TASK / Milestone	DELIVERABLES	Months	Schedule Proposed	Schedule Final	Delay Months
B4.1 Dematerialization: Zero Paper Policy	**B4.1** Report on the implementation of the documents management system (replaced by a manual on paper use good practices)	06	30/08/2014	15/03/2015	06
B4.2 Microsite for environmental quality information	**B4.2** Microsite manual	02	30/08/2014	15/01/2016	04
	B4.4 Municipal app operational report	04	30/08/2014	01/04/2015	07
	B4.5 Operational report on data collection in the microsite	03	30/08/2014	15/01/2016	04
B4.3 Smart Street: monitoring air quality and noise	Pilot Street installation. Light and sensors	03	30/08/2014	15/11/2015	14
	B4.3 Report on the data centre architecture	04	30/08/2014	01/04/2015	07
	B4.6 Operational report on the real time data system	04	30/08/2014	01/04/2015	07
	B4.7 Operational reports on the remote control systems	04	30/08/2014	01/04/2015	07
	B4.8 Experimentation report of Ayto. Logroño pilot action	14	15/11/2015	30/08/2016	09

Action B5 Green ICT procurement

The LIFE Green TIC Project was intended to contribute to identify and disseminate "green procurement" 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 Green TIC project technical team has gathered information and documentation regarding green and sustainable 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 search and collection, filed and analysis of all this literature was carried out by the own staff of the project team. The same staff was responsible for the resulting documents and its consultation processes as well as dissemination activities related. A description of the individual tasks follows:

Task B.5.1 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	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	Backup systems Networks

	External hard drives	Storage devices
Data centres	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

The process and information are detailed in deliverable B5.1 – *ICT product group identification.*

Task B.5.2 Identification of Green ICT specifications, labels and databases.

A benchmarking document was elaborated (deliverable B5.2) on the experiences of green procurement and call for national and international tenders that are considered to be most useful in line with Green TIC 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:

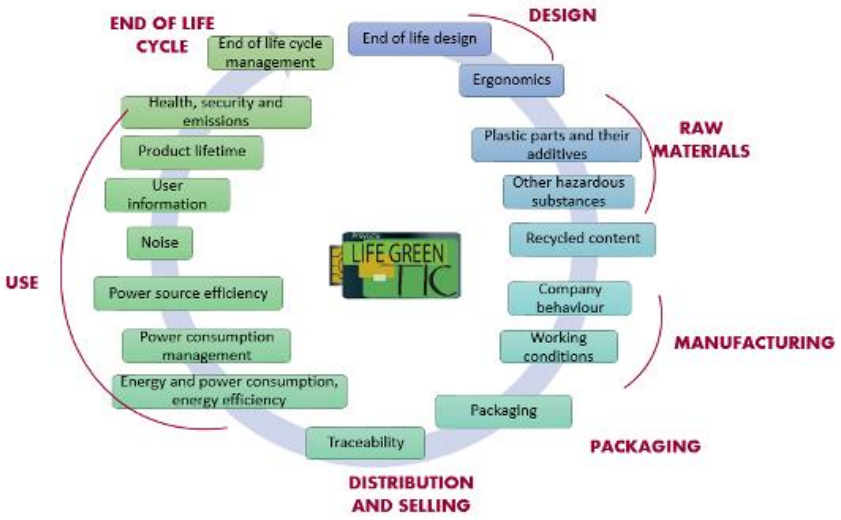
- A first block where all the applicable European and Spanish legislation is compiled, together with the existing strategies and methodologies and the keys for the legal implementation of green or sustainable criteria in ICT procurement for public authorities, including the already existing verification systems (standards, eco-labelling programmes, etc.).
- A second block where references to 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, pioneer countries within this field, some Spanish Regions and in international organizations and companies related to the ICT sector. The necessary information (website 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/sustainable criteria to procurement and tender, that the project team has learnt and that are considered essential to this subject matter.

Task B.5.3 Identification of Green Procurement criteria for ICT Product Groups.

A *Green Procurement Manual for ICT products* (deliverable B5.3) was developed by the working team of FPNCYL with the collaboration of the remaining partners in the tasks of review and approval of contents.

It 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. For instance, the tables summarizing criteria according to product, group of products and labelling scheme. See table for desktop computers and similar below:

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		√	√	√	

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.

Task B.5.4 Tender specifications templates for Green ICT procurement.

Complementing the *Green Procurement Manual for ICT Products*, 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 (deliverables B5.4.1, B5.4.2 and B5.4.3 – *Green ICT tender templates*).

These tender specifications templates for the green procurement of ICT equipment were reviewed and validated by the General Manager on Public Procurement, Quality and Community Services of the Logroño City Council.

Finally, several activities were designed and developed as a complement to the aforementioned tasks. Their aim was to disseminate the developed tools, methodologies and materials and to obtain useful feedback from different stakeholders (local and regional public authorities, educational community and ICT sector). At the same time, the different partners of the Green TIC project used the green procurement criteria and specifications in real practice to the purchasing of ICT equipment. This real exercise allowed to test and to validate them:

a) Training workshops on Green ICT procurement.

Four training workshops were organized in February and March 2016, 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.

b) Practical application of Green ICT procurement criteria by 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 - FPNCYL

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.*
- *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 - FSV

The incorporation of FSV 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 and CSR, the financial staff 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 – Ayto. Logroño

Ayto. Logroño 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 maximum power consumption of the server, 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 and modular expansion possibilities).

Analysis of contingencies and deviations from objectives, deliverables and milestones of this action:

Contingency	Solution / Comments	Impact on project´s objectives
Seven-month delay in the benchmarking and green procurement manual development	Much more literature, bibliography and experiences were found than expected. This enlarged the analysis period so as to reach the more accurate and complete documents possible.	Resulting delays in the launching of the main deliverables for this action: 7 month delay for B5.2 (Benchmarking) and 6 months for B5.3 (manual). Delays neither meant a risk to the targets fulfilment nor implied difficulties to end the tasks on time. They were all completed, the objectives reached and the related activities developed.
Delay in the drafting of the green ICT tender specifications templates	This delay is related to the previous one. To secure more validity to the drafted documents, collaboration with experts on public procurement and a review process were established.	Although the templates were made available with a 15-month delay (B5.4), the target was to have them ready for the training courses on green public procurement and this was achieved. The delay didn't affect the foreseen objective.
The planned training courses were not in line with the stakeholders demands	A new training programme was designed, integrating both green procurement criteria and best practices for ICT users (action B6). The geographical scope was also widened for a larger impact.	The new training programme has had a more positive impact due to a larger number of attendees (10 foreseen, finally 133) in a wider territory (Logroño, Valladolid, Zaragoza, Madrid, Murcia).

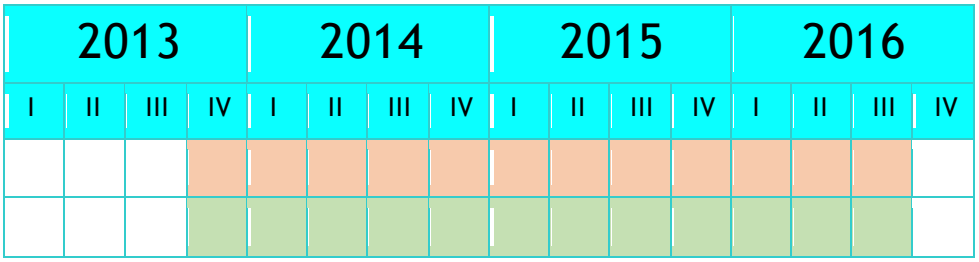
Perspectives for continuing the action and complementary actions outside LIFE

The green procurement criteria will keep on being applied after the LIFE Green TIC project by every partner in all their future ICT equipment and devices purchasing.

Besides, the FPNCYL made an official proposal to the Regional Government of Castilla y León to design and implement a Green Procurement Regional Plan and a specific Green ICT programme. This would include the employment of the developed tools: manual and tender templates. The proposal was approved by the regional authority (Junta de Castilla y León) to be developed in the 2017-2019 period.

Complementary actions / investment outside LIFE	FPNCYL has employed the green procurement criteria to the purchase of equipment and devices (UPS, new imaging equipment, WiFi router for PRAE building) outside the LIFE Green TIC Project.
	Ayto. Logroño has applied the green procurement criteria to the purchase of monitors outside the LIFE Green TIC Project.

The following table compares the initial time schedule (sepia colour) and the actual one (in green):



TASK / Milestone	DELIVERABLES	Months	Schedule Proposed	Schedule Final	Delay Months
Green ICT working group creation		01	15/10/2013	15/10/2013	--
B.5.1 Identification of the ICT Product Group	**B.5.1** ICT Product Group identification	02	01/11/2013	01/12/2013	01
B.5.2 Identification of Green ICT specifications and labels	**B.5.2** Benchmarking on Green ICT procurement	12	30/06/2014	01/02/2015	07
B.5.3 Identification of Green Procurement criteria	**B.5.3** Green ICT procurement guidelines	08	15/09/2014	15/03/2015	06
B.5.4 Drafting Tender Specifications Templates	**B.5.4** Green ICT tender templates	06	15/11/2014	15/10/2015	15
Training of civil servants and educational community		05	01/03/2016	01/03/2016	--

Action B6 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:

Task B6.1 To identify gaps and misuse of ICT and their CO_2 footprint

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

With the basic information previously gathered, the FPNCYL 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 the reality and help to complete this work of identifying these best practices.

The questionnaire (deliverable B6.1) 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 centres, 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 (as it was established in the project proposal).

Task B6.2 To identify good practices (benchmarking)

As a preliminary step, a comprehensive literature, database and expertise on best practices in the use of ICT 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 incorporating the results of this benchmarking work to the deliverable B6.2 *Benchmarking of ICT use best practices* (final version, March 2015).

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 Centre 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 Centres (ITU).
- Specific recommendations from equipment and devices manufacturers.
- GREENIT.NET.
- ENERTIC Reference Guides.
- ETICS – CONETIC.
- NICE Project - The Green Digital Charter.

Task B6.3 To elaborate 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" (deliverable B6.3) 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.

Sixty 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, e-mails, 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.

The dissemination of the *Best Environmental Practices Guide for ICT Users* begun on April 2015 by different means including the website and the social networks of the project, apart from e-mail shipping to the members of the project advisory group and other entities of the ICT and environment sectors (see section 5.2.2 of this report for more details).

The Guide document was subjected to a public consultation process through the social networks of the project and specially the blog "Mi Huella TIC" in order to correct and complete its content. This consultation was carried out from the 17th April 2015.

Task B6.4 To involve ICT users and students in the implementation of best practices

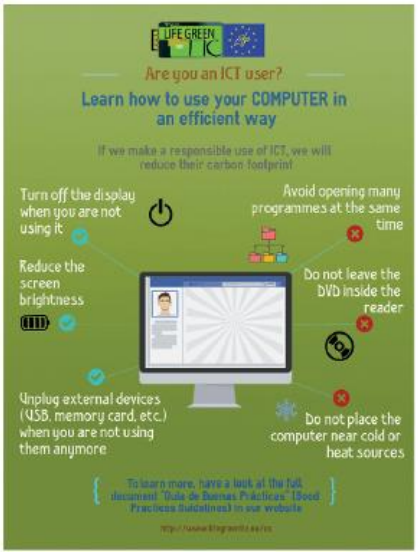
In order to strengthen the dissemination of the *Best Environmental Practices Guide for ICT Users* several activities have been developed by the project, additionally to their dissemination through the project website and social networks (blog, Twitter and Facebook).

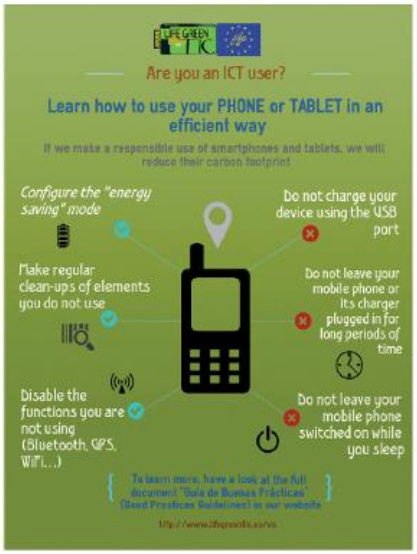
a) Infographics.

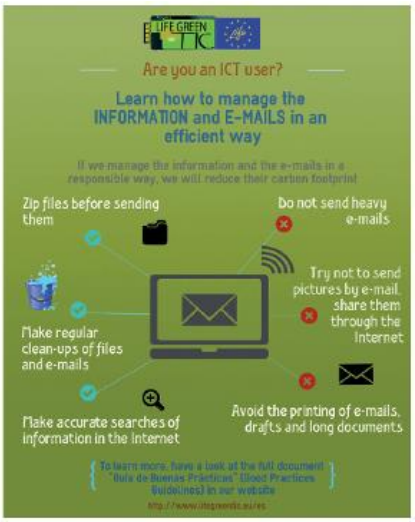
Four infographics summarizing the messages and main recommendations stated in the *Best Environmental Practices Guide for ICT Users* have been developed (in Spanish and English), as this is considered to be a highly effective tool for spreading information through social networks.

These infographics correspond to each of the four sections of this guidelines 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 on 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) Logroño's Best ICT Practices newsletter

Logroño City Council published a series of fact sheets based on the information of the *Best Environmental Practices Guide for ICT Users*. They are distributed periodically as a newsletter to all workers of Ayto. Logroño via e-mail. Direct impact: 385 workers. Factsheets already sent and example of one of them:

- Number 1/2014: equipment use in the workplace.
- Number 1/2015: paper consumption and printing.
- Number 2/2015: phantom energy consumption (see figure).
- Number 3/2015: right use of PC monitors.
- Number 1/2016: life cycle of ICT products.
- Number 2/2016 Programme "Use e-mail in an efficent way".
- Number 3/2016 Programme "Use printers in an efficient way".
- Number 4/2016 Programme "Use mobile phones in an efficient way".
- Number 5/2016 Programme "Use computers in an efficient way".

Analysis of contingencies and deviations from objectives, deliverables and milestones:

Contingency	Solution / Comments	Impact on project´s objectives
Eight-month delay in the completion of the benchmarking report	This delay was a consequence of the progressive incorporation of some recent initiatives to the benchmarking report.	A seven-month delay in the completion of the best practices guidelines (as the objective was to identify best practices and disseminate them among users and entities, the delay did not get a negative incidence on its fulfilment. The task was completed on time and continues in the present.
The planned training courses were not in line with the stakeholders demands	A new training programme was designed, integrating both best practices and green procurement criteria (action B5). The geographical scope was widened for a larger impact.	The new training programme has had a more positive impact due to a larger number of attendees (17 foreseen, finally 133) in a wider territory (Logroño, Valladolid, Zaragoza and Madrid).

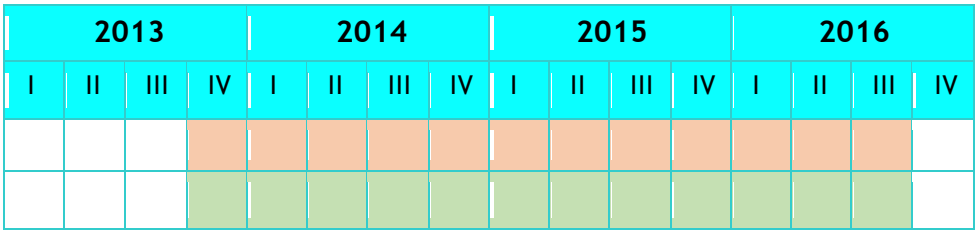
Perspectives for continuing the action and complementary actions outside LIFE

The dissemination of the *Best Environmental Practices Guide for ICT Users* produced under the LIFE Green TIC project receives special attention in the framework of the after-LIFE Communication Plan.

Partners are working with local and regional energy agencies to develop awareness raising activities using LIFE Green TIC best practices guidelines.

Complementary actions / investment outside LIFE	Production of 4 infographics to help disseminate the good practices guide. Spanish and English versions.
	Translation into English of the *Best Environmental Practices Guide*.

The following table compares the initial time schedule (sepia colour) and the actual one (in green):



TASK / Milestone	DELIVERABLES	Months	Schedule Proposed	Schedule Final	Delay Months
Technical group		01	15/10/2013	15/10/2013	--
B6.1 To identify gaps and misuse of ICT	**B.6.1** Best Practices Questionnaire	02	10/05/2014	15/12/2013	--
B6.2 To identify good practices	**B.6.2** Benchmarking Best Practices Report	16	30/06/2014	01/03/2015	08
B6.3 To elaborate a Best Practices Guide	**B.6.3** Best Practices Guide for ICT users.	07	15/09/2014	30/04/2015	07
B6.4 To Involve ICT users in Best Practices	(launching social networks)	14	01/03/2015	15/04/2015	01
	(training)	06	01/04/2016	01/02/2016	--

Action B7: ICT sustainability Laboratory

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 networks in this case) within the scope of co-creation and validation of innovative solutions.
- Promotion of entrepreneurs' ideas that can help to generate new environmental ICT products and services.
- Support for entrepreneurs in the exchange of experience and implementation of ideas.

Task B7.1 Drafting the Lab Working Plan

A company specialized in communication and social networks (Telcomedia) was hired to design and to help to implement the working plan for the Green TIC Lab, providing a "community manager service" and invigorating the participation through social networking on the framework of the project and also to generate the creation of ICT ideas and open solutions for environmental governance.

This external assistance also included the design and maintenance of an individualized Lab space in Internet with the aim of addressing Green TIC ideas and open solutions.

The working plan set the following as main milestones:

- Creation of a virtual Green TIC community in social networks through the blog (Mi Huella TIC) and Facebook.
- To invigorate and enlarge this virtual Green TIC community through specific tasks such as the Green TIC photo contest, and the generation of informative contents of interest about ICT and the environment.
- Success stories dissemination (best practices) about Green ICT solutions.
- Generation of Green TIC ideas and solutions by means of a competition under the name "GreenTIC-Emprende".

Task B7.2 Creation of Green TIC Lab social networks

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

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

This is the way to access to all of them:

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

Task B7.3 Benchmarking: ICT solutions for energy and the environment

To involve other entities in the Green TIC community, "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, 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 "Best Practices" section was enabled within the project´s blog *MiHuellaTIC* as a platform for the dissemination of this information and to shape the aforementioned success stories (see section 5.2.2). In addition to searching online, numerous entities were directly contacted in order to gather further information on their best practices. Some of the interviews conducted were then published in the blog.

These best practices were disseminated via *MiHuellaTIC* blog and the Green TIC Facebook profile. There is also a specific section of the blog where all these Green TIC success stories, projects and experiences can be looked up.

Sixty five success stories (seven belonging to LIFE projects) have been identified. Forty are published in the project´s blog, including descriptive information about them.

Task B7.4 Participation through social networks

To promote Green ICT creativity and innovation between professionals, small enterprises and students or ICT users exploring the linking of environmental governance and ICT, different initiatives were developed following the Lab´s Work Plan and adapting to other activities and milestones of the LIFE Green TIC project:

- My ICT Footprint Photo Contest.

In a first stage, a photo contest was launched through social networks. Seventy-three photos from forty-six different participants were received. The presentation and dissemination of this competition during April and May 2014 generated an important 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.

Below, from left to right and from top to bottom, finalist pictures of the photo contest: Adolfo Domínguez, prr2427, Francisco Luis, Tomas Castro, Francisco Luis).

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 TIC idea. These images are also proving to be very useful for illustrating documents and communication and dissemination materials (such as press releases, website news, etc.).

- Viralization of the LIFE Green TIC project on social networks.

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 Green TIC 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 on 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 posts have been published in the blog and social networks, being their content very well received by users and followers.

Task B7.4 Promoting Green ICT solutions

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 "GreenTIC-Emprende". From the very beginning, this action was considered essential to accomplish one of the main objectives of the laboratory: to get ideas and proposals from young students and entrepreneurs in order to achieve a more efficient use of ICT and to put ICT at the service of environmental management and information, enabling ICT and environmental services.

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

- **Projects**, implemented or planned technical proposals, such as innovative ICT tools (software, applications, websites, 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 ICT; how to use ICT 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.

One representative from each of the project partners plus a representative of the Spanish Association of Computer Technicians (ATI by its Spanish acronym) formed the jury. 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 transferability 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).

The jury assessed every proposal and chose five finalists in each category. This process ended on 15th May 2015. All finalists were summoned to present their proposal in a final event held 27th May 2015 in the headquarters of FPNCYL, in the PRAE building in Valladolid.

The young participants had the opportunity to present their proposals to enterprises and technological centres belonging to the fields of ICT and environment. Networking was an important target of the event with the aim of connecting education-business and administration in search of experiences and alliances for possible development of proposals.

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 Enterprises of Castilla y León together with the finalists of the competition and the project partners, attended the event.

Below, from left to right, two moments of this final event: networking companies-participants and award 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 controlling

parameters and competing with other users while driving in a more efficient, less intensive in emissions way.

- **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. Moreover, as a result of this competition there are many students, entrepreneurs, companies, technology centres 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 TIC community and will be directly involved in the dissemination of these concepts.

Analysis of contingencies and deviations from objectives, deliverables and milestones of this action:

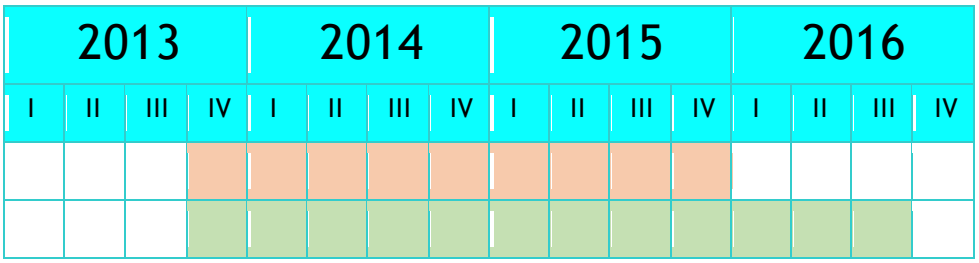
Contingency	Solution / Comments	Impact on project´s objectives
The implementation of the action needs one integrated action for all partners.	It is decided to hire just one lab strategy and its related tools, instead of the three contracts (one per partner) foreseen.	The integration of the lab tools (social networks) gave coherence to the action and had a positive impact. The competition (ideas, projects and actions) was adapted to the academic schedule (high school and university) in order to facilitate the participation, leading to a month and a half delay in its resolution.

Perspectives for continuing the action and complementary actions outside LIFE

Communication tools in social networks (Facebook, Twitter) developed for the Lab's performance will keep on been active and updated as part of the after-LIFE communication plan.

Complementary actions / investment outside LIFE	From the moment the Lab action finished, the work on social networks has continued. Both accounts (Twitter and Facebook) are active. They are still considered useful communication tools that will keep on been active beyond the LIFE Green TIC project.

The following table compares the initial time schedule (sepia colour) and the actual one (in green):



TASK / Milestone	DELIVERABLES	Months	Schedule Proposed	Schedule final	Delay (Months)
Creation of LAB Working Groups		01	15/10/2013	15/10/2013	--
B7.1 Drafting LAB Working Plan	**B.7.1** LAB working plan	02	30/01/2014	30/01/2014	--
B7.2 Opening LAB social networks		01	30/01/2014	30/01/2014	--
B7.3 Benchmarking: ICT solutions for energy and environment		04	01/03/2014	01/03/2014	--
B7.4 Participation through social networks		14	01/03/2015 Kick-off	22/05/2015 Kick-off	02
B7.5 Green ICT open solutions available to the public	**B.7.2** Green ICT solutions Report	08	15/12/2015	15/12/2015	--

Action C1: Monitoring

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 savings because of a 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, each partner (depending on the type of actions that each of them has carried out) has monitored the impact of the project through the application of the following parameters:

- Electricity consumption of the ICT infrastructure.
- Paper consumption when applying paper-less, e-administration and virtual campus policies.
- Fuel consumption saving per trips 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 FPNCYL and of Ayto. Logroño.
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 FSV.

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 tables below have been reached:

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**

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	

Within the framework of the Action C1, four monitoring reports were produced. The first one in January 2014 (deliverables C1.1, one report per partner), to establish a baseline of paper and energy consumption in each entity. Additionally, FSV analysed other variables such as those related to transport for measuring the impact of the change from face-to-face to on-line learning and the implementation of the Virtual Campus.

Subsequently, in May 2015 (using data collected until April 2015) a second monitoring report was prepared. They (again, one per partner, deliverables C1.2) enabled to compare baseline data with those data obtained after the implementation of different Green TIC measures included in the corresponding strategies (action B1) and the pilot actions (actions B2, B3 and B4). Main results are summarised in the following sub-sections.

FSV unified both deliverables (C1.1 and C1.2) in just one document because, as it was already mentioned, they follow a more complex methodology. The short period between the first and the second monitoring reports is due to the delays in the pilot actions implementation as already explained in the technical description of every action.

Later on, two other monitoring reports have been produced: deliverable C1.3 – *Third monitoring report*, with data until November 2015 and deliverable C1.4 – *Fourth monitoring report*, with data until August 2016.

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

C1.1 Monitoring and results in FPNCYL

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 an analyser in the Data Centre 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 Data Centre 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 Centre air conditioning system, consumption data of printers that were not connected to the electrical panel, and the UPS equipment's own losses.

Energy consumption of FPNCYL's 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)

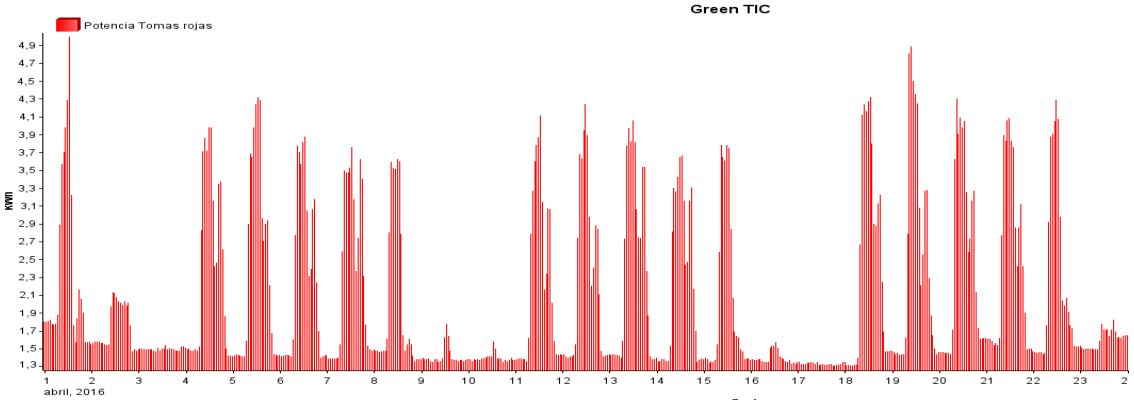
DATE		ELECTRIC CONSUMPTION (kWh)				PUE (Power Usage Effectiv	CO_2 emissions due to total ICT energy consumption (kg CO_2/kWh)
YEAR	MONTH	TOTAL ICT infrastructure	DATA CENTRES		DESKTOPS	CPD consumption/Total ICT devices consumption	
			SERVERS	COOLING			
2014	JANUARY	5.584	1.683	220	3.381	1,309025322	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

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 Centre were not monitored or manual counters were reading them (air conditioning on Data Centre 1, UPS losses, servers on Data Centre 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. Therefore, a new software (*Scada Circutor)* 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 Centre and the CO_2 emissions. New meters, some information processors (EDS-Circutor web server) and a software managing the entire system (Scada) were 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 (see image below).



The monitoring and registration system for the ICT infrastructure electricity consumption started working on-line and in real time in February 2015. From then, data started to be registered (first complete month was March 2015). This enabled a first comparative assessment regarding data of the "baseline year" and to value also the influence of the pilot action (B2) consumption.

This new system corrects the already mentioned failures of the previous system, integrating all the necessary parameters and automatically calculating the Data Centre Performance (PUE) and CO_2 emissions indicators. The table below shows an example of data registration (energy consumption of the virtualized ICT infrastructure for 2015):

DATE		ELECTRIC CONSUMPTION (kWh)				PUE (Power Usage Effecti	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

The following annual energy savings were achieved after the implementation of the virtualized infrastructure (pilot action B2) both in the Data Centre and desktop, and the adoption of additional measures included in the Green ICT Strategy:

Action	Energy Saving (*)	CO_2 Emissions reduction tonnes)(*)
Virtualization of Data Centre	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*

Certain conclusions were drawn once the virtualization of the pilot action was completed in the PRAE building. The main one is the demonstration of the energy saving potential and the confirmation of ICT equipment reduction thanks to the virtualised environments in comparison with conventional or physical ICT environments.

The reduction in the number of physical equipment (both servers in data centres and computers in desktops) has a direct impact on the energy consumption (less devices=less consumption). It has also an indirect impact: if less devices are needed, the energy consumption linked to manufacturing processes would disappear and therefore, the global impact of virtualization in the life cycle of an ICT infrastructure in an administrative building would be even more positive.

As for PRAE building, savings reached after data centre virtualization are near 30% (around 5.000 kWh/year). The intention had been to reach 85%. This lower impact is mainly due to the need of re-designing the technical solution initially proposed because the necessities of the different jobs (and therefore desktops) are complex and heterogeneous. For this reason, it was not possible to virtualise all equipment and therefore the data centre had to be sized with a higher number of servers (three foreseen, finally five).

There were other factors causing a lower energy saving in the data centre (compared to the expected):

- The ICT services and infrastructure of the building kept on growing when new necessities aroused. One example is the integration of a new VoIP phone system; other example is the telematic management of data related to wastewater treatment, water supply and energy management systems, developed by one of the entities sharing the building.
- Energy consumption of virtualised desktops and WiFi equipment has changed from the electricity network to the data centre and now all of them run on the own network electronics.
- 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.

On the other hand, the target of 90% saving due to desktops virtualization was reached compared to the previous conventional desktops. In absolute terms, their impact is lower because only 40% of desktop equipment was finally virtualised and because the number of desktops has increased in the building as new workers and trainees entered the staff.

The total annual savings due to the LIFE Green TIC project implementation in FPNCYL have reached 18.575 kWh once all actions are finished. It means total CO_2 emission savings in two years (project implementation) of 13,19 tonnes, which accounts for a total saving of 31% (the initially expected target was 50%).

C1.2 Monitoring and results in FSV

In the case of the San Valero Foundation (FSV), 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, fuel-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 the environment.

All the information related to this monitoring activity is reflected in the corresponding deliverables (C1.1 + C1.2, C1.3 and C1.4 FSV monitoring reports).

At a first stage in the development of the project, FSV studied the viability of monitoring consumption using technical solutions and measuring applications in real time. Their use was dismissed due to its complexity and measurements high cost, as it had to be implemented in infrastructures with very different networks and facilities and the additional difficulty of the typology distinction of ICT specific consumption in old buildings or buildings with no appropriate electric installations.

As a consequence, the monitoring of electricity consumed by ICT infrastructures and equipment in FSV was performed by the technical team of each educational entity that form the San Valero Group and was assessed (under the supervision of the IT responsible) compared to the baseline fixed at the beginning of the project.

A summary of the monitoring tasks carried out by FSV can be found here:

C1.2.1 Monitoring Zero Paper Policy

The software "PaperCut" was implemented (with the external assistance of ACESA) to monitor the paper consumption in the San Valero Group facilities (mainly the one used by the staff). This software provides automatic control and registration of data (use, number of copies, etc.) enabling to manage the copy and printing policy. The following table shows data (paper consumed and CO_2 emissions) before (2014) and after (2015) PaperCut implementation:

Comparative data before and after the PaperCut implementation in San Valero Group: second year of demonstrative experimentation.			2015 reduction compared with 2014 data
Before the implementation (2014)	Paper consumption (kg)	15.157	
	CO_2 eg. kg *	29.556	
After the implementation (2015)	Paper consumption (kg)	13.037	2,12 t paper
	CO_2 eg. Kg *	25.422	4,13 t CO_2 eq

C1.2.1 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 Green 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:

- 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's 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 CO2 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 consider these issues, a survey was done to participating students.

The energy and paper consumption was calculated during two school years (2013-2014 and 2014-2015), 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 can be seen below:

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

			TOTAL CLASSROOM EDUCATION (2014/2015)				
AREA	PROCESS	Indicator type	number of students	Total average paper consumpt	Total average fuel-oil consumpt	Total average energy consumpt	Total costs (euros)
Publicity	leaflets, documents	paper savings	110	0,54780	-	-	132,00 l
Publicity	offline events	CO_2 emissions	110	0,548	23,084	-	3.681,70 l
Publicity	open doors day	CO_2 emissions	110	0,548	41,316	-	7.601,00 l
commercial	centre's visit	CO_2 emissions	110	-	7,755	-	6.908,00 l
commercial	brochures, posters	paper savings	110	0,55	-	-	2.425,50 l
commercial	pre-registration form	paper savings	110	1,10	-	-	1.342,00 l
commercial	aditional documents	paper savings	110	-	-	-	0,00 l
administration	student documents required	paper savings	110	-	-	-	572,00 l
administration	registration form	paper savings	110	2,19	-	-	572,00 l
administration	certificates	paper savings	110	0,55	-	-	723,80 l
administration	registration process	paper savings	110	1,10	-	-	616,00 l
Teaching	books and syllabus	paper savings	110	657,36	-	-	3.300,00 l
Teaching	classrooms and equipment	Energy consumption	110	-	-	48979,25	8.585,80 l
Teaching	classes / tutorials	CO_2 emissions	110	-	3974,685	-	162.925,17 l
Teaching	calls	CO_2 emissions	110	-	0,000	-	5.725,01 l
Teaching	exams	CO_2 emissions	110	26,299	93,520	-	5.725,01 l
Teaching	evaluation and diplomas	paper savings	110	1,10	-	-	886,60 l
Students assistance	academic records	paper savings	110	0,55	-	-	414,15 l
	GLOBAL TOTAL (110 students):			692,44	4.140,36	48.979,25	212.135,74 l
				Kg	Litres	kWh	Euros
			ALUMNOS	Kg	Litros	Kw/h	Euros
	AHORRO TOTAL:		110	666,15	2057,37	46.098,12	110.899,93 l
			For 110 students switching from classroom to online education				

b) In the case of University Education:

			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	872,65	184.436,59 €
				Kg	Litres	Euros

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

C1.3 Monitoring and results in the Logroño City Council.

Three aspects related to CO_2 equivalent emissions reduction have been analysed as part of the Ayto. Logroño monitoring task:

1- Paper saved through dematerialization policies (documentary management and good practices)
2- Electricity savings of the ICT municipal infrastructure.
3- Electricity savings due to street lighting renewal (conventional to LED lamps).

C1.3.1 Monitoring CO_2 emissions of the ICT infrastructure

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

- Air conditioning and lighting consumptions of the Data Centre 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 IT department) in the Data Centre 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 IT department) of the Data Centre to the total consumption of ICT equipment in the building.

Monitoring started in 2015 and those are the first data available. 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 of ICT equipment), there are real data measured from the month of April. There were no measurements made of individual equipment during the months of January and February 2015, so the evaluation of consumption for those months 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 following images show the Energy Consumption Analysers used:

The table below shows energy consumption (kWh) of the Data Centre and IT staff:

DATE		ELECTRIC CONSUMPTION (kWh)				PUE (Power Usage Effectiveness)	CO_2 emissions due to total ICT energy consumption ** (kg CO_2/kWh)
YEAR	MONTH	TOTAL ICT infrastructure in Data Centre	DATA CENTRES			Data Centre consumption/Total ICT devices consumption	
			SERVERS	COOLING + LIGHTING	Desktops+others		
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*
2016	JANUARY	14.980	14.676	1.673	304	1,112	3.595
	FEBRUARY	14.387	14.062	1.645	325	1,114	3.453
	MARCH	15.076	14.735	1.480	340	1,098	3.618
	APRIL	14.867	14.561	1.378	307	1,093	3.568
	MAY	15.158	14.825	1.583	333	1,104	3.638
	JUNE	14.589	14.320	1.360	268	1,093	3.501
	JULY	14.286	14.130	1.485	157	1,104	3.429
	AUGUST	14.419	14.141	1.428	277	1,099	3.461
	TOTAL 2016*	*117.762*	*115.451*	12.031	2.311	*1,102*	*28.263*

* January to August

** emission factor corresponding to the Spanish energy mix: 0,24 kg CO_2/kWh

The energy consumption of different months may not reflect the saving expected from the measures implemented in the LIFE Green TIC 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 moment 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).

Furthermore, as part of the Green TIC action plan implementation during 2015, CRT (cathode ray tube) monitors started to be replaced by FDP ones (flat display panel) in Logroño City Council. By the end of the project (31 August 2016), a total of 172 displays were already replaced by efficient last generation ones and the energy savings reached 80% (estimation after direct measures).

C1.3.2 Monitoring results in the Smart Street with LED lighting

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).

Impact of lighting system change (from conventional to LED lamps)

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 21.000 kWh per year which means 8.120 CO_2 kg avoided.

The savings are a consequence of the lamps changing:

- 20 units double globe style: 150 W VASP → 30 W LED
- 11 units Albany style 2: 150 W VSAP → 34 W LED
- 5 units Albany style 3: 250 W VSAP → 92 W LED

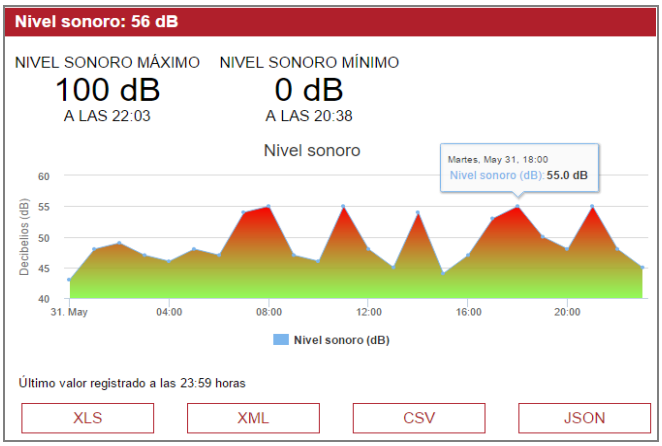
The change of sodium vapour lamps (VSAP) to LED meant an energy saving of 76%.

- Energy saving= VSAP energy consumption – LED energy consumption
- Energy saving=27.907 kWh/year - 6.782,8 kWh/year = 21.124,2 kWh/year
- Economic saving=21.124,2 kWh/year*0.21 €/kWh[1] = 4.436,082€/year

Likewise, this change has meant a reduction in CO_2 emissions of 76%, a total of 7.393,47 kg CO_2/kWh (21.124,2 kWh/year x 0,35 kg CO_2/kWh).

Monitoring of air quality and noise parameters

The system of sensors installed, 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. The following image shows an example of how data are visualized:



[1] Estimated price

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.

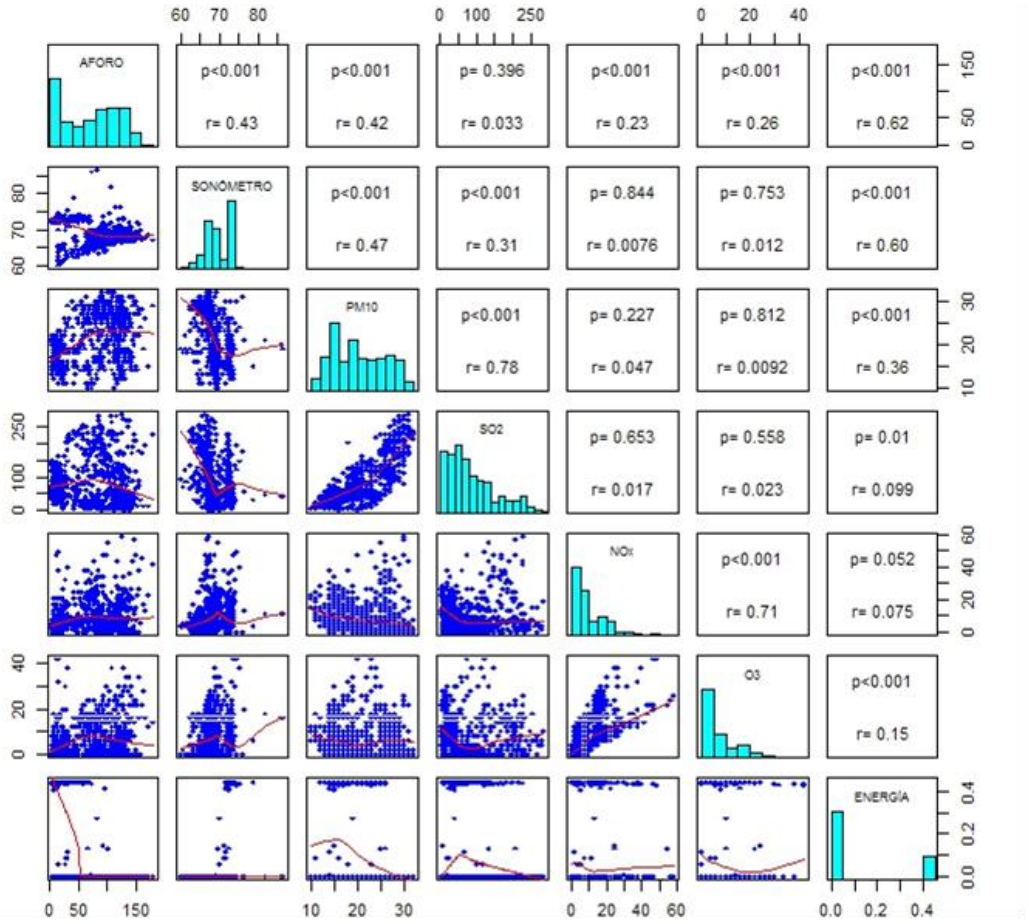
All these data are collected since January 2016 and are managed by the City council staff. They enable to make the foreseen experimentation according to three different scenarios: light intensity reduction, light intensity adaptation to motion detectors (for people or vehicles) and vehicles speed reduction. For these three scenarios, valid conclusions were drawn. These conclusions enable to consolidate the undertaken actions and to transfer the experience to other areas in the city or other cities.

A statistical software (R-project) helps in the monitoring tasks. It analyses all collected data, the correlation between parameters and helps to draw conclusions.

As an example, data for one of the scenarios (scenario 1, light intensity reduction) are shown. Graphics show correlation between parameters and the formulas related to it. For every scenario, the system collects values every quarter of an hour during a whole week for every of the seven parameters included: Traffic capacity; sound level meter (dB), particles (PM_{10}) ($\mu g/m^3$); SO_2 ($\mu g/m^3$); NO_x ($\mu g/m^3$); O_3 ($\mu g/m^3$); energy (kWh). For every of them, around 4.700 values have been compared.

The system also includes lineal relationships for the different variables using the physical units mentioned above. This helps to approximately calculate possible trends due to environmental factors change or to traffic. An example of such formulas would be:

Formula ==> **Traffic capacity** = Sound level meter x (-1.0353) + PM_{10} x (6.2536) + SO_2 x (-0.4180) + NO_x x (1.0235) + O_3 x (0.3148) + energy x (-85.6990) + 47.7329



Example on how to apply results:

When analysing the noise level according to the traffic level, we use the corresponding formula using data of a day in the first scenario:

Sound level meter = traffic capacity x (-0.006541) + PM_{10} x (-0.070267) + SO_2 x (-0.007646) + O_3 x (0.041019) + energy x (8.141263) + 70.880949

We complete values by choosing a moment in which 10 vehicles were detected in a quarter of an hour:

Sound level meter = 10 x (-0.006541) + 16 x (-0.070267) + 60,26 x (-0.007646) + 2 x (0.041019) + 0,4407 x (8.141263) + 70.880949 = 72,89dB

Now we repeat the process with a higher number of vehicles, for example 80:

Sound level meter = 80 x (-0.006541) + 16 x (-0.070267) + 60,26 x (-0.007646) + 2 x (0.041019) + 0,4407 x (8.141263) + 70.880949 = 72,4 dB

We can observe a decrease in the sound level. This relationship is an answer to the decreasing light intensity of lamps explained by a lack of long distance visibility and therefore, the decrease in the speed of vehicles for a higher security. We can conclude that the higher the number of vehicles, the lower their speed and the lower the noise emission associated.

C1.3.3 Monitoring of the documentary management and printing policies

The municipal reprography service is giving annually data on paper consumption (number of sheets). Knowing that value (DIN-A4 sheets) and the weight of a 500 sheet-package, the annual consumption related to weight can be traced:

Logroño City Council – Paper saving results			2015 reduction compared to 2014 data
Before the implementation (2014)	Paper consumption (kg)	34.481	
	CO_2 eg. kg *	66.300	
After the implementation (2015)	Paper consumption (kg)	23.704	
	CO_2 eg. Kg *	46.080	19,5 t CO_2 eq

To calculate CO_2 emissions attributable to paper consumption, all three partners agreed to use the same conversion factor: 1.9kg CO_2/kg of paper (8.100 kWh/t paper * 0.24 kg CO_2/kWh) (Source: Aragonese climate change and energy strategy - EACCEL).

Analysis of contingencies and deviations from objectives, deliverables and milestones:

Contingency	Solution / Comments	Impact on project´s objectives
Six-month delay in drafting the first monitoring report	For FPNCYL and Ayto. Logroño, it is due to delays in pilot actions implementation. For FSV the reason is the methodological complexity, solved by designing a specific methodology for the Virtual Campus action.	The real monitoring period begun at early 2015 allowing to measure the majority of the effects and results of the actions linked to paper and ICT energy savings. The data already obtained enabled to value with reasonable reliability the initial impact of the measures adopted in the three organisations.
Delay in the implementation of the pilot action in Ayto. Logroño	As explained for action B4, a rapid procedure is employed for data calibration and validation, for the application of experimentation scenarios and for results monitoring.	Even with a shorter monitoring period than the planned one, the rapid application of experimentation scenarios leads to a relevant period for data analysis, enough to take technical decisions. This is possible because the seasonal or meteorological variability does not substantially alter the weight of conclusions.

		The expected correlations and their reliability level (measure and control) have been confirmed by the system: both noise level and lighting energy consumption increase or decrease according to the traffic level; environmental pollution parameters (PM_{10}, NO_x and specially SO_2 and O_3, have a direct relation with traffic intensity with intense correlations multivariable. All this validates the expected results of the action.
An increase in FPNCYL IT equipment outside LIFE, due to new services provided and new staff working in the building.	The increased of energy consumption was solved by quantifying the consumption corresponding to the growing ICT infrastructure and compensating data to make them comparable.	The growing ICT infrastructure means a direct impact on CO_2 emission savings (lower than expected in the project framework). Nevertheless, the monitoring was feasible and validated and data obtained have driven to clear conclusions on the impact of pilot actions. All this is possible thanks to the unfold of a system consisting on consumption analysers and a monitoring software.

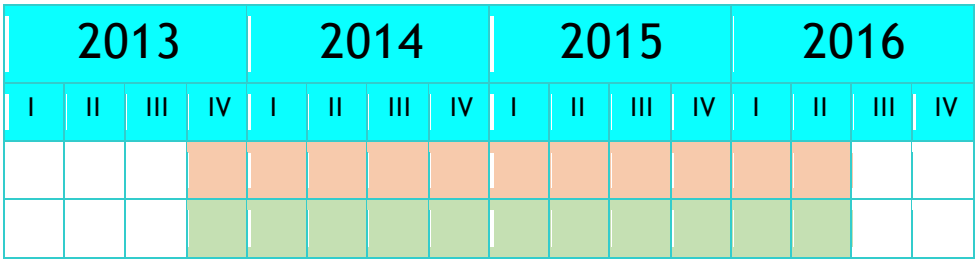
Perspectives for continuing the action and complementary actions outside LIFE

Monitoring electricity and paper consumption due to Green TIC and Zero Paper policies will continue to be developed by all partners. This goes in line with the continuity of the action plans designed in action B1 by every partner and also with the ISO 14.001 and EMAS environmental management systems in place in FSV and FPNCYL respectively, and the participation in the Covenant of Mayors of Ayto. Logroño.

The latter will continue with the "Smart Street" experimentation, being this a testing lab for other cities. One of the main advantages, seen the results, is the possibility to reproduce this model of sustainable lighting in other areas of the city or other cities or towns. This would lead to an important level of energy saving (thanks to LED technology and to lighting regulation through motion detectors) plus the reduction of environmental pollution due to traffic regulation using ICT.

Complementary actions / investment outside LIFE	Investment in manual energy consumption analyzers by Ayto. Logroño

The following table compares the initial time schedule (sepia colour) and the actual one (in green):



Task / Milestone	DELIVERABLES	Months	Schedule Proposed	Schedule Final	Delay Months
1st results report approved	C.1.1 First results report	03	30/06/2014	10/01/2015	06
2nd results report approved	C.1.2 Second results report	03	28/02/2015	15/05/2015	03
3rd results report approved	C.1.3 Third results report	06	30/11/2015	30/11/2015	--
4th results report approved	C.1.4 Fourth results report	06	15/06/2016	30/08/2016	02

Action C2 Socioeconomic impact

The development of this action started in February 2015. Coordinated by FSV, its aim is to assess the acceptance and the social impact of Green ICT policies and actions together with the potential of green ICT to enhance youth participation and to create jobs.

The following tasks have been implemented to reach the action targets:

C2.1 Green ICT survey

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.

For that reason, a specific questionnaire, adapted to three scope of actions (students, public employees and companies) was drafted to carry out a survey. The questionnaire was approved by the partners in February 2015 and the survey was launched in June 2015 using e-mailing and promoting it through social networks, newsletters and other media.

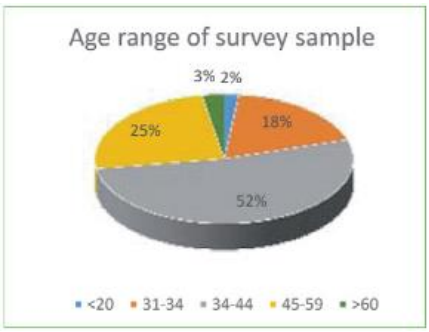
There was a first version of the questionnaire that was completed by 30 participants (mainly members of the advisory groups of the project). After deep consideration by partners, it was concluded that the questionnaire was too long and complicated. A second version, with a lower number of questions was designed in order to reach a considerable number of answers (84 more were received - significant enough to reach conclusions). An online version (quick answers) was also launched through the website of the project and social networks and other 125 online surveys were fulfilled in www.lifegreentic.eu. In total the number of participants in the survey was 239.

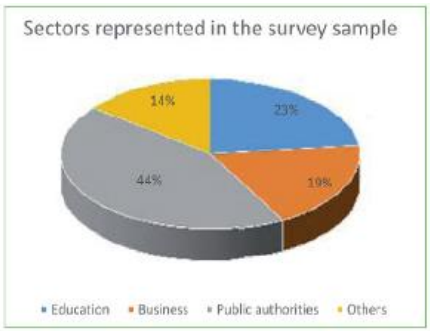
The project proposal was designed counting on an active participation of the San Valero Group students on the questionnaires fulfilling. It is a representative group of the educational sector because it includes both university students and vocational training students.

Previously to the launching of the socio-economic impact survey, these students (about 500) participated in specific surveys on the monitoring of the Virtual Campus pilot action as part of the impact monitoring methodology of the pilot action on energy and paper savings.

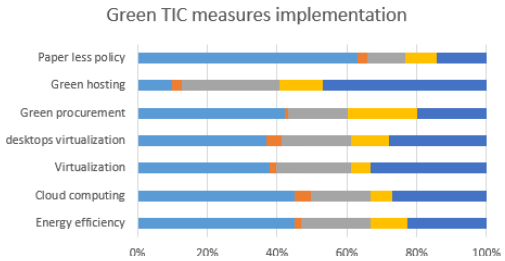
As a result, there was a lack of answers from the students to the written questionnaire (main reasons: they were tired of surveys and young students are generally not motivated by surveys with a technical content). Nevertheless, a certain correlation between the dissemination of the quick questionnaire online (via Green TIC website) and the promotion through social networks of IT students can be confirmed. 125 answers to this on-line questionnaire were registered.

The profile of the sample of the stakeholders written survey was 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 following graphs:

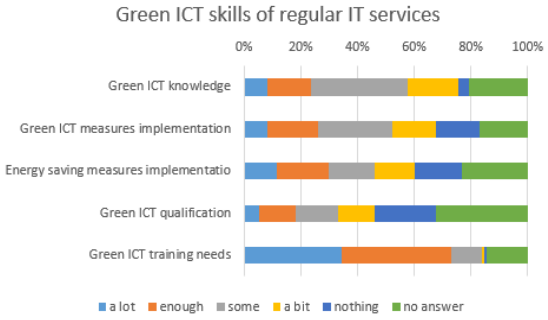


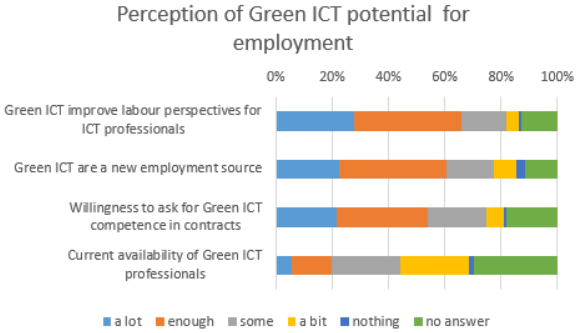


Less than half of the people surveyed recognized to have implemented Green ICT measures in their entities, except in the areas of printing and imaging equipment resource saving, which is the policy that has more implementation (73 %). The policy that has the least implementation (14%) is that of contracting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



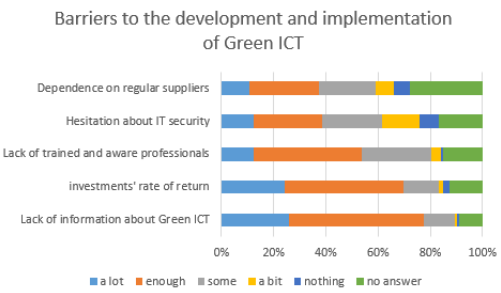
A majority of respondents (81%) think it is very necessary that the IT departments and the usual IT service providers improve their skills on Green ICT policies, services and products. This is consistent with the fact that only 30% report that their suppliers or IT departments have implemented Green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

C2.2 Drafting a report on the socio-economic impact of Green ICT

In parallel with the survey developed in task C2.1, a benchmarking of experiences and studies related and the potentiality of Green ICT employment creation was carried out. It is formed by a compilation of experiences and reference documents about the social and economic impact of ICT in order to analyse the "Green ICT" concept and its socio-economic impact.

A summary of these experiences was incorporated, together with the analysis of survey answer in the deliverable report of the action. This deliverable (C2.1 - *Green ICT Jobs and Economic-Impact Report*) suffered a three-month delay over the initially planned date (June 2015).

The main conclusions drawn and lessons learned from this Report 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.

C2.3 Green ICT Commitments

The "Green TIC Commitment Charter" was designed to boost the socio-economic impact of LIFE Green TIC project. This specific initiative focus on the dissemination of knowledge to help to implement measures that contribute to reduce the ICT carbon footprint.

The awareness raising among organisations in relation to energy and resources consumption of their ICT infrastructure could lead to the adoption of measures to reduce those values by improving efficiency and at the same time, competitiveness.

By signing the "Green TIC Commitment Charter", every organisation can decide the level of commitment (number and complexity of measures proposed) according to their own policies (corporate social responsibility, environmental management) and to their budget availability.

At the same time, LIFE Green TIC project put at the signatories' disposal a bunch of tools to help them implement and develop their own targets. Some of these tools are the methodology for drafting Green TIC strategies/plans, the green ICT purchasing manual or the good practices for ICT users. Information on the project has regularly been sent via e-mail to the signatories, together with other stakeholders or potential beneficiaries.

Any organisation could join the initiative. Green TIC approach is an important complement for entities that already have a certified environmental management system, a corporate social responsibility policy, a climate change strategy or simply an energy consumption control.

To participate, it was only necessary to download the model commitment Charter (www.lifegreentic.eu/es/documentos/9) and send it back once signed via e-mail.

Although it was planned for June 2015, the campaign "Organisations committed to Green ICT" was launched in the early stages of the project development (November 2014), taking advantage of the project's participation in the National Environmental Congress (CONAMA 2014), were visitors were invited to ask for information and sign the charter. The initiative raised interest among many participants in the Congress and almost 30 organisations and 122 individuals signed the charter (a different version for ICT users committing personally was designed for this purpose).

Later on, the initiative was disseminated among stakeholders and advisory groups of the project and through social networks to the Green TIC virtual community.

As a result of the campaign, 74 organisations have signed the Green TIC commitment Charter and among them public organisations (5 city councils, 1 provincial government, public foundations, public companies, 5 technological centres, 4 local or regional energy agencies) and private companies (ICT and environment sectors), associations (5 clusters of the ICT, energy efficiency and environment sectors), educational organisations and foundations. Most of them are Spanish but it must be highlighted that there are 5 signatories from Portugal and one from Peru.

The initiative was very useful to bring to light the commitment with fighting climate change that have many Spanish organisations, and more specifically the need to mitigate CO_2 emissions coming from ICT activity. At the same time, this has been seen as an opportunity to reduce energy costs and to improve competitiveness or investment capacity (due to general costs reduction). (Deliverable C2.2 – *Green ICT Commitment Charter).*

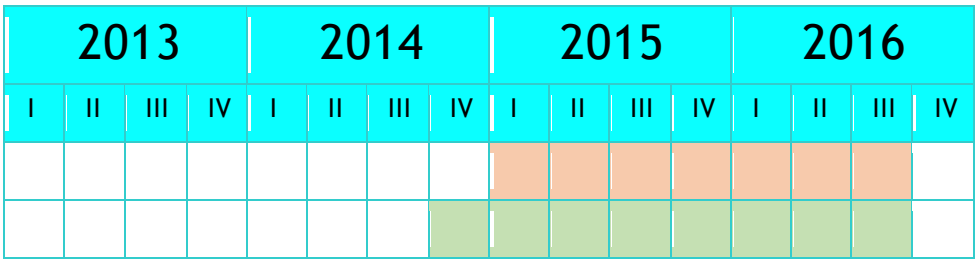
Analysis of contingencies and deviations from objectives, deliverables and milestones:

Contingency	Solution / Comments	Impact on project´s objectives
Low participation rate in the initial Green ICT survey	Only 30 people answered the first version of the questionnaire. The solution adopted was to design a shorter version addressed to stakeholders and an online quick-answer version managed through the project website and disseminated via social networks.	Finally, 239 people answered the survey. Even if that number is much lower than the target (1.000), results can be considered valid and representative for stakeholders, but with low participation of students. Nevertheless 500 San Valero students answered specific questions related to behavioural change linked to the pilot action and its monitoring.

Perspectives for continuing the action and complementary actions outside LIFE

The *Green TIC commitment charter* will play an important role in the after – LIFE communication plan as new organisations will be given the opportunity so sign the charter and signatories will keep on receiving information and will be subject to follow-up works to obtain their feedback on experiences and lessons learned.

The following table compares the initial time schedule (sepia colour) and the actual one (in green):



Task / Milestone	DELIVERABLES	Months	Schedule Proposed	Schedule Final	Delay Months
C2.0 Drafting a Questionnaire for Green ICT survey		01	20/02/2015	20/02/2015	--
C2.1 Drafting Green ICT socio-economic impact Report	C.2.1 Green ICT Jobs Report	08	12/06/2015	30/10/2015	04
C2.2 Green ICT Commitments	C.2.2 Green ICT Commitment	02	26/06/2015	20/11/2014	--

Action E3 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*** (www.greendigitalcharter.eu). **7th Framework Programme.** 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. Their coordinator 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 Centre of Castile and León" (FCSCL, by its Spanish acronym) in León. This cooperation has led to better guide the Pilot Action B2 developed by FPNCYL on virtualizing data centres.

- ***Green ProcA (Green Public Procurement in Action).*** (http://gpp-proca.eu/). **Intelligent Energy Europe**. 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 Mayors, 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 have been translated, adapted and

included in the *Green Procurement Manual for ICT Products* and in the tender specifications standard templates of the Life Green TIC project.

- ***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 was taken into account in the dissemination and on the Socioeconomic Impact Action (C2).

- ***Erasmus Mundus Green IT*** (emundusgreenit.uvigo.es). Talks 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 Clim´Foot** (www.climfoot-project.eu). LIFE Green TIC project has made available the set of tools developed within the project to Clim Foot, a project coordinated by the French Energy and Environmental Agency. More specifically, the Commitment Charter model, the methodology for the inventory of ICT energy consumption and CO_2 emissions and the conversion factors to CO_2 values used were found useful for the Clim Foot project.

- LIFE entities that have signed their Commitment Charter:
  - 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

- ***FIESTA Project***. Energy Intelligent Europe (www.fiesta-audit.eu/es/). The Fiesta partnership includes 19 partners form 5 countries (Spain, Italy, Croatia, Bulgaria and Cyprus), all of them committed to help families reduce their energy consumption at home with a special focus on vulnerable consumers (families living in social houses or with low incomes). Ayto. Logroño is partner in both projects and has made available to FIESTA participants all Green TIC materials on best practices for ICT energy saving. The coordinator of the FIESTA project attended the Logroño green procurement and best practices training day and made a presentation of their own project.

Other networking activities

- **DG CONNECT (European Commission**). LIFE Green TIC project awoke interest on DG Connect. Mr. Cristóbal Irazoqui, a Policy officer of ICT Environmental Sustainability, Directorate H – Sustainable & Secure Society, Unit H5 – Smart Cities & Sustainability contacted the coordinator. Green TIC project sent information and documents of interest for him concerning project results such as the methodology for drafting Green ICT plans, the monitoring system and savings achieved, the stakeholder's survey results and the socio-economic impact report.

  For his part, Mr Irazoqui provided numerous information of interest for the Green TIC project together with the experiences of other European projects.

- **Spanish Association of Computer Technicians (ATI**, by its Spanish acronym) 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) www.cepis.org/.

ATI has intensely worked in the "GreenTIC-Emprende" competition (action 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.

Analysis of contingencies and deviations from objectives, deliverables and milestones:

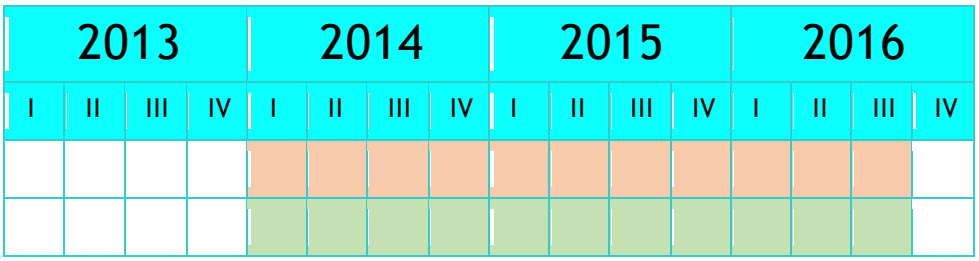
No contingencies have been faced in the development of this action, which has run smoothly with a very positive impact on the project, especially in the final stage once other organisations have get to know the Green TIC project results and products developed.

Perspectives for continuing the action and complementary actions outside LIFE

An active contact will be kept with those projects and organisations with which the Green TIC project has developed the networking activity. Collaboration will consist on sharing feedback from different activities, capitalize on results and develop possible networks and joint projects.

Additionally, the task of searching and contacting new European projects that could be related with the Green TIC objectives will be maintained with the aim of sharing products and results.

The following table compares the initial time schedule (sepia colour) and the actual one (in green):



Task / Milestone	DELIVERABLES	Months	Schedule Proposed	Schedule final	Delay Months
First identification of target projects for networking		02	28/02/2014	28/02/2014	--
Promotion of networking agreements		03	15/05/2014	15/05/2014	--
Updating of target projects for networking		02	16/02/2015	16/02/2015	--
Promotion of networking agreements		03	15/05/2015	15/05/2015	--
Updating of target projects for networking		02	15/02/2016	15/02/2016	--
Promotion of networking agreements		03	16/05/2016	16/05/2016	--

5.2 Dissemination actions

5.2.1 Objectives

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.
- FSV: 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).
- Ayto. Logroño: to *smart cities* and local authorities in general.

Target audience for project's dissemination actions:
- Public authorities (as big ICT consumers): specially addressed by green procurement actions (procurement and IT departments), best practice actions (public employees as ICT users) or environmental governance.
- Academic Community: educational authorities, universities, higher education and vocational training centres.
- Youth: as main users of ICT (mobile phones, tablets...) & social networks (both kinded with app.), young people are main target audience for the awareness raising activities on sustainable use of ICT and best practice application to reduce carbon footprint & participation in environmental governance.
- Enterprises: ICT enterprises and young entrepreneurs will be involved in the project, through their associations and also through R&D and innovation centres. Enterprises have participated in working groups for drafting GPP criteria, identifying good practices and misuses of ICT, networking with students, and as followers of technical information in project´s social networks.
- General Public: awareness raising on the environmental impacts of ICT is also important for the overall population as all of us are users of this products. For this purpose, mass media dissemination activities have been implemented.

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

Dissemination and communication actions have enabled the participation in the project of:

- About 29.000 students, of which 2.152 directly in the Virtual Campus pilot action of FSV and 154 in the "GreenTIC-Emprende" competition. Indirect participants through social networks of the San Valero educational Group are more than 24.000.
- More than 20.000 civil servants and public bodies' employees, of which 18.000 were direct target for best practices dissemination by the regional government (Junta de Castilla y León) and 500 by the Logroño City Council. Furthermore, 82 have been trained in Green Procurement of ICT and Best ICT Practices.
- More than 200 entrepreneurs and ICT sector professionals, of which 43 through the expert groups (project advisory groups), 74 through the signing of the "Green TIC Commitment Charter" and 90 in the training seminars on green procurement of ICT.

- More than 1.500 followers with a professional profile (ICT, environment, education and public authorities sectors) in the Twitter and Facebook project accounts.
- Dissemination actions meant for general public, mainly via mass-media and other high impact activities have reached near 5.000.000 people.

For the success of these dissemination activities and other technical actions, the implication of stakeholders and the networking developed with other organisations and European projects has been key. Among them:

- Cluster and ICT business associations: regional and local (AETICAL, AVEIN, AERTIC and TECNARA), national (ENERTIC) or international (GreenIT.fr).
- Smart cities and innovation networks such as RECI (Spanish Smart Cities Network by its Spanish acronym), INNPULSO (cities of science and innovation network), eSMARTCITY.es web portal or the Linköping (Sweden) City Council.
- In the educational field, San Valero Group students network, the web portal on education of Castilla y León (EDUCACYL) or the network of vocational training centres linked to the Spanish Association of IT professionals (ATI by its Spanish acronym).
- Other European projects such as Green Digital Charter, Green ProcA, LIFE Clim'Foot, Is IT Green or the collaboration with DG Connect (European Commission).

5.2.2 Dissemination: overview per activity

5.2.2.1 Dissemination Tools

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 was launched 15 November 2013, once all partners validated the design.

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.

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.

The number of visits has reached a regular pattern with an average of 780 visits/month (650 users) and more than 1650 webpages visited. Contents are updated on a regular basis by the own staff of the project coordinator with the contribution of all partners.

The design and creation of the website was hired to the external assistance SOUTHERN LABS. A main contingency emerged in the last steps of the project has been a series of hacker attacks to the website and the blog developed for action B7. The immediate reaction was to contract a company to repair them both. Nevertheless, they were attacked for a third time, and at that point a more in depth analysis was done to find that an internal virus was compromising many files in the website. Seen the seriousness, a cleaning and security reinforcement job was hired. Without this latter, it would had not been possible to disseminate the project results or guarantee the website running for a five-year period after-LIFE. It was also necessary to work with main IT security portals as the website had been classified as non-secure and was blocked in many of them.

MihuellaTIC Blog

The project´s blog MiHuellaTIC (My ICT Footprint, 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 TIC virtual community in Spanish.

The number of visits per month to the blog reached 550 users.

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.

By the time the project was closed, the number of followers in Facebook was 538 and 950 in Twitter.

Dashboard / noticeboard

LIFE Green TIC project partners have installed posters and information points about the project objectives in different strategic locations in their facilities and centres.

FPNCYL has a large information sign (210 cm x 140 cm) placed in the hall of the PRAE building. This building is home to its headquarters and to the Environmental Resources Centre of Castilla y León, receiving more than 30.000 annual visitors.

FSV has installed an information foam panel at its offices, and a sign in the Secondary Education and Vocational Training School. The number of potential visitors to those areas is 3.625 per year

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. The number of potential visitors to those areas is 75.000 per year + 105.000 the dashboard at the "smart street" control cabin.

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.

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. It was also used to deliver documentation to the project´s stakeholders (signatories of the "Commitment Charter", 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) certificate as coming from sustainably managed forests, RoHS compliance and certified as Carbon Neutral.

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 2014). A final video of the project was also developed summarizing the main results thereof and the actions undertaken. Also videos of training courses were recorded. All are available online at the project website (www.lifegreentic.eu/es/videos/video-divulgativo-del-proyecto-life-green-tic).

Events

Project partners have been very active in participating in national and international events in which the project has been disseminated to stakeholders and potential beneficiaries of the results:

Ecoinnovation sector	ICT sector	Education sector	Public administrations and smart cities
• Greenweek 2014, Brussels • Workshop on energy efficiency and climate change (Brussels, 04/06/2014) • CONAMA – National Environmental Congress (Madrid, 24-27/11/2014) • International Days in Critical Raw Materials – ICCRAM (Burgos, 25/06/2015) • Local CONAMA (Málaga, 7-8/10/2015)	• Forum of the International Communication Union (Madrid, 18/09/2013) • Aragón Open Data (Zaragoza, 06/02/2014) • III Smart Energy Congress by Enertic (Madrid, 23/04/2014) • MATELEC – International Fair of the Electric Industry (Madrid, 28/10/2014) • Aragón ICT Forum (Zaragoza, 20/11/2014)	• Hack for Good - #H4G (Valladolid, 16/04/2015) University of Valladolid • Environmental Education and Communication National Congress - COMEA (Valladolid, 14/04/2015)	• I Smart cities national congress (Madrid, 24/03/2015) • Training courses in green ICT procurement and best practices, various cities and dates: Valladolid, Zaragoza, Madrid and Logroño between 18 February and 31 March 2016 • Murcia's Local Energy Agency. Conference on ICT Green procurement – 04/05/2016

The project has searched for specific media to disseminate the technical and specialized content of the project, for a more direct relationship with potential beneficiaries of the project's results:

Publications, media and others	Range
Articles in specialized magazines and books	3 in CylDigital (TIC sector) 2 in Equipamientos y servicios municipales (Local authorities sector) 1 in Engranajes (education sector) 1 in "ECLAP al día" (public employees training) Communication published in the Book of Communications of the Spanish National Environmental Congress (CONAMA). Communication published in the Book of Communications of the I Smart Cities Congress. 1 Interempresas.net (Innovation sector) 1 Compromiso Empresarial (Social Responsability) 1 Retema (Environment sector)
Press Releases / Conferences	6 press releases / press conferences in Castilla y León, Logroño and Zaragoza
TV news / interviews	1 National (TVE) green week 2014 2 regional TVCYL

Publications, media and others	Range
Radio interviews	4 radio interviews and different mentions of activities and press releases
Newsletter news / mentions	More than 35 news published in several stakeholder newsletters: Enertic, AETICAL and CONETIC, together with the digital newsletter of Logroño City Council "De Buena Fuente". And specialized newsletter as "esmartcity.es" and "Efeverde"
Training activities	5 training courses. Green IT Procurement and Best Practices for IT users in Valladolid, Logroño, Zaragoza, Madrid y Murcia. 1 webinar: best IT practices. 1 technical course for Pentaho users in Logroño. 231 participants
General public direct high impact actions	Awareness Fiche addressed to 300.000 natural gas company consumers Best practices infographics distributed to 18.000 public employees of the regional government of Castilla y León

5.2.2.2 Dissemination: specific activities related to every project action

Even when many dissemination activities comprehend various project actions, a more detailed analysis per action can be developed:

- B1. Green ICT action plans: the developed methodology for drafting Green ICT action plans was disseminated via project website and Twitter account, together with personal presentation to interested stakeholders in the stand of the National Environmental Congress 2014. A reference was also included in the Green ICT commitment Charter (see action C2).

  The methodology developed by the project was disseminated along the first year of the project at specific events, meetings and congresses, as it was the main result available at the earliest steps of the project.

  It was also included at the project website news section (13 January 2015) and twitted several times with more than 1.000 impressions.

  As a second step, the methodology and measures adopted by each partner in their own green ICT Plan were disseminated together with other products and actions in articles, events and courses, and finally included in the Layman's report and Final Publication.

  The following pictures show the impact of dissemination in Twitter, with a mention by Telefonica.

- B2, B3 and B4 – Pilot Actions: specific dissemination activities were mainly developed in the final stage of the project, once results were obtained and verified for every of the three pilot actions. Main information on these actions is included in the Layman's report and the Final Publication, which have been distributed to stakeholders and publicized in Green TIC social networks. A specific press release was

sent to media and main results were included as contents of the final project video (also distributed via social networks). All this took place in August 2016. The After-LIFE communication plan also pays special attention to the dissemination of the pilot actions results.

The description and results of pilot actions have been disseminated through press releases by each partner and through social networks. Also the Final Publication and Layman's report have been distributed to stakeholders. The virtualization action implemented by FPNCYL in Valladolid was also disseminated by the regional TV (TVCyL7). There is also information in the news section of the project's website.

The following pictures show the impact of dissemination in newspapers, newsletters, Twitter and other media:

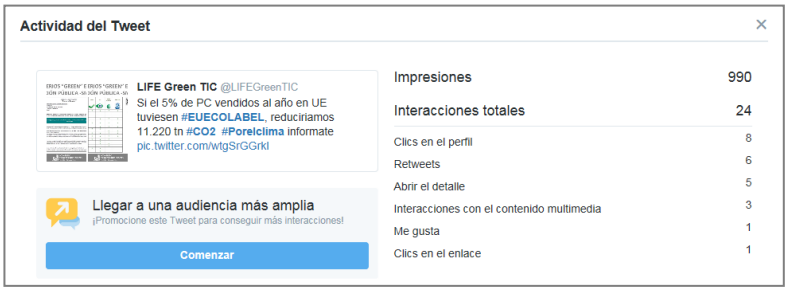
- <u>B5 – Green ICT procurement</u>: the green procurement manual for ICT equipment was disseminated at different stages: public consultation phase of the draft and once the final version was launched. Five training courses were an important showcase.

The *Manual* is available at the project website, but also in specialized websites thanks to networking activities (for instance the website of the Spanish Network of Smart Cities (RECI) or the specialized website "esmartcity.es").

News about the *Manual* was published in the news section of the project website (12 May 2015) and about tender templates (24/08/2016). The information was also twitted several times with more than 3.000 impressions.

Dissemination was reinforced before and at the time of Green ICT procurement training courses in February and March 2016. The Spanish school of public employees (INAP) collaborated in the dissemination of the training courses.

The following pictures show the impact of dissemination in newspapers, newsletters, Twitter and



- <u>B6 – Best practices:</u>

The *Best Environmental Practices Guidelines for ICT users*, is available at the project website and has been announced in the news section from 17th April 2015.

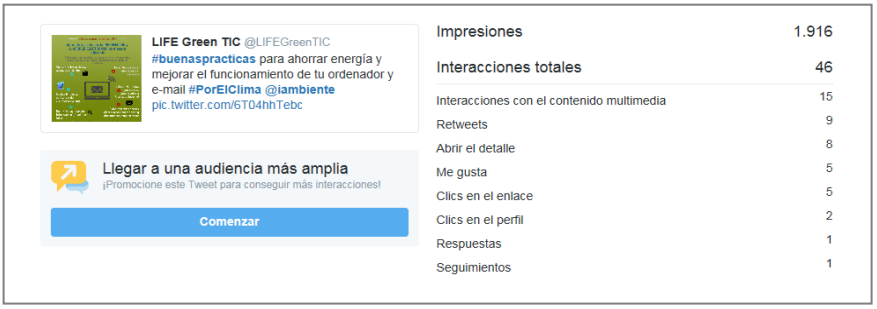
The information was also twitted several times with more than 4.000 impressions. It has been one of the results with more impact in social networks. The dissemination was reinforced with the publication of four infographics and with e-mailing to members of the advisory groups and other stakeholders. Several external newsletters and specialized publications included articles and news related to the guidelines.

Best practices were also disseminated through five training courses, together with the *Green ICT Procurement Manual*. A specific webinar course was launched for the Best Practices in collaboration with the Telecommunications General Directorate of the regional Government of Castilla y León.

Other specific activities (of high impact) were implemented to disseminate Green TIC best practices:

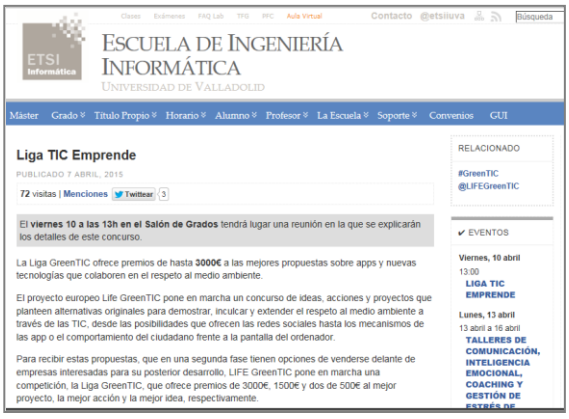
- Best practices infographics. Distribution among 18.000 workers of the Regional Government of Castilla y León.

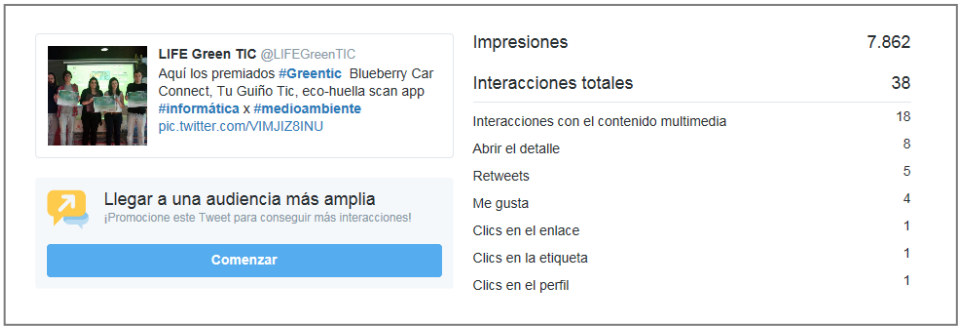
- Infographics distribution together with best practices sheets to 800 civil servants of Logroño City Council.
- Best practices guidelines document published in the web portal of the Education regional authority of Castilla y León (EDUCACYL) used by students, teachers and parents.



- <u>B7 Sustainability Lab</u>: the lab itself is a communication and participation channel, including social networks (blog, Facebook and Twitter). The most significant figures related to these social networks created as part of the Lab are:
    - Twitter: 1500 twits, 950 followers
    - Facebook: 538 followers
    - Blog: 550 users/month; 750 sessions/month

People and organisations with an interest on IT and the environment formed the main target audience. Followers' activity grew mainly during the participation in CONAMA, in the Smart Cities Congress, in the Environmental Education and Communication Congress and in the Hack4Good 2015.





The lab has built a virtual Green TIC community with two objectives. First, to help to generate among youth, green ICT ideas, project and solutions (Green TIC – emprende competition).

Second, to create a place that allows sharing experiences and success stories. Main indicators of this strategy are:

- Number of participants (under 30 years old) in the competition: 154
- Number of Green TIC proposals participating in the competition: 98
- Number of Green TIC success stories published in the blog: 52
- Number of followers (lab and its social networks): 1.200 permanent

The dissemination of the Lab activities (Photo contest, and the Ideas Competition) was very active through social networks. It was also publicized via e-mail to more than 30 universities, 60 vocational training centres, 2.000 primary and secondary schools and other stakeholders. EFE – verde (one of the main green media in Spain) paid specific attention to it.

The final event of the Green TIC ideas Competition had more than 10.000 impressions in Twitter. Websites of IT Engineering Universities and IT Vocational training centres collaborated in the dissemination of this action.

- C2 Socioeconomic impact

Under this action, the following products/activities have been disseminated:

- Green ICT socioeconomic report
- Green ICT survey
- Green ICT Commitment Charter

All of them have been disseminated mainly through social networks, but in the cases of the survey and the "Commitment Charter", specific e-mailing were made to stakeholders.

The project website inserted news related to the survey (16/05/2015) and the first signatories of the "Commitment Charter" (14/08/2015). The dissemination via Twitter reached more than 2.000 impressions for the survey call, 1.500 for the socioeconomic impact article and 1.300 for the "Commitment Charter".

Several stakeholders and specialized newsletters collaborated in the dissemination of these activities (see pictures below).

- **List of communication deliverables**

  7.3.1 Layman's Report

  7.3.2 After-Life Communication Plan

  7.3.3.1 Photographs

  7.3.3.2 Dissemination Products (Communications, articles, infographics, fact-sheets)

  7.3.3.3 Videos

  7.3.3.4 Standard PowerPoint presentation

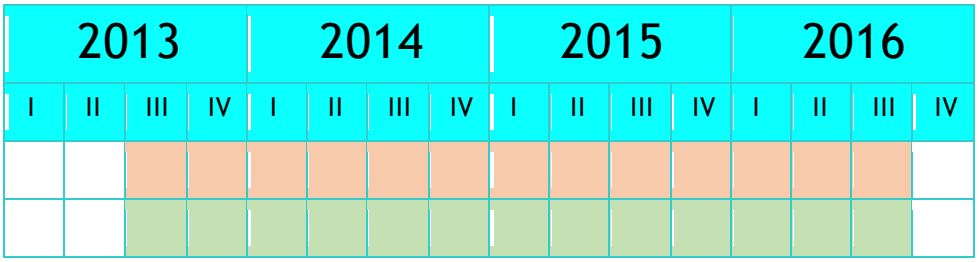
  7.3.3.5 Final Publication

  7.3.4 Final Dossier of dissemination and communication activities

  7.3.5 Examples of Logo uses

The dissemination actions were carried out from the beginning of the project without incidents. The delay experienced in other actions meant that the results of such actions were also disseminated belatedly, but in general, the initial schedule was followed for every specific action planned, achieving the foreseen results.

The following table compares the initial time schedule (sepia colour) and the actual one (in green):



Task / Milestone	DELIVERABLES	Months	Schedule Proposed	Schedule Final	Delay Months
Webpage creation		02	02/12/2013	15/11/2013	--
brochures, posters, dashboard		02	01/01/2014	01/03/2014	02
Compilation of news, photos and dissemination actions		06	15/05/2014	15/05/2014	--
		06	15/01/2015	15/01/2015	--
		06	30/11/2015	30/11/2015	--
		06	29/07/2016	29/07/2016	--
Video		05	29/07/2016	20/11/2014	--
	D.1.1 Final Publication D.1.2 Layman's Report	02	29/07/2016	29/07/2016	--
Results dissemination		constant	29/07/2016	29/07/2016	--

5.3 Evaluation of Project Implementation

Methodology applied:

The working methodology applied by LIFE Green TIC project partners is based on three pillars:

- An intense benchmarking and documentation work carried out by the project partners themselves.
- A close collaboration with stakeholders and potential beneficiaries of the project results.
- Networking with other European projects and organisations dealing with the carbon footprint of ICT.

Thanks to this methodology applied, LIFE Green TIC project is right now the main reference in Spanish when talking about awareness raising related to the carbon footprint of ICT use. Several organisations have contacted the project to show interest on its results and to propose future joint action as a consequence of this visibility.

Among the actions with a higher impact, is worth mentioning the development of a *Best practices manual for ICT users* (action B6). Institutions like the regional government (Junta de Castilla y León) have asked for permission to use the guide as a means to raise awareness among their staff (civil servants and others). Other interested institutions have been the Energy Agency of Murcia and the web portal EDUCACYL (education Castilla y León). This has been the *best value for money* action.

The *Green procurement guidelines for ICT equipment* (action B5) has also been welcomed by many entities that have asked for permission to use it. Some of this are the Smart Cities Network or the web portal smartcity.es. Nevertheless, its exploitation, use and transfer has encountered barriers caused by the low level of application that green procurement criteria have in most of Spanish public bodies.

From the beginning of the project, a lot of attention was paid to action B1, which focused on the development of a methodology intended for organisations wanting to design Green ICT strategies. The developed methodology starts by inventorying the CO_2 emissions of the ICT use, and it stablishes the permanent monitoring of those emissions. The implementation of this methodology by project partners has been very successful and a very good rate cost-efficiency. However, the transferability of the methodology has been more difficult as most organisations asked, do not have an energy monitoring system in place and it will be expensive for them to implement one when they do not know the investment profitability.

Comparison of the results achieved against the objectives

Project results: action B1 – Green ICT action plans

Foreseen in the revised proposal	Achieved	Evaluation
3 ICT inventories	3	These inventories allow to have a control of the ICT infrastructure and to estimate electricity consumptions weighting them in the global consumption of the entities
3 action plans	3	These Green TIC action plans were adapted to every entity. The implemented measures have had a great impact on the CO_2 emissions reduction.
3 engineering projects	3	These were necessary to the right development of the pilot actions
3 monitoring systems	3	Monitoring systems of the energy and/or paper consumption have been implemented so as to assess the impact of pilot actions

Project results: action B2 – Pilot action in an Administrative Centre

Foreseen in the revised proposal	Achieved	Evaluation
5 servers removed	10	The engineering project recommended to unify the two existing data centres in just one for the whole building aiming to optimize the infrastructure and to get higher energy savings
30 CPU removed	23	Finally, 30 equipment were installed. 23 are replacing old desktop computers and seven are destined to new job positions, avoiding new computers to be displayed.
58.000 kWh/year saved	18.575 kWh/year	The actual savings achieved have been 18.575 kWh/year. Nevertheless, the energy and CO_2 emissions savings represent 31,5%. This lower impact is mainly due to the need of re-designing the technical solution initially proposed because the necessities of the different jobs were different at the moment of implementation than at the moment of the proposal. And also due to the ICT services and infrastructure of the building kept on growing when new necessities aroused.
24 t CO_2 eq./year saved	6,52 t/year	The reasons under this CO_2 emissions saved are the same as for energy (see above), as they are a direct consequence of the energy saving. The conversion factor (kWh to CO_2) was 0,4 in the proposal but was later updated during the project to 0,35.

Project results: action B3 – Pilot action: Virtual Campus in Educational Settings

Foreseen in the revised proposal	Achieved	Evaluation
Implementation of a virtual campus	yes	The virtual campus has been totally displayed and was welcomed by teachers and students alike in FSV educational centres. 43 vocational students and 1.179 university students used it in the 2013-2014 schoolyear. In the 2014-2015 schoolyear the numbers grew to 110 vocational training students and 2.042 university students.
Reduction of 5 tonnes paper direct consumption	4,10 t	Direct saving reached by implementing paper-less policies and the PaperCut management software.
Reduction of 6 tonnes paper indirect consumption	21,83 t	The impact of the virtual campus in the indirect saving of paper (both by students and during the administration processes) has been higher than expected.
Reduction of 17.000 kWh energy consumption	64.118 kWh	The electricity savings due to the implementation of the virtual campus are much higher than the ones expected. Complementary actions related to ICT infrastructure optimization have enabled to get higher savings not accounted here (113.670 kWh).
Reduction of 2.000 litres fuel oil consumption	4.910 litres saved	The implementation of the virtual campus and zero paper policies have been the key to be way over the planned objectives. By avoiding car trips of the students and other complementary actions, the savings reached (not accounted here) are higher.

Project results: action B4 – Pilot action: Environmental Management in a Smart City

Foreseen in the revised proposal	Achieved	Evaluation
Monitoring of 42 LED street lighting points	36	Thirty-six 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.

Municipal WiFi: increase in 3.000 users per month	405	WIFI average users per month 9.218
Installation of 3 micro-stations	3	These micro-stations have different functions: one measures air quality and noise, the second one is for electric sensors and the third one to manage traffic (people and vehicles).
5.000 users of the municipal app	25.000	From the beginning of the project, more than 37.434 downloads of the app have taken place. The environmental information available in the first place was only temperature. All users can right now access to all air quality and noise data (monitored during the Green TIC project).
17 tonnes of paper saved	20 t	This reduction in the use of paper is due to the implementation of a documental management system in the communication department and the application of a best practices strategy for paper use as part of the Green TIC project. The 50% of the paper used now is recycled.
41 tonnes of CO_2 saved	50,93 t	Paper saving: emissions reduction has reached in 2 years 39t CO_2/year ICT: the implementation of the Green TIC action plan is thought to be responsible for an annual emission saving of 3,81 t CO_2. The change of RCT to LCD-TFT monitors is estimated to have caused a reduction of 2t CO_2/year (accounted outside the LIFE project). LED lighting: the impact of changing 36 lamps and managing their smart use is responsible for an emission saving of 8,12t CO_2.

Project results: action B5 – Green procurement

Foreseen in the revised proposal	Achieved	Evaluation
Green procurement guidelines for ICT equipment	yes	These guidelines have been published (see www.lifegreentic.eu)
Dissemination of guidelines among more than 100 local entities	yes	The ICT Green procurement manual has been explained in five seminars, in the Smart Cities Network (RECI), via e-mail to chosen stakeholders, with a direct impact in the staff of more than 240 local bodies. Also, disseminated through INNPULSO Network.
Dissemination of guidelines to more than 10 universities / vocational training centres	35	The manual has been disseminated to 5 universities and 30 vocational training centres.
Dissemination of guidelines to more than 20 public procurement departments in Castilla y León regional government	20	The manual has been sent to the advisory committee of public procurement to be disseminated among all departments. It has also been directly sent to 10 responsibles of IT departments.
Training of the Ayto. Logroño staff	42	Pentaho course (22 attendants) ICT Green procurement and best practices course (20 attendants)

Project results: action B6 - Best environmental practices in the smart use of ICT

Foreseen in the revised proposal	Achieved	Evaluation
Publication of a *Best Practices Manual for ICT users*	yes	The manual was published and is included as deliverable B6.3. It has been translated into English to widened its impact and transferability.
At least 500 students and 1.000 civil servants involved in Green TIC Best Practices application.	2.000 students	The manual has been disseminated among workers of public institutions (Castilla y León regional government, Logroño city council) and among students of San Valero group (directly to their

	20.000 workers of public bodies	computers or via e-mail and internal ways of communication). It has also been disseminated among other educational and administrative public institutions through social networks and other means. The manual has reached the general public via social networks.
Feedback on best practices from users and students	yes	Positive comments and proposals have been received. They helped to capitalize the results through the infographics, the webinar course and social networks.

Project results: action B7 – Sustainability Lab: the enabling effect

Foreseen in the revised proposal	Achieved	Evaluation
More than 200 participants in the Lab	200	Participation in the ideas competition involved 40 team with 154 young people. 46 people and 73 photos took part in the Green TIC photo contest.
More than 50 ideas proposed through the Lab and contests	98	98 proposals received, 18 of which were projects, 13 actions and 67 shared ideas
More than 1.000 participants in the Lab social networks	1.488	This is the number of Lab social networks followers (Twitter and Facebook)
More than 10 open data contents involved in the Lab	6	6 of the 98 proposals have clearly opted for open sources / open data. They are based on systems such as Arduino, Raspberry PI or free access web tools.

Project results: action C1 – quality control, monitoring and analysis of results

Foreseen in the revised proposal	Achieved	Evaluation
More than 50% energy saving achieved in every pilot action	yes	The most important energy saving is the one got in the FSV virtual campus (95%), whereas measures implementation helped to reach 31% savings in FPNCYL and 20% in ayto. Logroño.
100 t $CO_{2\ eq}$ reduced due to pilot actions implementation	218 t	Final project results double the foreseen targets of CO_2 emissions reduction, showing the high potential of Green ICT policies.
3 monitoring plans	3	The monitoring plans show the importance of controlling ICT consumption separately from other electricity consumptions. For FSV it was necessary to implement a specific monitoring system because the calculation of indirect emissions associated to the virtual campus implementation and to the life cycle of the vocational training and university teaching processes.
4 monitoring reports per partner	4	As expected, reports C1.1-C1.2-C1.3-C1.4 have been developed and are included as deliverables
4 PFMEA reports (Process Failure Mode and Effects Analysis)	4	These reports have been updated in parallel with the 4 monitoring reports.
Report on the results of the pilot action experimentation	15	These reports match with deliverables B2.1; B2.2; B2.3; B2.4; B2.5; B3.1; B3.2; B4.1; B4.2; B4.3; B4.4; B4.5; B4.6; B4.7; B4.8

Project results: action C2 – Socio-economic impact

Foreseen in the revised proposal	Achieved	Evaluation
More than 1.000 survey respondents	239 + 500	Stakeholder's consultation had an important impact and was representative enough to give validity to the drawn conclusions. Students' participation was

		lower than expected even though more than 500 students from San Valero participated in surveys related to the implementation of the virtual campus.
More than 100 companies committed to the Green ICT policies	74	As a result of the campaign, 74 organisations have signed the Green TIC Commitment Charter and among them public organisations (5 city councils, 1 provincial government, public foundations, public companies, 5 technological centres, 4 local or regional energy agencies) and private companies (ICT and environment sectors), associations (5 clusters of the ICT, energy efficiency and environment sectors) and educational organisations.

Project results: action D1 – dissemination and communication

Foreseen in the revised proposal	Achieved	Evaluation
Effective dissemination of the project	yes	General public has been reached through mass media but also public specialized in environmental and digital society issues. The impact of Green TIC project own resources has been: website (19.000 sessions and 15.302 users) and dashboard (100.000 people). Social networks: 1.500 followers.
Participation in national and international Congresses	13	2 international events in Brussels and 1 in Madrid. 10 national Congresses or Conferences. 2 papers presented in national congresses. Direct impact in a specialized target group of more than 20.000 people.
Continuous presence in media	yes	6 press releases, 1 national TV, 3 regional TVs, 4 radio programmes. References and articles in more than 10 stakeholders' newsletters. Articles in 10 specialized magazines. 2.500 results in a Google search of "LIFE Green TIC". Direct impact in general public target group of more than 3.000.000 people.
Final publication	500	500 paper format (Spanish / English) and 500 DVD (Spanish /English/German summary). Available in the project website.
Project video	yes	A first video was done, as a support to the dissemination activities of the project (specially in CONAMA 2014). A final video recorded and published explains the project results. Also videos of the speakers in training courses are recorded. All are available in the project website.
Civil servants training	82	More than 60 workers of public bodies have attended specific training courses on ICT green procurement and best practices (5 face-to-face courses and a webinar organised). Besides, 22 members of the Ayto. Logroño staff were trained in the Pentaho technology for the pilot action monitoring.

Project results: action E3 - Networking

Foreseen in the revised proposal	Achieved	Evaluation
Reaching 5 cooperation / networking agreements	20	Effective collaboration has been established with 20 organisations, 17 of which are projects financed by the EU. The others are DG Connect (European Commission) and 2 organisations (Spanish and French).
Links to websites of 10 "friend-projects"	10 + 7	In the website, there are links to 10 organisations or projects and other 7 links in the best practices database of the Green TIC blog. There is also constant mutual following through social networks.

Project results immediately visible and other expected results

Results that have been immediately visible are the following:

- Awareness of the ICT energy consumption as an environmental problem by stakeholders and project target groups. The project gave visibility to an unknown problem, not faced before by most of the organisations and professionals that have participated in the project activities. For instance, the project has raised interest among regional and local energy agencies to incorporate tasks related to this problem for the first time, and they have profited from the project products.
- Partners immediate project results have been to achieve important energy savings and the integration of green ICT policies in the framework of their own environmental management systems and the Ayto. Logroño Covenant of Mayors.

Other results expected:

- Implementation of Green ICT action plans by those organisations that have become aware of the environmental problem, mainly the ones that have signed the Green TIC Project Commitment Charter, together with other actions such as implementation of green procurement criteria and best practices. As a consequence of the after-LIFE plan other organisations would join.
- Development of awareness raising campaigns by regional and local energy agencies and by other entities, thus making the most of project LIFE Green TIC products.

Amendments

No significant amendment has been necessary. The only question asked for was the approval of a specific and not foreseen expense (5.500 €) in cash prizes for the Ideas Competition ("GreenTIC-Emprende, action B7). These prizes were an incentive to promote an active participation of students and young entrepreneurs. It would have been very difficult to involve 154 participants without the incentive of the cash prizes. The main reason is that there are many other IT competitions providing prizes. To incentive young IT innovators to change their mind and begin thinking "Green" it was considered necessary to reach a similar level of prizes.

Effectiveness of the dissemination and major drawbacks

Dissemination has been very effective, especially in the last stage of the LIFE Green TIC project, once the main project products were available. Target groups were not very receptive during the first months of the project due to the fact that they could not perceive ICT energy consumption as a problem.

Several facts prove the effectiveness of the dissemination. For example, the project's Twitter account is the Green TIC main reference in Spanish. It is also significant that different institutions (education and training centres, public authorities, energy agencies) have contacted the project to use its products, to publish articles (for free) in their digital magazines / newsletters or to present papers to conferences and congresses.

Finally, it is worth mentioning that dissemination results have gone beyond the partner's geographical area. Other regional and national Spanish organisations have shown interest in the project results but also international entities mainly from Europe and Ibero-America. More precisely, the project has raised interest and has effective collaboration from DG Connect (European Commission), LIFE Clim'Foot project, Green IT Club from France, Green ProcA project and Green Digital Charter among others.

5.4 Analysis of long-term benefits

1. Environmental benefits

a. Direct / quantitative environmental benefits:

The implementation of pilot actions (B2, B3, B4) and the measures included in the Green TIC strategies (B1-action plans) for every partner have had a direct impact on the reduction of CO_2 emissions associated to the performance of each organisation participating in the project. This reduction has many causes: the use of energy efficient ICT equipment, best practices application in the use of ICT devices, paper saving or use of recycled paper, e-administration in the virtual campus implementation (which implies also less transport needed for students changing from classroom to online teaching). The estimated CO_2 emissions reduction for the project duration is an average of 90 tonnes/year.

b. Relevance for environmentally significant issues or policy areas

LIFE Green TIC project has significant consistency with 7th EU Environment Action Programme, mainly with:

- the key objective to turn the EU into a resource-efficient, green, and competitive low-carbon economy and
- the two additional horizontal priority objectives which complete the programme:
    - to make the EU's cities more sustainable
    - to help the EU address international environmental and climate challenges more effectively.

The project contributes to fully implement the EU Climate and Energy Package and to reach the milestones identified for 2020 together with the building of a competitive, safe and sustainable low-carbon economy by 2050.

ICT energy consumption should be at the climate change agenda, due to its relevance, as it represents 10% of total electricity consumption in EU. LIFE Green TIC project has contributed to it through dissemination and awareness actions, developing tools, manuals and other products that are going to facilitate the implementation of Green ICT measures in the public and private sectors and by citizens.

The 7th EU Environment Action Programme also encourages Member States and regions to take further steps to reach the target of applying green procurement criteria to at least 50% of public tenders. Energy efficiency specifications for ICT equipment and devices are a key element to reduce their carbon footprint. The project has contributed to that objective by drafting a Green ICT Procurement Manual and tender templates for computers, servers and printing equipment.

2. Long-term benefits and sustainability

a. Long-term / qualitative environmental benefits

The project aims at giving more visibility to the environmental problem related to the increasing use of ICT, which leads to a direct increase in CO_2 emissions. Indirectly, this also causes other problems such as a growing use of resources (raw materials) very valuable and scarce, or hazardous waste production at a large scale. Nevertheless, the main objective of the project is to fight climate change.

During the development of the project, one of the main barriers identified is the lack of visibility of the environmental problem detailed above, both among users and among companies and organizations. The energy consumption of ICT infrastructures, equipment and devices normally goes unnoticed even though is constantly growing. That is the reason why making this situation visible has become one of the project's priorities.

b. Long-term / qualitative economic benefits

The implementation of Green TIC strategies, including green procurement and the application of best practices, by companies and public bodies will have a positive economic effect by means of a growing competitiveness due to a higher potential of the ICT infrastructure performance and to a lower electricity consumption.

Economic savings can be achieved in most sectors, but they are especially important in administrative buildings.

The educational sector has the highest potential by means of implementing similar models to the FSV virtual campus. Their management model both by changing face-to-face to online teaching and by the electronic documental management has meant only for the school year 2014-2015, and economic saving of 273.000€.

Another major economic saving (up to 75%) for local authorities can be reached through the joint management of LED lighting and light intensity regulation combined with motion sensors. Ayto. Logroño got a total annual saving of 4.436€ after changing 36 lamps in just one street.

c. Long-term / qualitative social benefits

From a social perspective, the project is expected to firstly stimulate the introduction of Green ICT knowledge and skill development in the e-skills teaching programmes, training new IT professionals ready for a green economy model and therefore improving their employment opportunities. Secondly, the project is expected to foster the provision of new Green ICT services among professionals and ICT companies, or to improve the services already provided by invigorating the labour market in the ICT sector.

d. Continuation of the project actions by the beneficiary or by other stakeholders.

Activities aimed at giving visibility to the environmental problem identified and to spread useful tools developed in the framework of the project such as those related to green procurement and best practices are expected to have a successful continuation after the end of the LIFE project both by partners and by other stakeholders and entities committed to Green ICT development.

3. Replicability, demonstration, transferability, cooperation

The project experience has proved that once people or organisations get to know the environmental problems and the possibilities to minimise it and once they get to know the available Green TIC tools, they are in general very keen to commit to participate. Therefore, the potential transferability of the project is very high. All pilot actions can be easily replicated in other similar organisations in every region or country and adaptation to new sectors would be a very easy one seen that ICT infrastructure and equipment use is a cross working subject and that methodologies developed in the framework of the project are valid for almost any sector/activity.

Furthermore, all LIFE Green TIC partners are committed to advice any individual or organisation wanting to use Green TIC tools and methodologies in the after-LIFE period, including the organisation of new training courses and the direct cooperation with new interested organisations.

4. Best Practice lessons

The main best practice put in place is the setting-up of alliances with other Spanish and European institutions to share knowledge and exchange experiences that can mean a mutual enrichment for the Green TIC project and the projects of those other organisations contacted.

Thus, organisations such as CEPIS (the European association of IT professionals) have implemented initiatives similar to the "*Best Environmental Practices Guide for ICT Users*" or the Charter of organizations committed to Green ICT.

Likewise, collaboration with the Green Digital Charter led to the verification of their work on integrating ICT emissions in the Covenant of Mayors' SEAP (sustainable energy action plans). This latter also led to have the software already tested in other European cities, available to monitor consumptions in the inventory stage.

5. Innovation and demonstration value

Once different benchmarking studies were completed, it can be said that both the *Best Environmental Practices Guide for ICT Users* and the *Green Procurement Manual for ICT products* are documents that provide high added value. Their innovative feature resides on the fact that no complete such documents were available in Spanish.

In the framework of the pilot actions, the following deserves to be mentioned:

- FPNCYL: virtualization of the ICT infrastructure (data centre and desktops) is not a usual option for small organizations or public administration buildings and educational institutions. Therefore, the pilot action developed has a high innovative character and would serve as a reference for other entities wanting to see the actual impact of this ICT management measures in the energy costs reduction.
- FSV: virtual campuses do not have an acceptable introduction level in educational institutions, neither universities nor vocational training centres. The pilot action experience shows how valuable is, not only for the improvement of educational management, but also in terms of environmental impacts and for the reduction of carbon footprint, contributing thus to the transfer of results and their replicability by other educational institutions.

At the same time, the use of social networks in the framework of the project has demonstrated the potential to reach stakeholders: individuals and organisations interested in the project results from anywhere, even other European countries or other continents (mainly America). For this purpose, Twitter is especially useful, where it is easier to include contents in both English and Spanish at the same time.

6. Long term indicators of the project success:

Long term indicators of project results will be related to two specific fields:

1.- The continuation of every measure implemented by all partners in their buildings:
- Total electricity consumption reduction of the ICT infrastructure.
- Total CO_2 emissions reduction of the ICT infrastructure.
- Paper volume reduction.
- CO_2 emissions reduction in the virtual campus.
- Electricity consumption reduction in the "LED smart street".

2.- Other organisations profiting from project results:
- Number of organisations that implement green TIC strategies.
- Number of organisations including green criteria in the purchase of ICT.
- Number of cities that, in the framework of their plans to fight climate change, integrate the monitoring of ICT consumption and adopt related measures.

6. Comments on the financial report

The final financial implementation rate of the project is 94%. Personnel, travel and other categories of expenditure are 9% higher than the foreseen costs. On the other hand, the least implemented categories of expenditure are consumables (66%) and equipment (69%). For external assistance, costs are in line with the global rate of budget implementation (95%).

PROJECT COSTS INCURRED				
	Cost category	Budget according to the grant agreement	Costs incurred within the project duration	%
1.	Personnel	710.000 €	765.885 €	108 %
2.	Travel	10.500 €	11.485 €	109 %
3.	External assistance	224.500 €	216.280 €	96 %
4.	Durables: total non-depreciated cost			
	- *Infrastructure sub-tot.*			
	- *Equipment sub-tot.*	272.000 €	188.139 €	69 %
	- *Prototypes sub-tot.*			
5.	Consumables	140.000 €	92.627 €	66 %
6.	Other costs	12.000 €*****	18.436 €	108 %
7.	Overheads	86.240 €	82.146 €	95 %
	TOTAL	**1.455.240 €**	**1.374.998 €**	**94 %**

*****) The Commission has approved a budget modification for awards of the Green TIC Competition (5.500 €) added to the proposal budget for other costs (12.000 €). Therefore, the final amount is 17.500€ without increasing the total budget.

Summary of costs per action

Action no.	Short name of action	1. Personnel	2. Travel and subsistence	3. External assistance	4.a Infra-structure	4.b Equip-ment	4.c Prototype	5. Purchase or lease of land	6. Consumables	7. Other costs	TOTAL
B1	Green ICT Action Plan	85.165		9.064							**94.229**
B2	Pilot Action FPNCYL	78.200	164	35.218		130.598			20.137		**264.317**
B3	Pilot Action FSV	85.079	3.042	51.781		13.430			32.328		**185.660**
B4	Pilot Action Ayto Logroño	25.870		10.164		44.111			26.374		**106.519**
B5	Green Procurement	62.735									**62.735**
B6	Best Practices	61.975		21.199							**83.174**
B7	Sustainability Lab	59.126		25.013						5.500	**89.639**
C1	Quality control monitoring	53.685		2.332					9.572		**65.589**
C2	Socio-economic impact	36.219									**36.219**
D1	Dissemination	80.833	5.164	53.793					4.114	12.683	**156.587**
E1	Project management	113.745	3.115	7.716					102	253	**124.931**
E3	Networking	23.253									**23.253**
Over-heads											**82.146**
	TOTAL	**765.885**	**11.485**	**216.280**		**188.139**			**92.627**	**18.436**	**1.374.998**

The major discrepancies between the final costs per action and the budgeted amounts in the grant agreement (more than 10% deviation) are the following:

Action B1: the level of costs implementation was -20%. This was mainly due to some expenses that were foreseen in the proposal and have not been finally done. This is the case of the ICT audit/green IT action plan and engineering project design of the Ayto. Logroño pilot action, which has been finally carried out by their own staff instead of the foreseen support of an external service.

Action B2: the costs implementation was +11%. The final cost of equipment was slightly higher than the expected one, and the working time of its own staff charged to the project was higher than expected due to the contingencies already explained.

Action B3: the costs implementation was -38%, because of the lower expenses in equipment and consumables. As already mentioned, the impossibility to disaggregate some equipment expenses made by FSV for the virtual Campus to allocate them to the LIFE Green TIC project was under the FSV decision to leave it out of the project.

Action B4: the costs implementation was -15%. The reason is that the implementation of the "smart street" required less consumables than expected plus working time was slightly lower than expected due to the delays in the implementation and experimentation phase.

Action B7: there was a budget increase due to the cash prizes approved by the EC.

Action D1: the costs implementation was +21% It was due to not foreseen expenses for securing and repairing the project website after hacker attacks, and the presence for dissemination in some events requiring fees (FPNCYL). It was also considered necessary the assistance of Graz Energy Agency to promote the involvement of regional and local energy agencies in the training and communication strategy adopted by FSV.

7. Annexes

7.1 Technical annexes

7.1.1 – List of keywords and abbreviations used

Symbols:

% - percentage

€ - euro

NOTE: In this report, in the Excel tables corresponding to the Financial Tool, in the annexes, and in the auditor report commas are used to separate whole numbers from decimals, while dots are used to separate thousands, millions, etc.

Keywords, abbreviations and acronyms used:

ASHRAE - American Society of Heating, Refrigerating and Air-Conditioning Engineers
App – software application
ASCENTIC - Asociación Cántabra de Empresarios de Nuevas Tecnologias de Información y Comunicaciones (Association of new ICT companies from Cantabria)
ATI - Spanish Association of Computer Technicians
Ayto. Logroño – Logroño City Council

BOE – boletín oficial del estado (Official Spanish Estate bulletin)

CEPIS - Council of European Professional Informatics Societies
CIP – Competitiveness and Innovation Programme
cm - centimetres
CO_2 – carbon dioxide
CO_2 eq – carbon dioxide equivalent
CONAMA – Congreso Nacional de Medio Ambiente (Spanish Environmental Congress)
CONETIC – Confederación Española de Empresas de Tecnologías de la Información, Comunicaciones y Electrónica (Spanish Association of Information and Communication Technologies and Electronics companies).
CPD – Centro de procesamiento de datos (Data Centre)
CPU - Central Processing Unit)
CRT - Cathode Ray Tube
CTIC - Fundación Centro Tecnológico de la Información y la Comunicación (Foundation Technological Centre for Information and Communication)
CyL – Castilla y León

dB - decibel
DCiE - Data Centre Infrastructure Efficiency
DG – Directorate General
DVD - digital versatile disc or digital video disc

EACCEL – Estrategia Aragonesa de Cambio Climático y Energías Limpias – Climate Change and Clean Energy Strategy of Aragón.
ECMA – (European Computer Manufacturers Association) An international standards organization for information communication technology and consumer electronics.
EEE - Energy Efficient Ethernet

enerTIC - Plataforma de Tecnología e Innovación para la mejora de la Eficiencia Energética y la Sostenibilidad (Platform on Technology and Innovation for the improvement of Energy Efficiency and Sustainability)
EPA - Environmental Protection Agency
EPEAT - Electronic Product Environmental Assessment Tool
ERP - Enterprise resource planning
Etc. – etcetera
EU – European Union

FCSCL - Foundation Supercomputing Centre of Castilla y León
FPNCYL – Fundación Patrimonio Natural de Castilla y León (coordinating beneficiary of the project).
FSC – Forest Stewardship Council
FSV – Fundación San Valero (associated beneficiary of the Green TIC project)

GeSCI - The Global e-Schools and Communities Initiative
GHG – Greenhouse Gas
GPP – Green Public Procurement
GPU - Graphics Processing Units
Green TIC – LIFE project Acronym (Reducing CO_2 footprint of information and communication technologies).

h – hour
HVAC - Heating, ventilation and air conditioning

ICT – information and communication technologies
IDAE – Instituto para la Diversificación y Ahorro de la Energía (Spanish Institute for Energy diversification and saving)
i.e. – *id est* – that is
IEE - Intelligent Energy Europe
IR – inception report
ISO – International Standard Organisation
IT – information technology
ITC – Instituto Tecnológico de Galicia - Galician Technology Institute
ITU - International Telecommunication Union

kg – kilogram
km/h – kilometre per hour
KVM - keyboard, video, and mouse switch
kWh - Kilowatt hour

LAB – the sustainability lab (action B7 of the Green TIC project)
LCD - Liquid Crystal Display
LED – light-emitting diode

MATELEC - Salón internacional de soluciones para la industria eléctrica y electronica (International Trade Fair For The Electrical And Electronics Industry)
MR – midterm report
MW – megawatt
$\mu g/m^3$ – micrograms per cubic metre

NiCE - Networking intelligent Cities for Energy Efficiency
NO_x - nitrogen oxides

O_3 - ozone

PBX - Private branch exchange
PC – personal computer
PFMEA - Process Failure Mode and Effects Analysis
PM_{10} – Atmospheric particulate matter
PoE - Power over Ethernet

POLLUTEC – French International Fair of environmental equipment, technologies and services
PRAE – propuestas ambientales educativas (headquarters of FPNCYL)
PUE - Power Usage Effectiveness

R&D+i – Research, development and innovation
RECI – Spanish Smart Cities Network
RoHS - Restriction of Hazardous Substances
ROI - Return on Investment

SEAP – Sustainable Energy Action Plan
SME – small-medium enterprise
SNIA - Storage Networking Industry Association
SO_2 – Sulfur dioxide

t – tonnes
TCO - Swedish Confederation of Professional Employees (Tjänstemännens Centralorganisation)
TFT - Liquid Crystal Display (Thin Film Transistor)
TEER - Telecommunications Energy Efficiency Ratio
TIC – (= ICT) Tecnología de la información y la comunicación
TV – television

UPS - Uninterruptible Power System

VASP – vapour sodium lamps
VAT - value added tax
VET – vocational education and training
VMM - Virtual Machine Manager or Virtual Machine Monitor
VoIP – Voice Over Internet Protocol

W – watts
WWF – world wildlife fund

7.1.2. – Technical annexes

Together with the Final report, a series of technical annexes (deliverables) were provided and are listed below. The ones that are public can be found in the documents section of the project website (www.lifegreentic.eu).

B1.1 – Green TIC Action Plans Methodology

B1.2 – FPNCYL Green TIC Action Plan

B1.3 – FSV Green TIC Action Plan

B1.4 – Ayto. Logroño Green TIC Action Plan

B1.5 – Engineering Design of Pilot Action - Fundación Patrimonio Natural de Castilla y León

B1.6 – Engineering Design of Pilot Action - Fundación San Valero

B1.7 - Engineering Design of Pilot Action – Ayuntamiento de Logroño

B1.8 – First Green ICT Action Plan Monitoring reports

B1.9 – Final Action Plan Monitoring Reports

B2.1 – Data Centre Test Report – Fundación Patrimonio Natural de Castilla y León

B2.2 – Virtualization server test report – Fundación Patrimonio Natural de Castilla y León

B2.3 – Desktops virtualization test report – Fundación Patrimonio Natural de Castilla y León

B2.4. –Installation Manual – FPNCYL

B2.4.2 –Installation Manual – FPNCYL (updated final version)

B2.5 - Virtualization tests (*new deliverable not foreseen in the grant agreement*)

B3.1 – Report Pilot Action Implementation – Fundación San Valero

B3.2 – Experimentation report of the pilot action – Fundación San Valero

B4.1 – Manual for paper reduction in the Logroño City Council

B4.2 – Microsite manual – Ayuntamiento de Logroño

B4.3 - Data Centre system architecture report – Ayuntamiento de Logroño

B4.4 – Municipal app functional report - Ayuntamiento de Logroño

B4.5 – Microsite data capture operating report – Ayuntamiento de Logroño

B4.6 – Real time data system operating report - Ayuntamiento de Logroño

B4.7 – Remote control system operating report - Ayuntamiento de Logroño)

B4.8 – Experimentation report of Ayto. Logroño pilot action (*new deliverable not foreseen in the grant agreement*)

B5.1 – ICT Product Category Group Report

B5.2 – Green Public Procurement for ITC - Benchmarking report

B5.3 – Green ICT procurement guidelines

B5.4 – Green ICT tender templates (computers, printers, servers)

B6.1 – Questionnaire for gaps and best practices identification

B6.2 – Benchmarking of ICT use best practices

B6.3 – Sustainable use of ICT Manual

B7.1 – Green TIC LAB working Plan

B7.2 – Green ICT solutions report

C1.1 – First Monitoring Report: one document per partner. FSV has joined together both the first and second monitoring reports in just one document

C1.2 – Second Monitoring Report: one document per partner. FSV has joined together both the first and second monitoring reports in just one document

C1.3 - Third Monitoring Report: one document per partner

C1.4 – Forth Monitoring Report

C2.1 – Green ICT jobs and economic impact report

C2.2 – Green ICT Commitment Charter

E1.1 – Dossier on Procedures and Protocols

7.2 Dissemination annexes

7.2.1 Layman's report

The coordinating beneficiary designed and drafted the Layman's report (deliverable D1.2) with close collaboration of all associated beneficiaries. A first draft was revised in July 2016 and the final version was approved, translated into English and published in August 2016, and has been disseminated since

then. The document can be found in the website of the project (www.lifegreentic.eu). Some paper copies were printed and are available (contact project coordinator) in both versions (English and Spanish).

7.2.2 After-LIFE Communication plan

This compulsory plan was drafted and approved by all partners at the last stage of the project. It is published in the website of the project (www.lifegreentic.eu) in both Spanish and English versions.

7.2.3 Other dissemination annexes

The following list gives details on the dissemination documents and materials submitted to the European Commission at the inception report (IR) and mid-term report (MR) stages:

Name of dissemination document/material annexed	**Submitted with:**
First dossier of dissemination and communication activities	IR
Project brochure (EN/ES)	IR
	MR
Second dossier of dissemination and communication activities	MR
Dossier on the use of LIFE and Green TIC logos (examples)	MR
Photographic annex	MR
Green TIC dissemination poster	MR
LIFE Green TIC paper for CONAMA (November 2014)	MR
Annex on *Green TIC-emprende* competition (winners and rules)	MR
LIFE Green TIC initial video	MR
LIFE Green TIC paper for the I Smart Cities Congress (March 2014)	MR

That information was completed with more dissemination documents provided together with this final report (some of them in more than one language: EN -English, ES-Spanish, DE – German):

Name of dissemination document/material annexed	**Language**
Layman's Report	ES/EN
After-Life Communication Plan	ES/EN
Photographs	EN
Dissemination Products (Communications, articles, infographics, fiches)	ES
Videos	ES/EN
Standard PowerPoint presentation	ES
Final Publication	ES/EN/DE
Final Dossier of dissemination and communication activities	ES
Examples of Logo uses	ES

8. Financial report and annexes

Complete and detailed information on the financial aspects of LIFE Green TIC project were compiled and provided (Annex 8 to the Final Report) but is not included in this public version of the final report.

This list details all financial documents that were sent to the European Commission together with the Final report:

Name of the annex	Annex number	Format
Cost Per Action	8.1	Digital
Standard Payment Request and Beneficiary's Certificate, duly signed (original paper copy)	8.2	Paper/digital
Consolidated Cost Statement for the Project, duly signed (original paper copy)	8.3	Paper/digital
FPNCYL Financial Statement, duly signed (original paper copy)	8.4.1	Paper/digital
Ayto. Logroño Financial Statement, duly signed (original paper copy)	8.4.2	Paper/digital
FSV Financial Statement, duly signed (original paper copy)	8.4.3	Paper/digital
Auditor's report	8.5	Paper/digital
Supporting documents (either requested by the EC in its letters or necessary to support other explanations)	8.6 (and 7.5)	Digital