Competitiveness & Innovation Programme (CIP)
THEME 1- ICT FOR A LOW CARBON ECONOMY AND SMART MOBILITY

Bringing the past into the future

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Deliverable quality review

	Date	Comments
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GLOSSARY

AC	Alternating Current
BEMs/BAS	Building Energy Management Systems/Building Automation System
CDBMS	Centralised-Data-Recording-System
CENELEC	European Committee for Electrotechnical Standardization
CO2	Carbon Dioxide
CPC	Central Power Control
DALI	Digital Addressable Lighting Interface
DC	Direct Current
EPC	Energy Performance Contract
ESCO	Energy Service Company
ETSI	European Telecommunications Standards Institute
ICT	Information and Communication Technology
ICT CIP	ICT Policy Support Programme as part of the Competitiveness and Innovation framework Programme (CIP)
ICT PSP	ICT Policy Support Programme
IPMVP	International Performance Measurement and Verification Protocol
KNX	Standard administered by the KNX Association (EN 50090, ISO/IEC 14543)
LED	Light Emitting Diode
LSTK	Lump Sum Turnkey
MySql	Source SQL database management system
PLC	Power Line Communication
PowerLAN	Power Line/digital network
PV	PhotoVoltaic
RSs	Remote Stations
Sbs	Light Switch Boxes
SELV	Safety Extra-Low Voltage
SEP	Smart Energy Platform
SSL	Solid State Lamp

PARTICIPANT ORGANISATIONS

Participant organisation name	Short name	Country
FONDAZIONE UGO BORDONI	FUB	Italy
SIELTE SA	SIE	Romania
TSITALIA	TSI	Italy
BK TELEMATICS LTD	BKT	Greece
VRIJE UNIVERSITEIT BRUSSEL	VUB	Belgium
FONDAZIONE IDIS-CITTÀ DELLA SCIENZA	IDIS	Italy
COMUNE DI LETTOMANOPPELLO	LMP	Italy
COMUNE DI MANOPPELLO	MNP	Italy
COMUNE DI ROCCAMONTEPIANO	RMP	Italy
SEMPLE & MCKILLOP LTD	SMK	United Kingdom
ANCITEL SPA	ANC	Italy
ENEL SOLE S.R.L.	ENSO	Italy
TRAFFIC OBSERVATION VIA MANAGEMENT LTD	TOM	United Kingdom
SOUTHERN HEALTH AND SOCIAL CARE TRUST	SHT	United Kingdom

Abstract

EDISON project aims to demonstrate, under real operational conditions, the effectiveness of a smart lighting system, easily integrated with PhotoVoltaic (PV) systems, which allows a significant reduction of energy consumption and CO2 emissions in public buildings (e. g. schools, museums, administrative offices, hospitals, etc.).The building maintenance costs are drastically reduced thanks to the reliability of the LED lamps fed by external power supply modules and the use of professional components for the implementation of the overall system. These are the main features of the EDISON solution jointly to the use of DC power supply as large as possible. The increment in the energy saving is due to an efficient and professional DC power supply, as mentioned, and to an ICT platform that relies on «dumb» sensors and control-actuators available on the market at low cost. This platform uses part of the existing lighting infrastructure as cabled data link, without significant renovation works or investments in new infrastructures.

All the mentioned components operate as a Smart Energy Platform (SEP), in order to realize an efficient lighting system. The SEP uses advanced smart meters and PC systems for data consumption elaboration and lighting network supervision.

In particular the SEP gives evidence of the energy saving results, efficiency, real-time operation and maximizes energy savings without distracting occupants.

A key feature of EDISON project is to create on the existing lighting power infrastructure “a DC low Voltage Lighting Power Distribution Network” which allows the direct connection with renewable energy sources such as solar, wind, or other native DC alternative energy sources, boosting the corresponding markets.

The EDISON Pilot Actions, implemented in seven Pilot Actions (more than 12 sites), intend to validate the effectiveness of the proposed ICT solution for smart lighting through the integration of hardware and software components selected over a range of products based on cutting edge technologies and available off-the-shelf, each one investigated and appropriately deployed in the Pilot trials.

The Pilots, implemented in three different countries (Italy, Belgium and UK) and in diverse real life contexts (schools, museums, administrative offices, hospitals), served as showcases to give confidence with ICT solutions and to prove the effectiveness of the proposed approach, mainly to facilitate its wider uptake and replication, not only in public contexts, but also in buildings which present architectural constraints like historical ones.

Measurement and analysis tools, as well as key indicators of energy performance, are part of the solution.

The results have been made available to other ICT CIP projects for validation and for a synergetic collaboration.

Introduction

The ICT Policy Support Programme (ICT-PSP) is one of the three specific programmes of The Competitiveness and Innovation framework Programme (CIP) and runs for the years 2007-2013. The ICT-PSP aims at stimulating smart sustainable and inclusive growth by accelerating the wider uptake and best use of innovative digital technologies and content by citizens, governments and businesses.

It provides EU funding to support the realisation of the Digital agenda for Europe.

The programme addresses obstacles hindering further and better use of ICT based products and services and barriers for the development of high growth businesses, notably SMEs, in this field. In addition to illustrating and validating the high value of digital technologies for the economy and society, it will foster the development of EU-wide markets for innovations enabling every company in Europe to benefit from the largest internal market in the world.

Particular emphasis is put on areas of public interest given their weight in the European economy and the unique solutions that ICT can bring to the societal challenges that lie ahead such as health and ageing, inclusion, energy efficiency, sustainable mobility, culture preservation and learning as well as efficient public administrations. The main challenges include the relatively slow uptake of ICT innovations in the public sector and the high fragmentation of relevant markets due notably to a lack of interoperability between ICT solutions deployed across the Member States and Associated Countries.

The EDISON project is one of the CIP projects dedicated to the energy efficiency in public buildings, with an emphasis on energy savings awareness tools and services for tenants and building owners/managers.

In the next sections will be briefly revisited the project objectives and their rationale, the pilots' results followed by the socio-economic impact, the conclusions and lessons learnt, the target audience and the performed dissemination of results.

Reference documents

[RD- 1]: Deliverable D1.1.1 Project Management Plan

[RD- 2]: Deliverable D1.2.1 Progress Report to the EU

[RD- 3]: Deliverable D1.2.2 Progress Report to the EU

[RD- 4]: Deliverable D1.2.3 Progress Report to the EU

[RD- 5]: Deliverable D1.3.1 EDISON Intranet

[RD- 6]: Deliverable D2.1.1 Pilot Description and EDISON model

[RD- 7]: Deliverable D2.2.1 Analysis of Best Practices

[RD- 8]: Deliverable D2.3.1 Standardization Activity Report

[RD- 9]: Deliverable D3.1.1 EDISON hardware & software design

[RD- 10]: Deliverable D4.1.2 EDISON hardware & software implementation and integration (Final Version)

[RD- 11]: Deliverable D4.4.1 Running of the Pilots and Results

[RD- 12]: Deliverable D5.1.1 Analysis of socio-economic aspects

[RD- 13]: Deliverable D5.2.1Interoperability description

[RD- 14]: Deliverable D5.2.2 EDISON Architecture assessment

[RD- 15]: Deliverable D6.1.1 Dissemination Plan

[RD- 16]: Deliverable D6.1.2 EDISON web site and project promotional material

[RD- 17]: Deliverable D6.1.3 Workshops & exhibition events

[RD- 18]: Deliverable D6.1.4 Exploitation Plan

[RD- 19]: Deliverable D6.2.1 EDISON training activities description document

[RD- 20]: Deliverable D6.3.1 EDISON ethical and privacy Safeguard aspects

[RD- 21]: http://ec.europa.eu/clima/policies/2030/index_en.htm

EDISON: A smart platform for energy efficient buildings

EDISON architecture and main features

A key feature of EDISON is to create on the existing lighting power infrastructure "*a DC low Voltage Lighting Power Distribution Network*". As known, the existing lighting power infrastructures consist of three wires: **L**+**N**+**E**arth, fed by AC Voltage, ranging worldwide from 85 to 265V AC with input frequency from 47 to 63 Hz. In EDISON the power to the luminaries is supplied over low voltage DC pair of wires (**N**+**E**arth). The third wire (**L**), which is used in the existing lighting power infrastructure (AC network, category 1, as defined in Cenelec HD60364 e HD384), is useless when DC Voltage is applied to the luminaries. This wire, coupled with the common negative earthed wire (Earth), is used to form *a pair of "data" wires.* The resulting wired infrastructure constitutes an integrated *power line/digital network*, *or more succinctly a* ***"*PowerLAN".**

The digital network, and related data, is managed by an intelligent monitoring and controlling system, integrated in the **Central Power Control (CPC)**, that is connected to LED luminaries (Figure 1) through **Remote Stations** (**RS**s), located into commercial **light Switch Boxes (SBs).** The RS module controls the local lighting section (a room, a group of rooms, a gym space, a large office, a museum hall, etc.) and it is physically and electrically integrated into the SB jointly to on/off, automatic/manual electric switches, as illustrated in the same Figure 1. The RS basic block is located at an intermediate level between the CPC, the distribution power lighting infrastructure and the network of LED lamps, sensors and actuators. The RS integrates mature off-the-shelf technologies in the field of LED controller or dimming modules and remote controls, which will be easily installed in the existing light switch boxes.

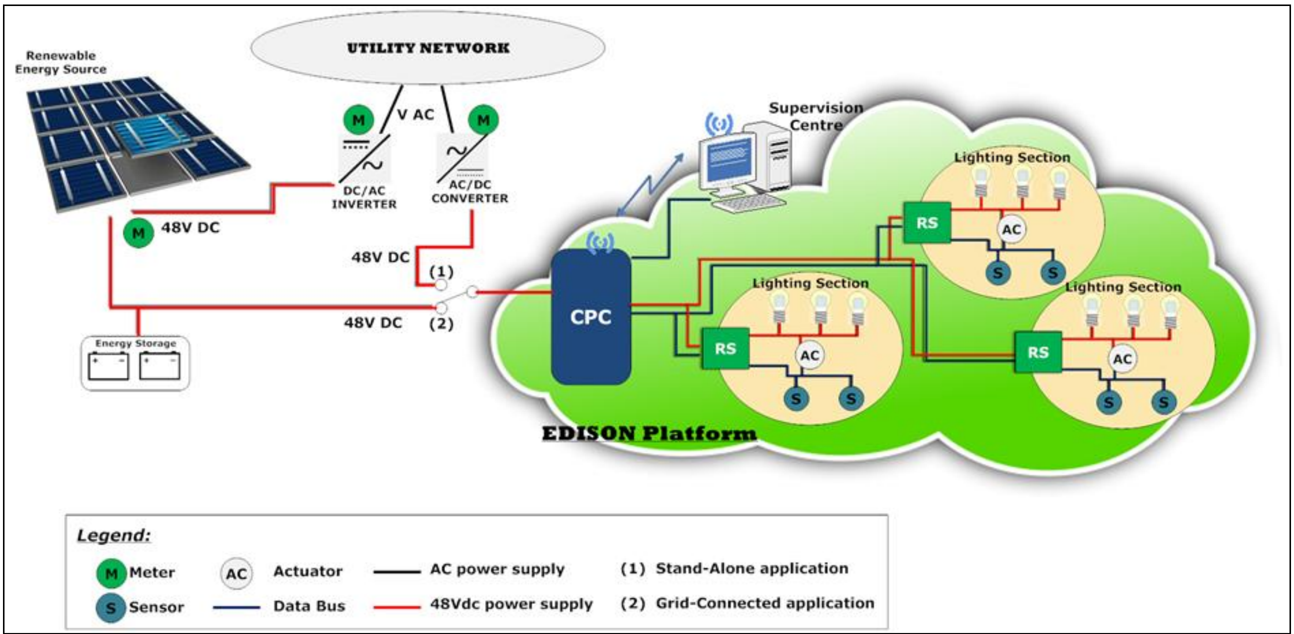
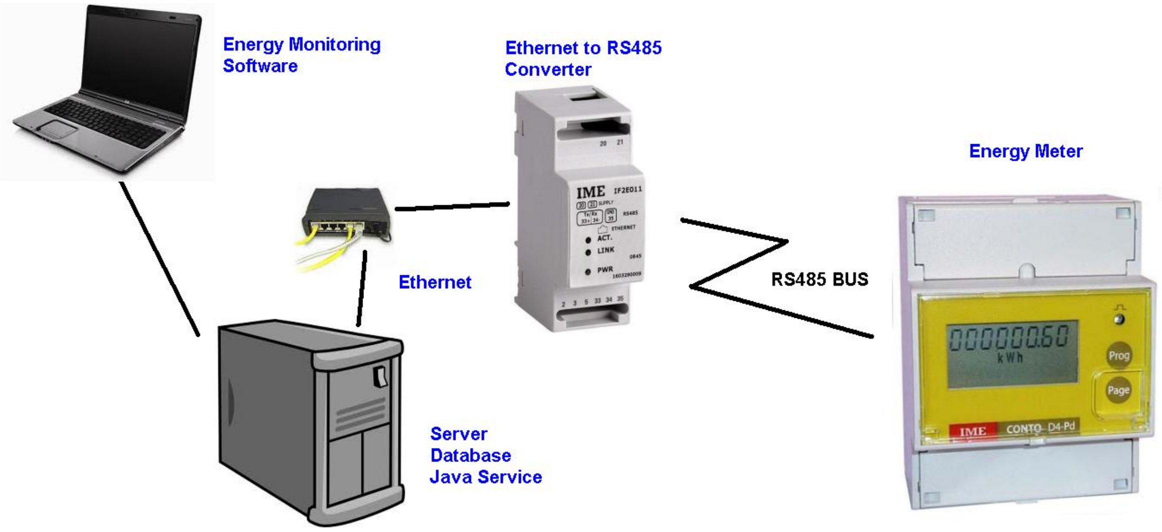


Figure 1 – EDISON Architecture

The EDISON approach uses the lighting network controlled by an intelligent platform, named SEP, in order to deliver both ongoing energy savings and workspace productivity enhancements. In fact, EDISON's solution integrates, in the same electrical power supply infrastructure, information originated in ICT components and systems (e.g. smart metering, power electronics, renewable energy sources, etc.). The SEP delivers a smart lighting system based on LED technology, powered and controlled through the same electrical wires, thanks to a specific power supply solution, described in the following. The resulting energy metering and control system is able to provide 100% visibility into where and how electric power is being used in lighting.



Highly accurate motion detection and control of groups of lamps are used to maximize energy savings without distracting occupants. Moreover, LEDs dimming, is an additional feature to achieve a higher efficiency than fluorescents lamps. In particular with light-level control, the system permits:

- *on-demand/instantaneous harvesting of outside light (automated adjustment of interior lighting levels according to exterior light levels while maintaining a comfortable overall ambient light level);*
- *spaces that are infrequently/rarely used be automatically dimmed when vacant and brightened upon activity;*
- *lights in unoccupied sections of large rooms be dimmed or powered off without the occupants even noticing.*

Costs of both ICT controlling platform and LED lamps/fixtures could be reduced with EDISON solution. The integration in the same infrastructure of power and control systems result in a lighting infrastructure compatible with the electrical switches and junction boxes existing in the operating AC-powered lighting system. The low voltage doesn't require the intervention of skilled installation technicians and specific certifications for new electrical infrastructures.

To exchange information with any sensor and actuator, EDISON offers a "communication bus" (the power wires devoted to lighting infrastructure) that eliminates the problem of implementing an infrastructure dedicated to specific services.

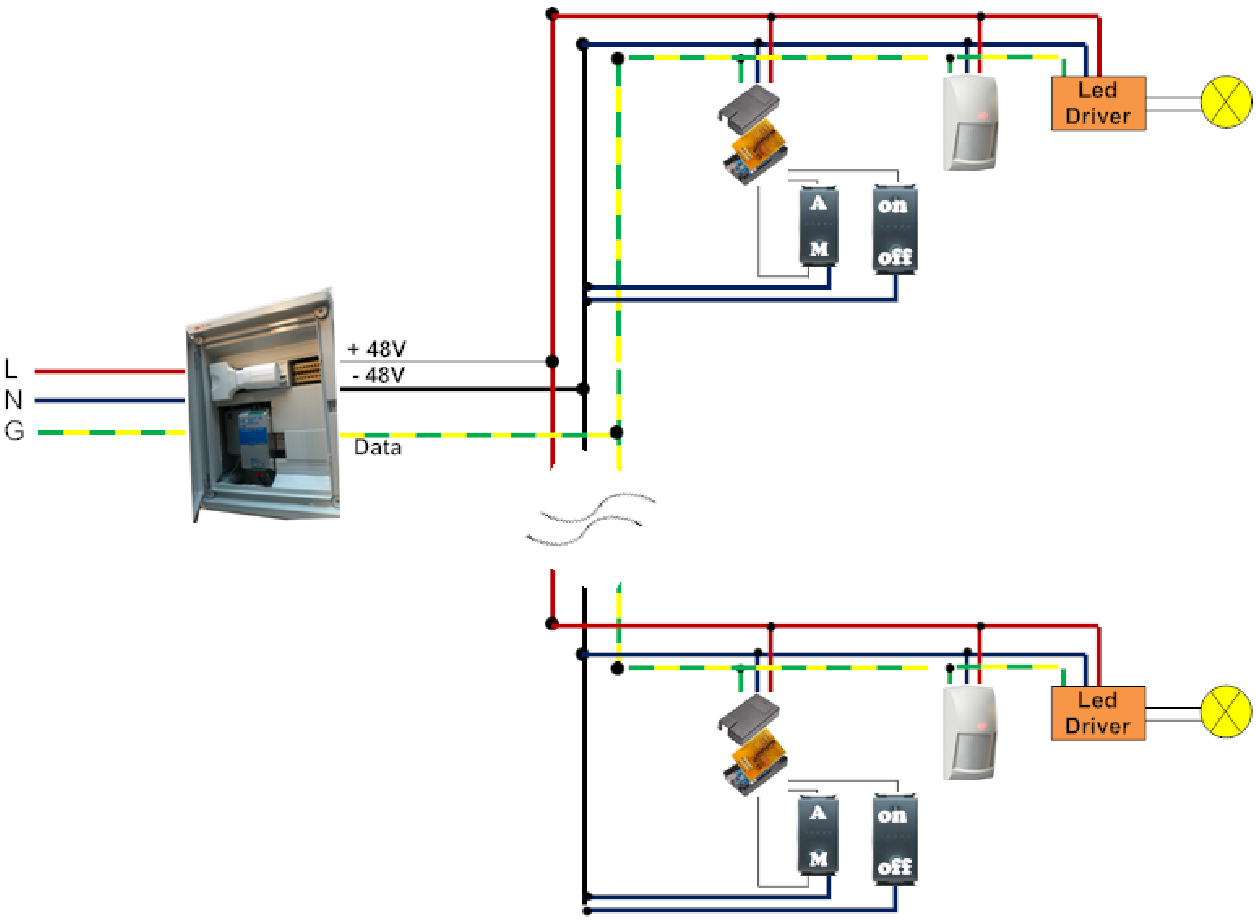


Figure 2 - General electrical EDISON scheme

EDISON provides different electrical configurations for the implementation of the solution, depending on the level of complexity. Specifically there are three configuration modes, ranging from "basic", used for simple installations realizable by electrical installers with basic skills, "intermediate" for technical people a little bit more expert and the "full" solution, suitable for electrical installers and system integrators who have completed a training course to use the "Smart" elements of the EDISON platform and are able to carry out more complex installations. The three configuration modes have the following characteristics:

- Basic Configuration:

This configuration is carried out without the need of a PC controller. Few modules are needed: AC/DC converters, dimmable LED drivers, electrical switches and buttons properly cabled compose the "Remote Monitoring & Control Basic System", including a “Smart

Metering System" for local data consumption reading and acquisition. The products compatible with the Basic Configuration allow limited functionality and are reserved for small/medium size installations.

- Intermediate Configuration:

This configuration offers several improvements compared to the basic one. It includes additional features such as the possibility to monitor the EDISON platform elements from a centralized PC, locally installed and devoted to control the building. It is reserved for all kind of size installations.

- Full Configuration:

The design, installation and configuration phases are performed with the support of a PC on which the EDISON Management Software is installed. The central PC operates as a gateway for "operations from the cloud" in order to have the possibility to access all the information collected in the central data base, to control single points of the network and to monitor the status of single sensors as well. In other words, the "Full Configuration" is a domotics/intelligent building solution, available for any possible service control in the building. It is mainly addressed to electrical installers and system integrators, since it is EDISON certified and applied in large and more complex installations.

All products proposed within the EDISON solution are off the shelf and CE certified to guarantee the compliance with European rules.

EDISON is going to be approved by CENELEC in respect to the:

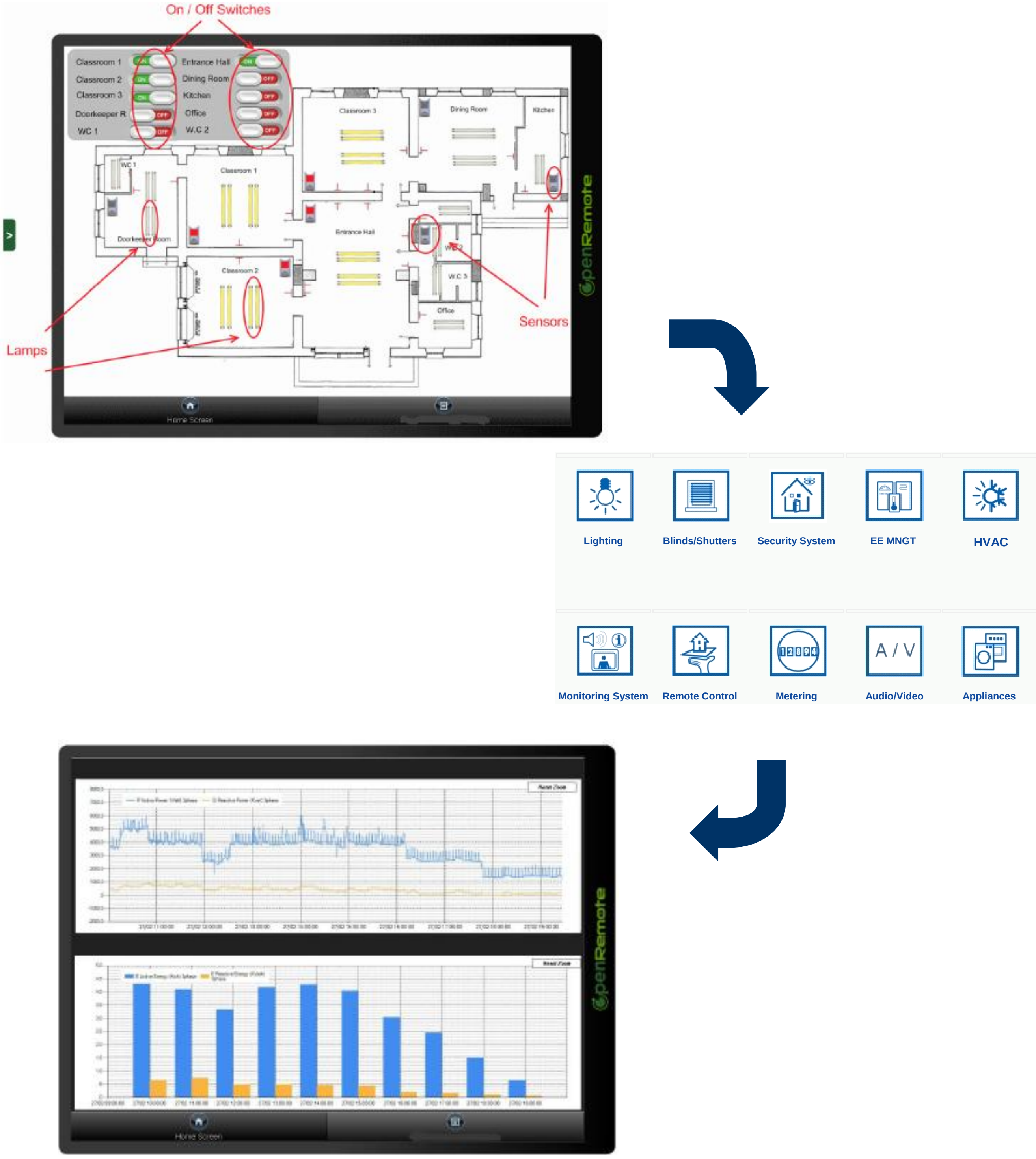
- European Standard (CENELEC EN 50090 and CEN EN 13321-1).

The solution proposed in the project, and mature for the market, is the best from reliability, flexibility and expandability point of view. Moreover it is a very cost-effective solution.

Inside the platform

The EDISON solution permits to use very simple electrical signals to locally interface sensors/actuators, they must only comply with a prefixed voltage (1-5 VDC) reading code.

The sensors and actuators, available off the shelf, for: lighting control, blinds/shutters handling, security systems, energy consumption control, heating ventilation and air conditioning systems, audio/video control, smart appliances, etc., can be operated and monitored via the central EDISON system, without extra electronics and control centres.



Few main components are needed to implement the basic platform:

- **Central Power Control** (CPC) module, consisting
  in a LAN interface (or a PowerLine modem),
  some AC/DC converters,
  a smart board (Arduino Ethernet, Rasperry Pi, etc.),
  relays, etc.
  Dimensions: 40x30x15 cm

- **Remote Station** (RS) modules, each one including
  a smart board (Arduino), step-down converter,
  sensors/actuators interface, etc.
  Dimensions: 62x112x35 mm.

- **Electrical Switches** and **Push Buttons** for dimming, Aut/Man setting, commercially available (Legrand, bTicino, etc.)
- **LED drivers** (by TSItalia, Cree, Recom, etc.), external to the lamp body, with PWM input control, operating voltage ranging up to 52 Volts.

Through the EDISON certification, physical interoperability of commercial products is guaranteed.

The EDISON certification process ensures that different products from different manufacturers, used in different applications, operate and communicate each other. The conformity of the commercial products has been tested in a neutral way in the laboratories of some technical partners of the EDISON Consortium (TSItalia, BKT).

Additionally, the Consortium offers certification programs for the selection of the commercial products compatible with the solution; courses are addressed to training centres (public and private), and to technicians (electrical installers and designers of buildings).

EDISON Benefits

Wherever used, the EDISON platform brings real benefits to building managers, designers, installers, and especially to end-users as:

- Low costs with significant savings in energy and time to operate

  Lighting and air conditioning are only switched on when needed, for example as a function of time profiles and/or actual presence, thus saving energy and money. Lighting can also be controlled automatically according to the intensity of natural light (thus ensuring an optimal level of brightness at each workplace) and human presence (only the light sources really needed remain lit), with the result of a huge energy saving. The opportunity to connect commercially available components to a single (existing) "bus", reduces the time for design and installation considerably. This chance, in combination with the use of low cost commercial sensors, makes EDISON a very attractive solution.

- Flexibility and adaptability to future developments

  The EDISON platform can easily support new applications and be extended to larger areas without problems. New components can be connected to the existing bus.

  Heating, ventilation, access control, remote control of all appliances are the most frequently used applications, in addition to lighting control, which can benefit from the EDISON functionalities, taking advantage from the potentiality of the platform to be able to offer completely new ways to increase comfort, safety and energy savings in homes and buildings.

- Interworking

  Interworking is the major resource of the EDISON solution and is defined as:

  "The ability of products that send and receive messages, of correctly understand and process the signals without additional equipment".

  To fully benefit from the use of a control system for homes and buildings, it is essential that the products of different manufacturers ("multi-vendor interworking") and the products of different fields of application ("cross-discipline interworking") can work together. Without respecting the interworking constraint, it would be impossible:

– provide building owners with a free choice between the products of a large number of manufacturers on the market today;

– allow installers a fast and easy implementation;

– broaden the product portfolio of SME;

– generate a OEM market between manufacturers;

– facilitate the development of interfaces between EDISON and other systems (BACnet).

As documented in the specifications, EDISON data can also be sent encapsulated in IP. In this way, the traditional LAN and Internet can be used for routing or tunneling EDISON data.

The EDISON experience has been gained in Pilot test-beds partially funded by the EC, with the ambition to make the platform an open standard for building control, mainly taking advantage from the strength points summarized below:

1st strength: unique wired infrastructure for the building

2nd strength: Supervisory Control And Data Acquisition (SCADA) system

3rd strength analog I/O and MODBUS communication protocol

4th strength: manufacturer independent sensors / actuators

5th strength: open architecture, open standards, royalty free

A simple case study

As a consequence of the above considerations, with the adoption of the EDISON platform, it is plausible to expect a significant reduction of energy consumption and CO_2 footprint.
LED lamps outperform neon, incandescent lamps in terms of efficiency and thus provide a saving potential of at least 50% of the electrical energy used for lighting. To have an idea of possible energy savings adopting LED lamps, in Table 1 are calculated some figures starting from the following hypothesis:

- 500 number of NEON lamps replaced with LED lamps of same luminosity;
- electricity cost/KWh 0,15 €;
- hours of light daily: 14;
- day per year: 260.

	Lamp energy consumption (W)	Lamp energy consumption (kWh/day)	Lamp energy consumption (kWh/year)	CO_2 Emissions (Kg)	Cost per year (€)
NEON	20	140	36400	14504	5460,00
LED	8	56	14556	5801	2184,00

Table 1- Energy saving: LED lamp vs Neon

Thanks to the intelligent light management system proposed in EDISON, an additional 20% of the energy saving has been gained with respect to the above mentioned figures (use of simple LED lamps) to achieve a total of energy saved higher than 70%.

In conclusion by adopting the EDISON solution, strictly based on LED lamps, for example in the overall European area, the following objectives could be achieved:

- from an environmental perspective more than 1000 Mt of carbon dioxide is saved per year on a global level;
- the economy will be boosted by increasing Europe's industrial position in LED lamps application, retrofitting actions and driving electronics, jointly employing more than 150,000 people today;
- each year more than 300 billion euro is saved on the global energy bill;
- society at large will profit from more visual comfort by superior light solutions and from less light pollution;
- energy efficient light technologies, as LED-based lamps, will take significant advantage by using an Extra Low Voltage Power Supply thanks to intrinsically safe lighting system (SELV) and easy, low cost retrofitting action (reuse of existing fixtures even though certified to operate with AC main supply).

In synthesis, the main results of the EDISON action are listed in Table 2.

Metric Parameter	**Reduction factor**
Annual energy consumption additional to LED adoption	> 20%
Annual electricity lighting consumption	> 65%
Annual CO_2 emissions	> 40%
Relative lighting cost savings using actual local prices	> 60%

Table 2- Factor of Reduction calculated in all the EDISON pilots

Main advantages

EDISON means high quality products

The EDISON solution requests a high level of control over the products and their quality throughout the life span of the products. For this reason, all the components compatible with the EDISON platform must be compliant with the European CE-RoHS certification.

In addition to the manufacturers' conformity to the ISO 9001 standard, products must also be in accordance with international and European standards for electronic systems, for home and buildings.

EDISON is suitable for different building typologies

EDISON can be installed in small domestic homes as well as in large buildings (offices, hotels, conference centers, hospitals, schools, department stores, airports, etc.).

The platform improves comfort and safety and contributes significantly to energy savings (more than 65% for lighting control and up to 25% for heating) and to reduce impact on the environment (reduction of CO_2 emissions).

The EDISON solution can communicate through different media and standards

The EDISON data transmission system can operate in combination with:

- Wires (Power Line Modems):

  The data collected using the EDISON protocols by the intelligent Remote Stations (RS) are transmitted on the existing power grid operating in AC (backbone).

- Wireless systems:

  The collected data are transmitted through commercial WiFi radio modules (Access point, etc.).

- LAN-IP / Ethernet (IP):

Where an IP/Ethernet network is available, the above mentioned data are exchanged via this network.

EDISON can be integrated with Building Energy Management tools

The EDISON solution provides a gateway to other networks, for example to Building Automation Systems and Building Energy Management tools, through the above mentioned communications modalities. Obviously, the platform can be interfaced to telephone networks, multimedia networks, IP networks, etc.. The EDISON system can be mapped to BACnet objects (as required by the international standard ISO16484-5) and offers the possibility to be interfaced to systems using the MODBUS communication standard.

EDISON is independent of any kind of hardware and software

The EDISON solution can be implemented in any microprocessor board. For each affiliate-board, the development of the EDISON platform is not subject to additional license fees.

Exploitable products and services

The exploitable products and services identified in the project and listed in Table 3 may be offered to the market under 7 different structured categories of products /services:

A. Consultancy services could be provided as standalone services and could be customized based on the reference context. They are not only ICT related.

B. ICT Solution–infrastructure: encompass the product and services needed to build the platform for collection and analysis of data. This infrastructure may encompass the collection of data from energy generation if this type of infrastructure is present in the building. The smart meters and sensors integrated in the infrastructure may be supplied by TSI or by external suppliers.

C. ICT Solution–infrastructure + tenants services – as B + the services customized for tenants. Services include the dedicated user interfaces for tenants (either sDisplay or VAS) and specific training, monitoring and awareness services.

D. ICT Solution–infrastructure + tenants services + managers' services – as C + the services customized for building owners/managers (including dedicated user interfaces, such as OPEN REMOTE).

E. Project, supply, installation, commissioning and maintenance: development of customized project, supply, installation, commissioning and maintenance services.

F. Full ICT solution (D+E) it encompasses the ICT solution + the services for tenants + managers services + development and maintenance of overall infrastructure.

G. Full solution with consultancy (A+F) services encompasses all the 15 Exploitable products and services identified.

Product/Service description	Maturity/Time to market	Application sectors/ customer	Partner responsible / Other partners for exploitation
LED Driver	Mature	LED power supply	TSI
Daylight Sensor	Mature	Light control	TSI, SIE, BKT, VUB
Presence sensors	Mature	Light control	TSI, SIE, BKT, VUB
Smart cards	Mature	Light/Power control	TSI, VUB
Power devices	Mature	Power supply	TSI, SIE
Wireless devices	Mature	Light control	TOM, SMK
Communication devices	Mature	Data transmission	TSI, FUB, TOM, SMK
Software tools	Mature	Monitoring/Control	BKT
Platform Design	Mature	-	FUB
Platform Installation	Mature	-	TSI, SIE
Platform functionality demonstration	Mature	-	LMP, MNP, RMP, IDIS, SHT
EDISON solution promotion and exploitation	Mature	-	All partners, mainly ANC and FUB
Commercial activity and financing	Mature	ESCO/ESPC	ENSO

Table 3 – Exploitable products and services

Best practices

Overview

The EDISON solution has been tested in 12 buildings, throughout six pilot actions located in three European countries. Moreover, it was also implemented in more than 10 additional sites without any financing from EC.

In this section, for each of the above mentioned site, a brief description of functional, architectural aspects of the building will be given.

A specific methodology which defines all the steps necessary to collect all the relevant information during the survey phase of the Pilot sites will be also illustrated. This survey-model can be considered a useful guideline to be taken into account in EDISON solution replication.

A relevant part of the analysis was devoted to the structure of the existing lighting system, reporting all its infrastructural components such as cables, panels, switches and so on. Furthermore a specific attention was devoted to the typology, power consumption and localization of all existing lighting points installed in the Pilot areas.

Some outcomes collected from the activity in the pilots will be illustrated. In particular:

- energy consumption and other parameters monitored after the implementation of the ICT solution,
- performance in terms of energy savings
- user acceptance assessed through questionnaires and interviews with a relevant number of people working and visiting the pilot sites.

The EDISON Survey Model

On the basis of the experience gained in the project pilot sites (the list of them is reported in Table 4) it has been possible to define an optimised procedure for survey actions in new implementations.

PILOT LOCATION	COUNTRY	BUILDING TYPOLOGY	RESPONSIBLE PARTNER	SHORT NAME PARTNER
Brussels	BELGIUM	Part of University building	Vrije Universiteit Brussel	VUB
Naples	ITALY	Offices	Fondazione IDIS	IDIS
Lettomanoppello	ITALY	Municipal Offices and Public School	Municipality of Lettomanoppello	LMP
Manoppello	ITALY	Public School	Municipality of Manoppello	MNP
Roccamontepiano	ITALY	Public School and Municipal Offices	Municipality of Roccamontepiano	RMP
Belfast	UK	Lurgan Hospital and Craigavon Healthcare Office	The Southern Health and Social Care Trust	SHT

Table 4 - Pilot Locations

Below are shown the individual steps that have been performed in the case of the EDISON project.

#	ACTIONS TO BE DONE	HOW TO CARRY OUT THE ACTION
1	Identify of relevant geographical/environmental informations of the site	Running software tools for positioning and mapping Analysis of pictures Ask to people living on the site location
2	Plan a meeting with a responsible of the site building	To collect all the necessary information concerning a Pilot building, usually two days of survey are necessary. In general the duration is depending on the size of the building.
3	Collection of topographical material relating to the site building	Collect printed topographical maps from buiding managers; Make measurements with appropriate tools of appropriate building environments to integrate the information available in the topographical material Verify the rooms brightness, due to daylight, in different period of the day
4	Collection of photographic material for the site rooms	Collection of pictures related to internal and external areas of the building site through a photo camera. Sometimes could be useful the use of a videocamera.
5	Collection of material on the electrical infrastructure of the site	For this activity the help of an electrical technician which has a good knowledge of the building electrical infrastructure is recommended. Collect all the info concerning the lighting points, switch boxes, conduits, electrical cables, lamps typology, etc.
6	Collect all relevant statistical data related to	Through the collaboration of building manager and

	the site	other people working in the building site collect all info concerning an estimation of: Number of people visiting the site per day/year Number of hours the lamps are turn on during a day Daylight during summer and winter
7	Identify building lighting requirements	Through the collaboration of building manager and other people working in the building site collect all info concerning specific building lighting requirements such as: - number and positioning of brightness/presence sensors that could be installed in each environment; - rooms/environments that need peculiar lighting conditions (i.e lights on all the day, etc.); - lighting infrastructure specific requirements (i.e. emergency lights, etc.); - other specific information
8	Carry out a questionnaire among people who attend the site focusing on aspects related with the lighting infrastructure	A comprehensive questionnaire will be prepared through the collaboration of project partners in order to submit it to people attending the Pilot sites and have a feedback about their feeling concerning the lighting in the building environments as well as possible improvements that could be adopted. The statistical sample of persons to which submit questions should be selected in order to have significative results.
9	Synthesize all collected data on a data base	Develop a database in which to place all the technical and logistic information collected during the surveys in order to have an effective tool for consultation for all the needs of the project. The data base should be made available to all the project partners.
10	Reproduce the structure of the building environments using a graphic tool	To carry out this activity it can be used different open-source software such as Blender and WebGL software packs. In particular Blender is an open-source software used for 3D modelling and animation and WebGL is one JavaScript API for rendering interactive 3D graphics.

Table 5 - List of Actions to implement EDISON solution

Pilots activated during the EDISON project

BRUSSELS PILOTS

DESCRIPTION

VUB Student Restaurant

Owner: Vrije Universiteit Brussel Year of construction: 1975 No. of floors: 1

Approx No of visitors (per year): 1500 Approx No of hours/month: 95 No of day/week: 5

No of rooms: 3 No of lighting points: 97 No of ICT elements: 20



VUB Dean's Office and Student welcome centre

Owner: Vrije Universiteit Brussel Year of construction: 1975 No. of floors: 1

Approx No of visitors (per year): 1000 Approx No of hours/month: 120 No of day/week: 5

No of rooms: 5 No of lighting points: 110 No of ICT elements: 16



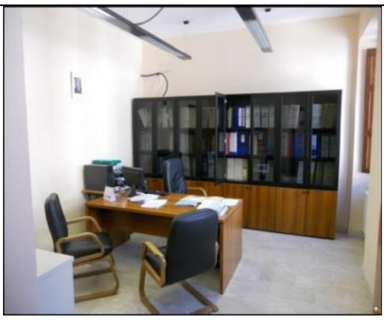
Naples Pilot

Description

Marie Curie Hall – Città della Scienza
Owner: Fondazione IDIS Year of construction: 1853 No. of floors: 1 Approx No of visitors (per year): 8100 Approx No of hours/month: 234 No of day/week: 6 No of rooms: 7 No of lighting points: 47 No of ICT elements: 19
  

LETTOMANOPPELLO PILOTS

DESCRIPTION

Municipality offices
Owner: Lettomanoppello Municipality Year of construction: 1863 No. of floors: 3 Approx No of visitors (per year): 2100 Approx No of hours/month: 200 No of day/week: 6 No of rooms: 41 No of lighting points: 128 No of ICT elements: 81
  

Nursery and Primary and School
Owner: Lettomanoppello Municipality Year of construction: 1960 No. of floors: 2 Approx No of visitors (per year): 25000 Approx No of hours/month: 225 No of day/week: 6 No of rooms: 46 No of lighting points: 512 No of ICT elements: 86
  

MANOPPELLO PILOTS

DESCRIPTION

Primary School
Owner: Manoppello Municipality Year of construction: 2000 No. of floors: 2 Approx No of visitors (per year): 10000 Approx No of hours/month: 200 No of day/week: 6 No of rooms: 34 No of lighting points: 107 No of ICT elements: 60
  

Primary and Secondary School
Owner: Manoppello Municipality Year of construction: 1954 No. of floors: 3 Approx No of visitors (per year): 30000 Approx No of hours/month: 200 No of day/week: 6 No of rooms: 36 No of lighting points: 100 No of ICT elements: 87
  

ROCCAMONTEPIANO PILOTS

DESCRIPTION

Municipality offices

Owner: Roccamontepiano Municipality Year of construction: 1972 No. of floors: 2

Approx No of visitors (per year): 12000 Approx No of hours/month: 200 No of day/week: 6

No of rooms: 16 No of lighting points: 40 No of ICT elements: 38



Primary and Secondary School

Owner: Roccamontepiano Municipality Year of construction: 1933 No. of floors: 3

Approx No of visitors (per year): 36000 Approx No of hours/month: 200 No of day/week: 6

No of rooms: 51 No of lighting points: 134 No of ICT elements: 87



Nursery

Owner: Roccamontepiano Municipality Year of construction: NA No. of floors: 1

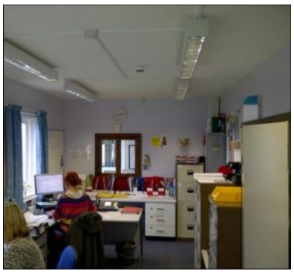
Approx No of visitors (per year): 8000 Approx No of hours/month: 220 No of day/week: 5

No of rooms: 8 No of lighting points: 19 No of ICT elements: 27



BELFAST PILOTS

DESCRIPTION

Bocombra Lodge Healthcare Offices
Owner: Semple&McKillop Ltd   Year of construction: 1990   No. of floors: 1 Approx No of visitors (per year): 12500   Approx No of hours/month: 200   No of day/week: 5 No of rooms: 2   No of lighting points: 9   No of ICT elements: 5
  

Lurgan Hospital
Owner: Southern Health And Social Care Trust   Year of construction: 1960   No. of floors: 1 Approx No of visitors (per year): 36500   Approx No of hours/month: 720   No of day/week: 7 No of rooms: 50   No of lighting points: 136   No of ICT elements: 58
  

EDISON implementations beyond the project

OUTLINE

As a consequence of the dissemination activity carried out during the project development, a significant number of public and private entities decided to adopt the EDISON solution in their buildings.

In this section is reported an overview of the most relevant implementations completed or still in progress at the project end date.

ZEIST MOSQUE

Zeist (NL) - Mosque
Owner: Muslim community of Zeist Year of construction: 2013 No. of floors: 2 Approx No of visitors (per year): 35000 Approx No of hours/month: 150 No of day/week: 7 No of rooms: 25 No of lighting points: 250 No of ICT elements: 20


PRIMARY SCHOOL AND NURSERY OF RONCIGLIONE (ITALY)

Ronciglione (I) – Primary school and nursery
Owner: Municipality of Ronciglione Year of construction: 1975 No. of buildings: 3
Approx No of visitors (per year): 125000 Approx No of hours/month: 160 No of day/week: 5
No of rooms: 60 No of lighting points: 300 No of ICT elements: 65

EXPLORA MUSEUM IN ROME (ITALY)

Rome (I) – Museum

Owner: Group of private institutions Year of construction: 2001 No. of buildings: 1

Approx No of visitors (per year): 160000 Approx No of hours/month: 220 No of day/week: 6

Square meters: 2000 No of lighting points: 18 No of ICT elements: 8

OTHERS IMPLEMENTATIONS

Apart from the above illustrated ones, a list of other relevant implementations, completed or in progress, is reported in the following:

End user	Where	Completed / In progress
PASSARELLI AUTOMAZIONI SRL	Rome (I)	Completed in 2014
P.O.S.T. MUSEUM	Perugia (I)	In progress
AGFA headquarters Belgium	Mortsel (B)	In progress
AGFA headquarters Italy	Padua (I)	In progress
Municipality of Narni (Parking)	Narni (I)	In progress
Condominium “Manara”	Rome (I)	In progress
English Embassy in Rome	Rome (I)	In progress

An example of Business Plan

On the basis of the experience accumulated during the project an example of business plan, evaluated for a typical primary school building, is reported in Table 6, in order to give an idea of EDISON platform implementation costs and the corresponding payback period.

In this case a payback period of 4 years has been estimated.

		Previous Lamps Amount/ Costs					LED LAMPS INSTALLATION COST (€)	EDISON Solution Cost (COMPON. & INSTALL.) (€)	TOTAL COST (€)	COST DIFFERENCE (WITHOUT EDISON Project support) 1st (€)	COST DIFFERENCE (WITHOUT EDISON Project support) 2nd (€)	COST DIFFERENCE (WITHOUT EDISON Project support) 3rd (€)	COST DIFFERENCE (WITHOUT EDISON Project support) 4y (€)	COST DIFFERENCE (WITHOUT EDISON Project support) 5y(€)	COST DIFFERENCE (WITHOUT EDISON Project support) 10y (€)	COST DIFFERENCE (WITHOUT EDISON Project support) 15y (€)
		Incandescent bulbs	Fluorescent	Modular ceiling Neon tube	T8 Neon tube	Total (€)										
CAPITAL COSTS	Old lighting system	30	10	800	80	**7.140,00**	-	-	7.140,00	- 36.154,50	- 27.107,37	- 18.060,24	- 9.013,11	34,02	45.269,66	90.505,31
	EDISON lighting system					**17.920,00**	11.224,50	14.150,00	43.294,50							
MAINTENANCE COSTS	Old lighting system					**4.148,57**	-	-	4.148,57	4.148,57	4.148,57	4.148,57	4.148,57	4.148,57	4.148,57	4.148,57
	EDISON lighting system	none	none	none	none	**none**	-	-	-							
REPLACEMENT COSTS	Old lighting system	40	2	151	15	**1.414,29**	-	-	1.414,29	1.414,29	1.414,29	1.414,29	1.414,29	1.414,29	1.414,29	1.414,29
	EDISON lighting system	none	none	none	none	**none**	-	-	-							

		Electricity Cost				COST DIFFERENCE (WITHOUT EDISON Project support) (€)	COST DIFFERENCE (WITHOUT EDISON Project support) (€)	COST DIFFERENCE (WITHOUT EDISON Project support) (€)	COST DIFFERENCE (WITHOUT EDISON Project support) (€)	COST DIFFERENCE (WITHOUT EDISON Project support) (€)	COST DIFFERENCE (WITHOUT EDISON Project support) (€)	COST DIFFERENCE (WITHOUT EDISON Project support) (€)
		Rate (€/KWh)	Consumption (KW)	Hours of lighting infrastructure use	Total (€)							
ENERGY COSTS	Old lighting system	0,20	20,47	1320	5.404,08	3.484,27	3.484,27	3.484,27	3.484,27	3.484,27	3.484,27	3.484,27
	EDISON lighting system	0,20	9,09	1320	1.919,81							

	COST DIFFERENCE (WITHOUT EDISON Project support) (€)	COST DIFFERENCE (WITHOUT EDISON Project support) (€)	COST DIFFERENCE (WITHOUT EDISON Project support) (€)	COST DIFFERENCE (WITHOUT EDISON Project support) (€)	COST DIFFERENCE (WITHOUT EDISON Project support) (€)	COST DIFFERENCE (WITHOUT EDISON Project support) (€)	COST DIFFERENCE (WITHOUT EDISON Project support) (€)
CUMULATIVE COST SAVINGS USING EDISON SOLUTION	- 27.107,37	- 18.060,24	- 9.013,11	34,02	9.081,15	54.316,79	99.552,44
ANNUAL TOTAL COST SAVING USING EDISON SOLUTION	9.047,13	9.047,13	9.047,13	9.047,13	9.047,13	9.047,13	9.047,13
SIMPLE PAYBACK (years)	4,00						
ROI (%)	25,02						

Table 6 - Example of business plan

Figure 3 shows the trend of the Cumulative Cost Savings derived from the use of the EDISON solution over 15 years (lifetime of a LED lamp).

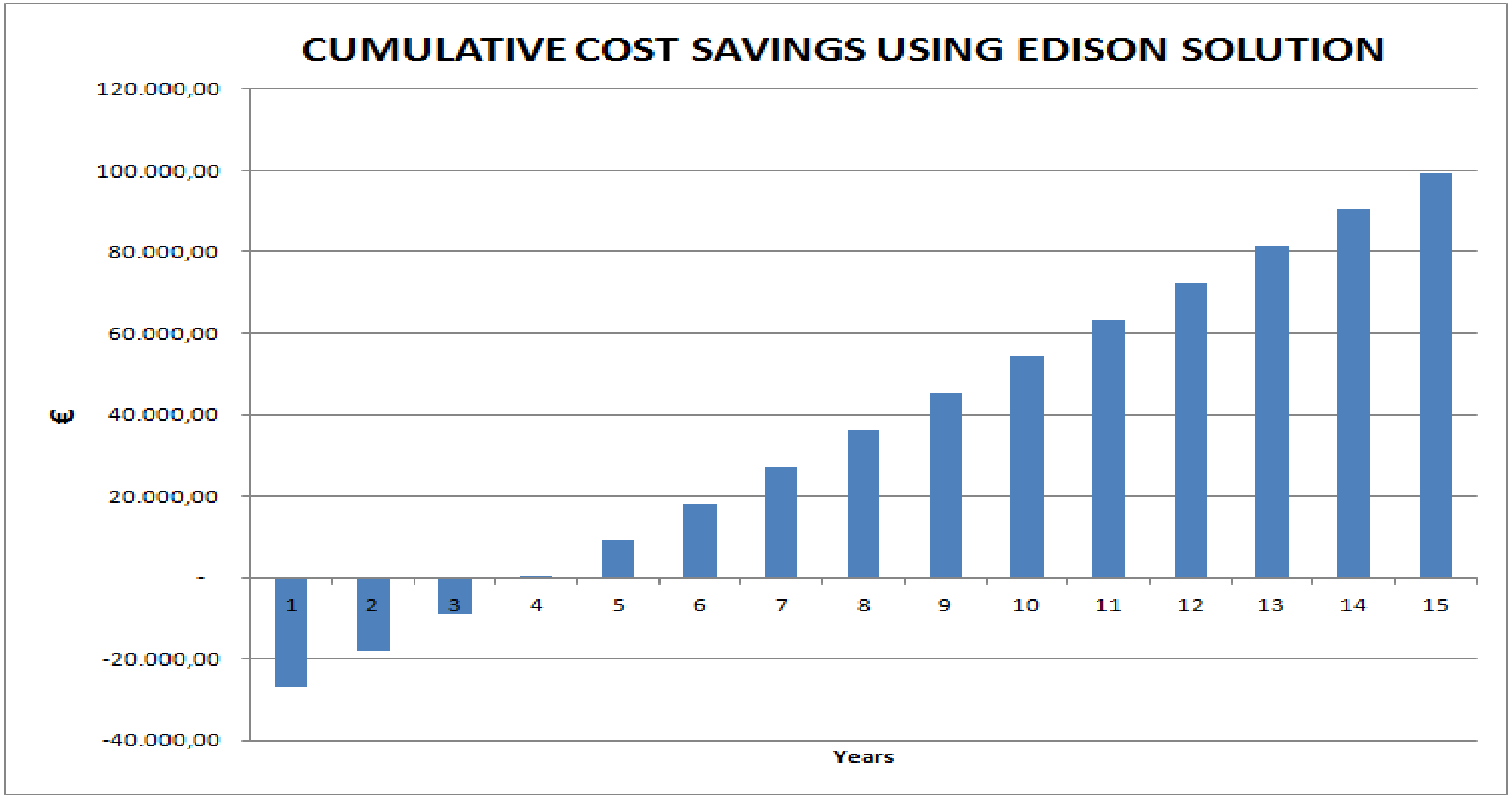


Figure 3 – Example of trend for the cumulative cost savings in case of use of the EDISON solution

Main project results

Savings achieved in the Pilot sites

Taking into account the pilot site characteristics detailed in the previous section, in the following a synthesis of performance results, with specific focus on ICT components impact, calculated on the basis of the data collected during the running session of the pilots, has been reported.

A first performance result, highlighting the energy savings achieved by using ICT components jointly to DCC (DC power Centralization) approach, calculated with respect to the nominal LED power consumption, is provided through a pie chart. In these charts, for each pilot site, the reference nominal power load (KWh) and the average energy saving (in percentage), calculated over the running period, are reported.

In addition, to illustrate the monthly savings due to the separated contributions of LED lights, ICT components and DCC approach, specific bar chart graphs have been reported. In these graphs, for each month, the gain due to each contribution is reported with a different color. The width of each colored bar gives a measure of how the specific contribution impacts, in percentage, on the monthly overall saving.

Brussels Pilots

Performance Results

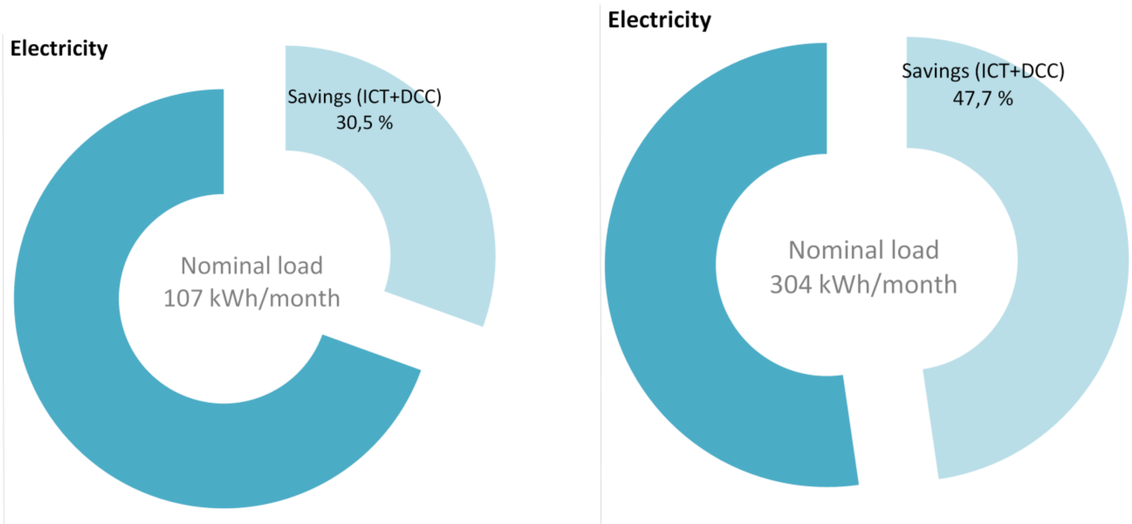
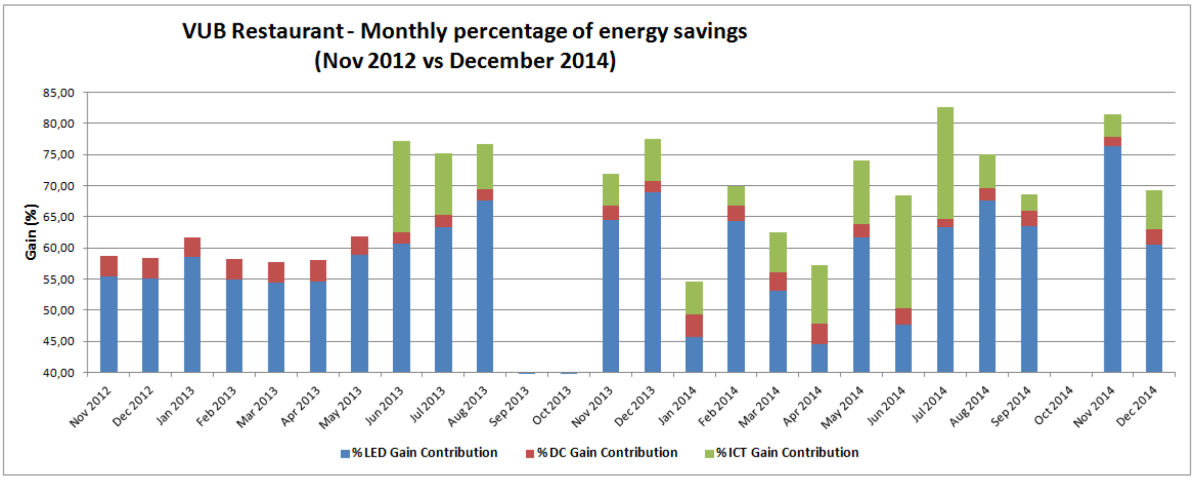


Figure 4 – Energy savings due to ICT components and Centralised DC power supply (DCC) in VUB Restaurant (left) and Dean's Office (right)



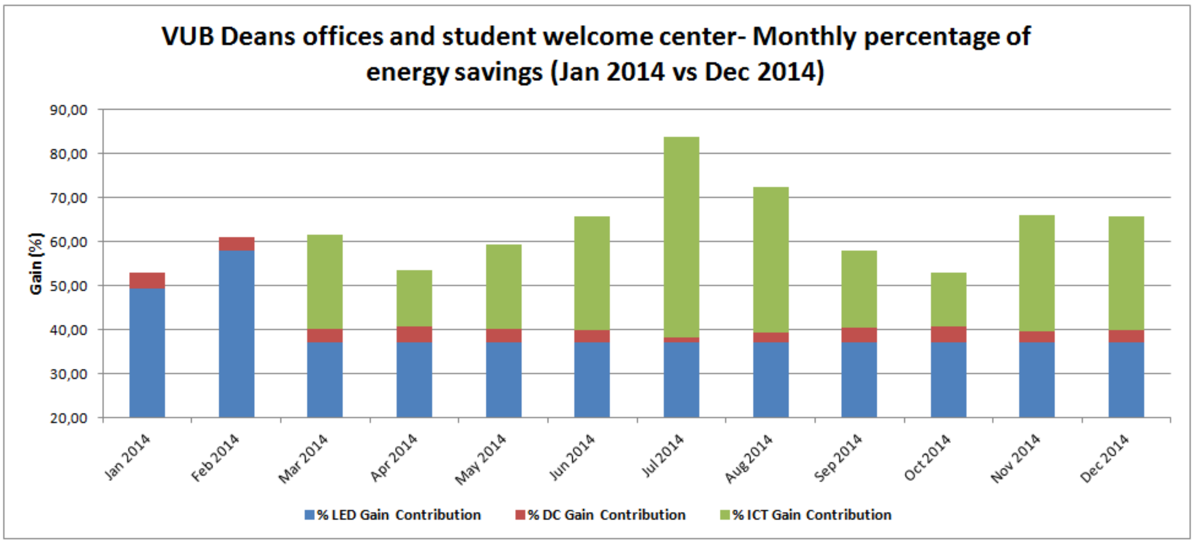


Figure 5 – Monthly energy savings highlighting the contribution due to LED lamps, ICT components and DCC power supply solution at VUB Pilot sites

ANALYSIS OF RESULTS

<u>VUB RESTAURANT</u>

1-The Pilot had a running period of 26 months, from November 2012 to December 2014

2-Savings due to the ICT contribution have begun to occur from June 2013. Thanks to the early starting of the Pilot, anticipated in respect to the plan, it was possible to gather data with and without the ICT (sensors) contribution. In fact the installation and the running of the sensors were postponed of around half a year. This two- phases installation was useful to compare results obtained in the different periods and to have a clear vision of the ICT contribution.

3-The overall savings measured during the running period (with ICT components working) ranges from 55% to 82%. The average energy gain with respect to the baseline data is around 65% as reported in Table 7.

4-The average monthly energy saving of ICT components and DCC approach, over the running period (after EDISON platform implementation with a LED lamps nominal load of 107 KWh/month) is around 30%, ranging from 20% to 51%, as reported in Table 7.

5-The contribution of ICT components to energy saving results are more relevant in the summer periods when, as a consequence of the reduced presence of students at the university, the restaurant was not very busy, thus some areas were not used at all.

6-Similarly, in the winter periods, the ICT contribution is a little bit lower because the daylight period is shorter.

7-Results have been evaluated for the overall running period excluding some months (September 2013, October 2013 and October 2014) when the EDISON data collection system was not operative due to technical problems.

VUB DEAN'S OFFICE AND STUDENT WELCOME CENTRE

1-The Pilot had a running period of 12 months, from January 2014 to December 2014.

2-Savings due to the ICT contribution started from March 2014. Initially the data were collected without sensors running, in order to compare results in presence or absence of sensors and to have a realistic estimation of their contribution.

3-The overall savings measured during the running period (with ICT components working) ranges from 53% to 84%. The average energy gain with respect to the baseline data measured on the basis of the nominal power of the lamps operating before the EDISON platform implementation, is around 66% as reported in Table 7.

4-The average monthly energy saving of ICT components and DCC approach, over the running period (after EDISON platform implementation with a LED lamps nominal load of 304 KWh/month) is around 47%, ranging from 20% to 72%, as reported in Table 7.

5-The contribution of ICT components to energy saving is more relevant in the summer periods when, as a consequence of the personnel vacation period, the offices were not frequently attended, and the pilot site was partially used. In addition also the longer daylight period contributes in improving the energy saving.

NAPLES PILOT

PERFORMANCE RESULTS

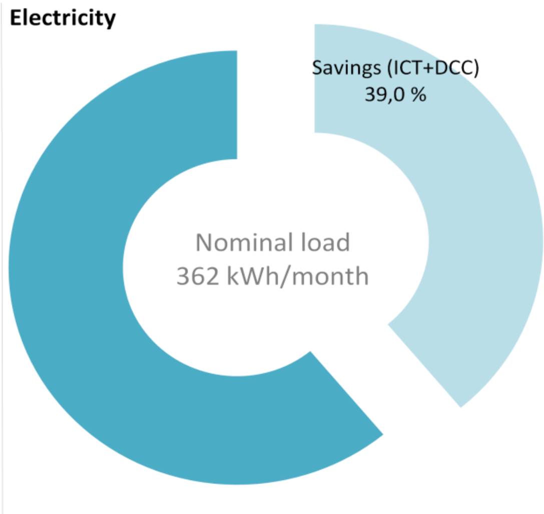


Figure 6 - Energy savings due to ICT components and Centralised DC power supply (DCC) at IDIS museum

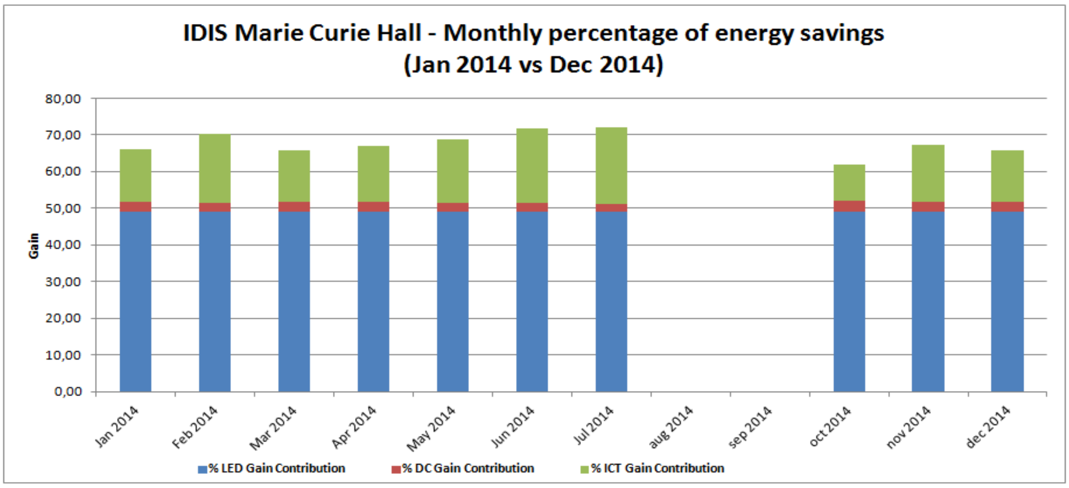


Figure 7 - Monthly energy savings highlighting the contribution due to LED lamps, ICT components and DCC power supply solution at IDIS Pilot site

ANALYSIS OF RESULTS

1-The Pilot had a running period of 12 months, from January 2014 to December 2014.

2-The Marie Curie pilot site was chosen to replace the originally planned Pilot area destroyed by a fire event. For this reason the baseline data was obtained measuring the consumption of the existing lamps operating before the EDISON platform implementation. Additionally, taking into account that in the summer period the Pilot area is closed (because the operating time of the site is the same of the scholastic one, since visitors are essentially students), it was decided to start immediately with the overall EDISON platform operational (including ICT components), without any trial period.

3-The overall savings measured during the running period ranges from 62% to 72%. The average energy gain with respect to the baseline data is around 69% as reported in Table 7.

4-The average monthly energy saving of ICT components and DCC approach, over the running period (after EDISON platform implementation with a LED lamps nominal load of 362 KWh/month) is around 39%, ranging from 33% to 45% as reported in Table 7.

5-Note that there is a limited variability of the monthly gains over the running period due to a constant flow of people inside the museum and to the specific architecture of the building, whose absence of windows causes a lack of external natural lighting.

6-Results have been carried out for the overall running period excluding some months (August 2014 and September 2014) when the EDISON data collection system did not collect data due to the summer closure of the Pilot.

LETTOMANOPPELLO PILOTS

PERFORMANCE RESULTS

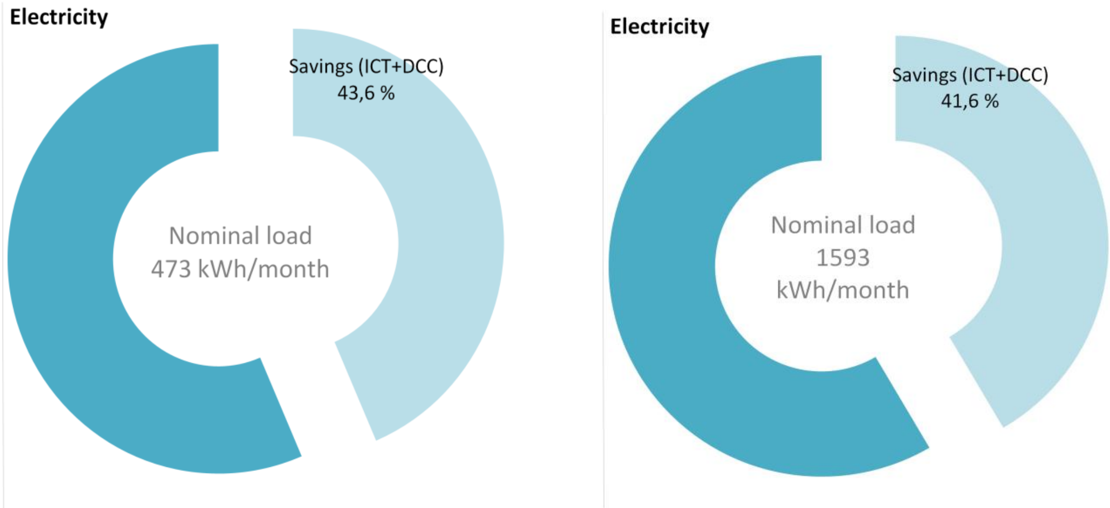


Figure 8 - Energy savings due to ICT components and Centralised DC power supply (DCC) at LMP Municipality offices (left), Nursery and Primary school (right)

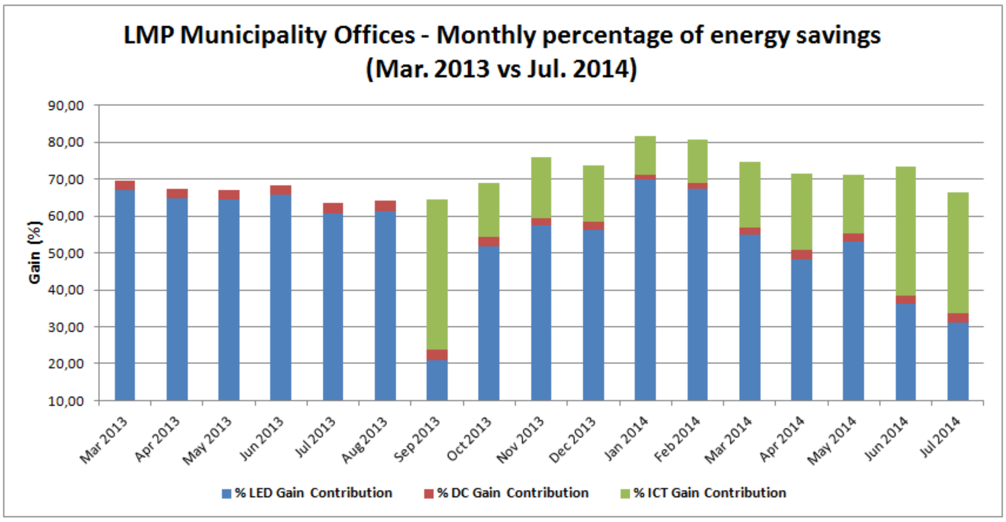


Figure 9a - Monthly energy savings highlighting the contribution due to LED lamps, ICT components and DCC power supply solution at LMP Pilot site

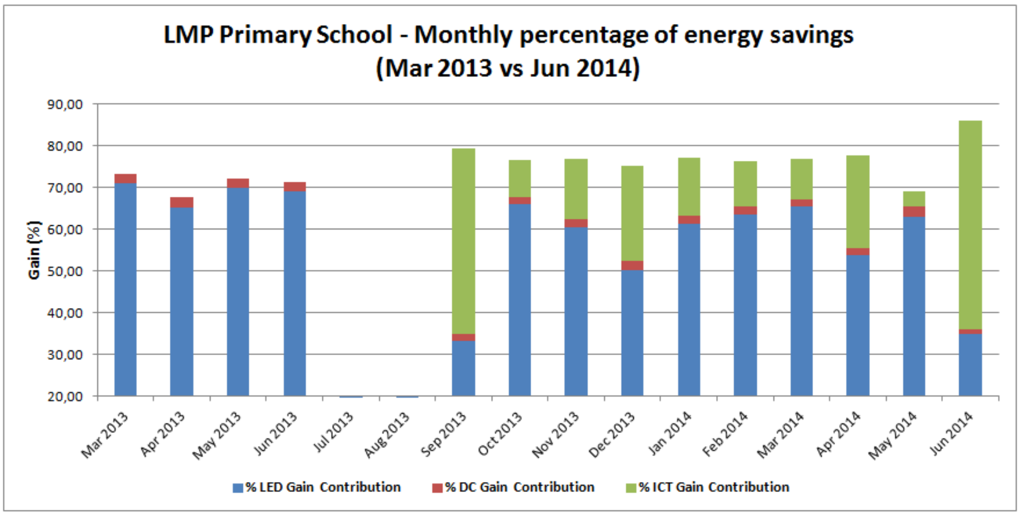


Figure 9b - Monthly energy savings highlighting the contribution due to LED lamps, ICT components and DCC power supply solution at LMP Pilot site

ANALYSIS OF RESULTS

MUNICIPALITY OFFICES

1-The Pilot had a running period of 16 months, from March 2013 to July 2014.

2-Savings due to the ICT started from September 2013. Initially the data were collected without sensors running, in order to compare results in presence or absence of sensors and to have a realistic estimation of their contribution.

3-Initially the data were collected without sensors running, in order to compare results in presence or absence of sensors and to have a realistic estimation of their contribution.

4-The overall savings measured during the running period ranges (with ICT components working) from 65% to 81%. The average energy gain with respect to the baseline data is around 73% as reported in Table 7.

5-The average monthly energy saving of ICT components and DCC approach, over the running period (after EDISON platform implementation with a LED lamps nominal load of 473 KWh/month) is around 44%, ranging from 30% to 58% as reported in Table 7.

6-The contribution of ICT components to energy saving is more relevant in the summer period (June, July and September) when, as a consequence of the personnel vacation period, the attendance of the offices is limited, thus the pilot site is partially used. In addition also the longer daylight period contributes in improving the energy saving.

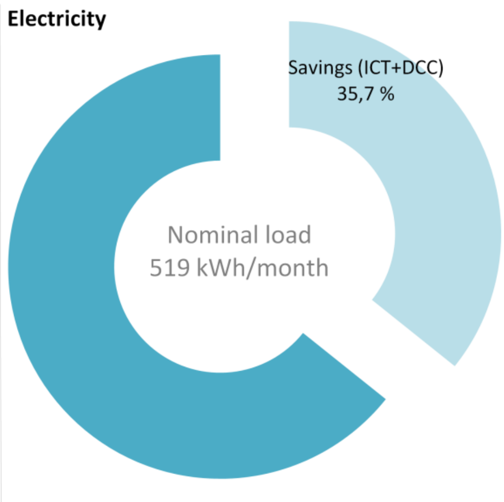
7-Similarly, in the winter periods, the ICT contribution is a little bit lower because the daylight period is shorter.

NURSERY AND PRIMARY SCHOOL

1- The Pilot running period lasted for 15 months, from March 2013 to June 2014.
2- Savings due to the ICT started from September 2013. Initially the data were collected without sensors running, in order to compare results in presence or absence of sensors and to have a realistic estimation of their contribution.
3- The overall savings measured during the running period (with ICT components working) ranges from 69% to 86%. The average energy gain with respect to the baseline data is around 77%, as reported in Table 7.
4- The average monthly energy saving of ICT components and DCC approach, over the running period (after EDISON platform implementation with a LED lamps nominal load of 1.593 KWh/month) is around 41%, ranging from 16% to 78% as reported in Table 7.
5- The contribution of ICT components to energy saving is more relevant in the summer period (June and September) when, as a consequence of the absence of students in the building, the pilot site is partially used. In addition also the longer daylight period contributes in improving the energy saving.
6- Similarly, in the winter periods, the ICT contribution is a little bit lower because the daylight period is shorter.
7- Results have been evaluated for the overall running period excluding some summer months (July 2013 and August 2013) when the EDISON data collection system did not collect data due to the summer closure of the Pilot.

Manoppello Pilots

Performance Results



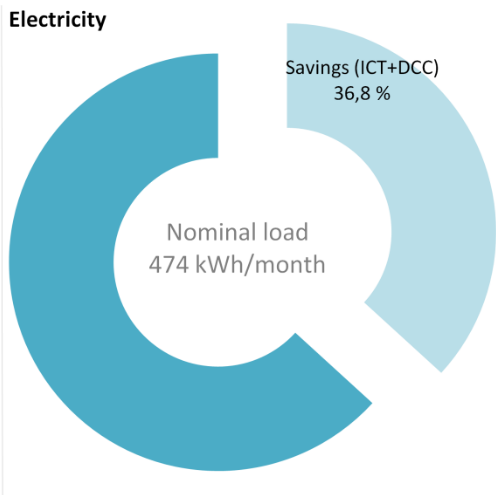


Figure 10 - Energy savings due to ICT components and Centralised DC power supply (DCC) at MNP Primary school (left) and at Primary and secondary school (right)

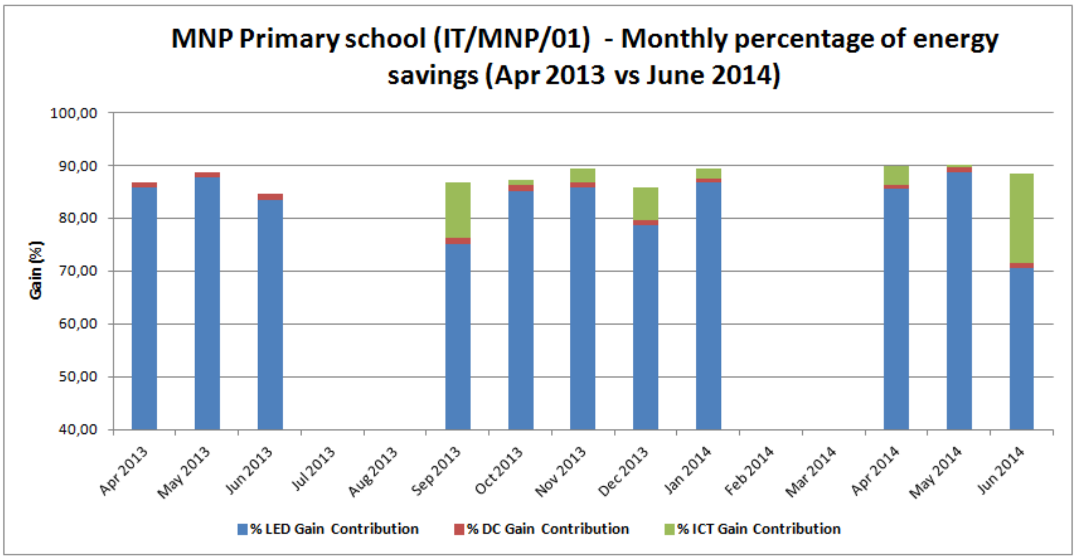


Figure 11a - Monthly energy savings highlighting the contribution due to LED lamps, ICT components and DCC power supply solution at MNP Pilot sites

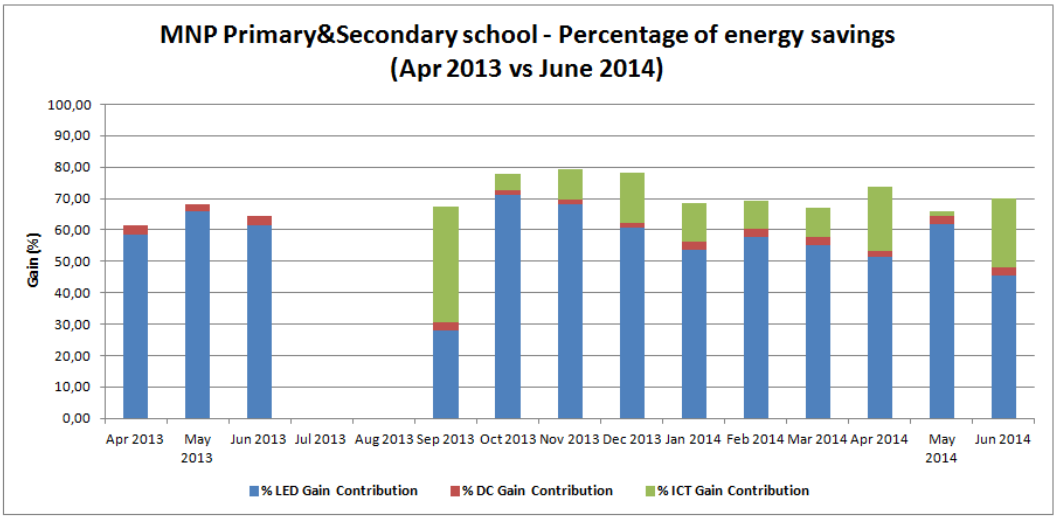


Figure 11b - Monthly energy savings highlighting the contribution due to LED lamps, ICT components and DCC power supply solution at MNP Pilot sites

Analysis of Results

Primary school

1-The Pilot had a running period of 15 months, from April 2013 to June 2014.

2-Results have been evaluated for the overall running period excluding two summer months (July 2013 and August 2013), when the EDISON data collection system did not collect data due to the summer closure of the Pilot, as well as from February to March 2014 because the collected data, due to technical problems, were not validated.

3-Savings due to the ICT started from September 2013. Initially the data were collected without sensors running, in order to compare results in presence or absence of sensors and to have a realistic estimation of their contribution.

4-The overall savings measured during the running period (with ICT components working) ranges from 85% to 90%. The average energy gain with respect to the baseline data is around 88% as reported in Table 7.

5-The average monthly energy saving of ICT components and DCC approach, over the running period (after EDISON platform implementation with a LED lamps nominal load of 519 KWh/month) is around 26%, ranging from 10% to 43%, as reported in Table 7.

6-The contribution of ICT components to energy saving is more relevant in the summer period (June and September) when, as a consequence of the absence of students in the building, the pilot site is partially used. In addition also the longer daylight period contributes in improving the energy saving.

7-In some months (particularly in October 2013 and May 2014) the ICT components have not given their full contribution due to an excessive use of manual mode in the rooms of the pilot area.

PRIMARY AND SECONDARY SCHOOL

1-The Pilot running period lasted for 15 months, from April 2013 to June 2014.

2-Results have been evaluated for the overall running period excluding two summer months (July 2013 and August 2013), when the EDISON data collection system did not collect data due to the summer closure of the Pilot.

3-Savings due to the ICT started from September 2013. Initially the data were collected without sensors running, in order to compare results in presence or absence of sensors and to have a realistic estimation of their contribution.

4-The overall savings measured during the running period (with ICT components working) ranges from 65% to 80%. The average energy gain with respect to the baseline data is around 72% as reported in Table 7.

5-The average monthly energy saving of ICT components and DCC approach, over the running period (after EDISON platform implementation with a LED lamps nominal load of 474 KWh/month) is around 27%, ranging from 10% to 46% as reported in Table 7.

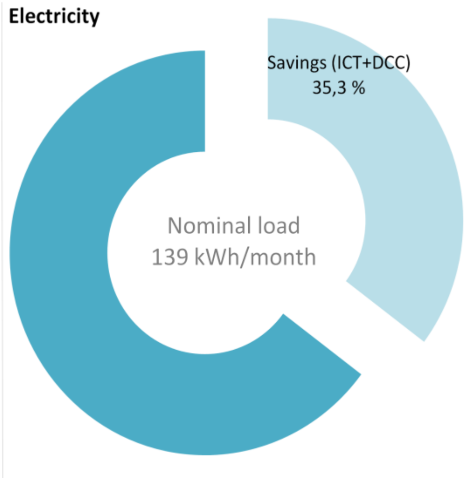
6-The contribution of ICT components to energy saving is more relevant in the summer period (June and September) when, as a consequence of the absence of students in the building, the pilot site is partially used. In addition also the longer daylight period contributes in improving the energy saving.

7-Similarly, in the winter periods, the ICT contribution is a little bit lower because the daylight period is shorter.

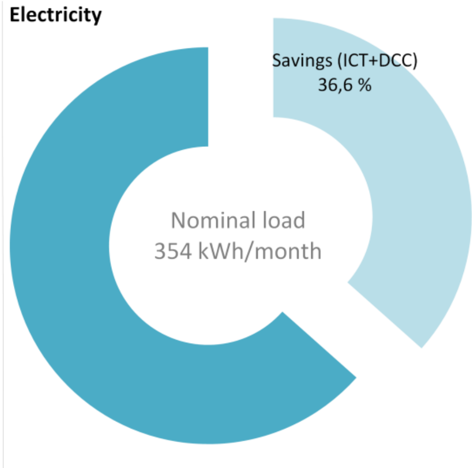
8-In some months the ICT components has not given their full contribution due to an excessive use of manual mode in the rooms of the pilot area.

ROCCAMONTEPIANO PILOTS

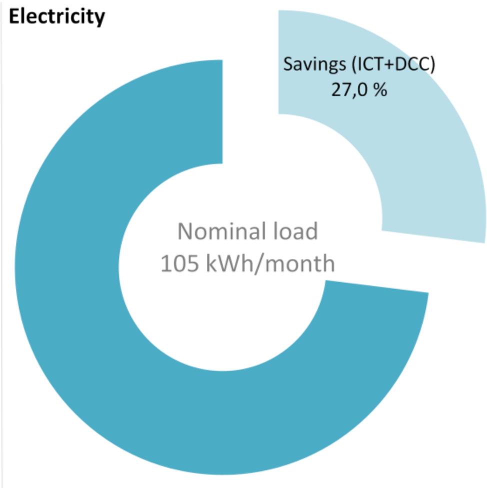
PERFORMANCE RESULTS



(a)

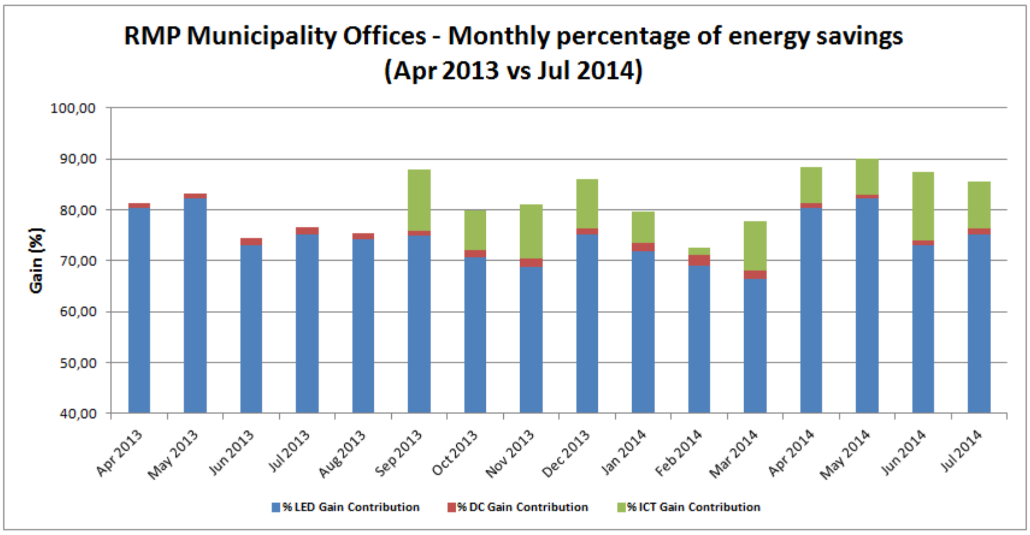


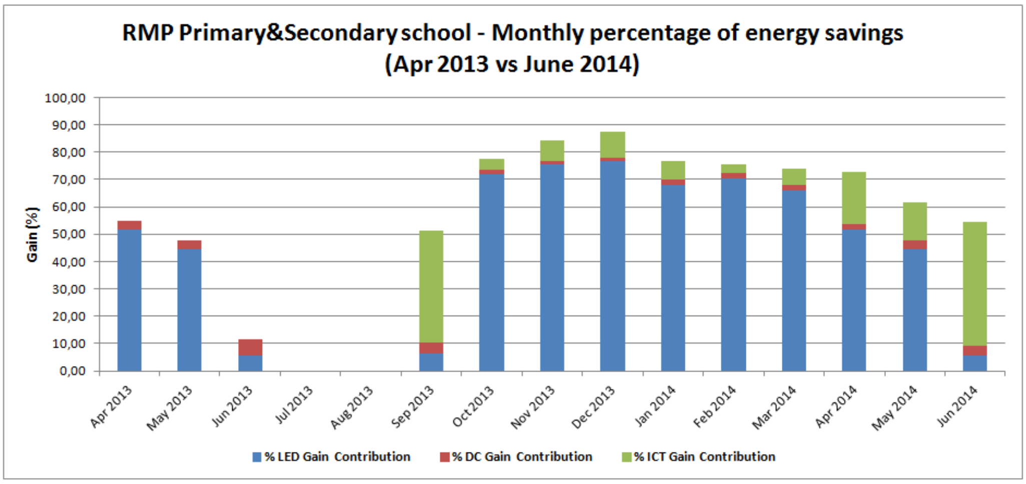
(b)



(c)

Figure 12 - Energy savings due to ICT components and Centralised DC power supply (DCC) at RMP Municipality offices (a), Primary and secondary school (b) and at the Nursery (c)





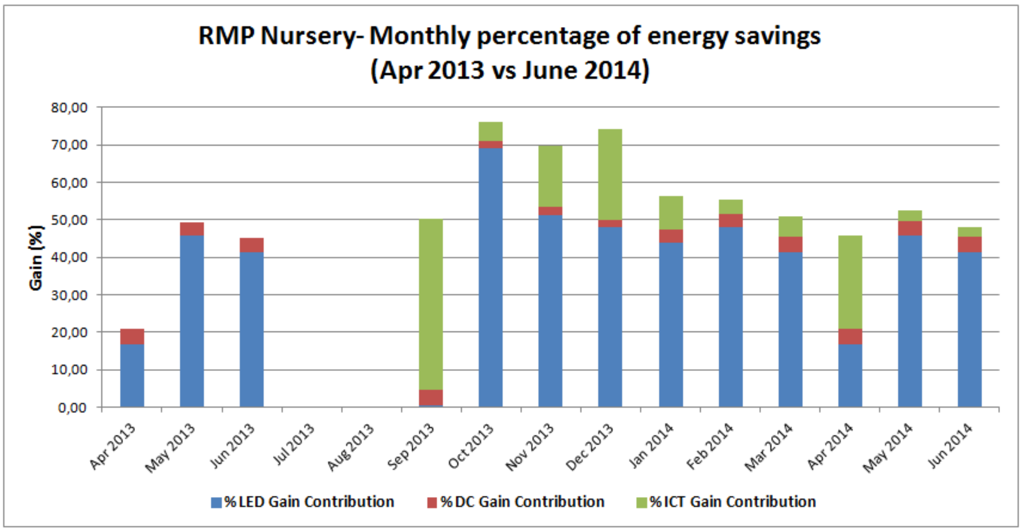


Figure 13 - Monthly energy savings highlighting the contribution due to LED lamps, ICT components and DCC power supply solution at RMP Pilot sites

ANALYSIS OF RESULTS

MUNICIPALITY OFFICES

1-The Pilot had a running period of 16 months, from April 2013 to July 2014.

2-Savings due to the ICT started from September 2013. Initially the data were collected without sensors running, in order to compare results in presence or absence of sensors and to have a realistic estimation of their contribution.

3-The overall savings measured during the running period (with ICT components working) ranges from 72% to 90%. The average energy gain with respect to the baseline data is around 83% as reported in Table 7.

4-The average monthly energy saving of ICT components and DCC approach, over the running period (after EDISON platform implementation with a LED lamps nominal load of 139 KWh/month) is around 24%, ranging from 7% to 47% as reported in Table 7.

5-It is shown a reduced contribution of ICT components to energy saving in the winter period (from January to March) as a consequence of the shorter daylight period. In the other periods the contribution appears almost homogeneous.

PRIMARY AND SECONDARY SCHOOL

1-The Pilot had a running period of 15 months, from April 2013 to June 2014.

2-Savings due to the ICT started from September 2013. Initially the data were collected without sensors running, in order to compare results in presence or absence of sensors and to have a realistic estimation of their contribution.

3-The overall savings measured during the running period (with ICT components working) ranges from 51% to 88%. The average energy gain with respect to the baseline data is around 72% as reported in Table 7.

4-The average monthly energy saving of ICT components and DCC approach, over the running period (after EDISON platform implementation with a LED lamps nominal load of 354 KWh/month) is around 36%, ranging from 26% to 51% as reported in Table 7.

5-The contribution of ICT components to energy saving appears more relevant in the summer period (June and September) when, as a consequence of the absence of students in the building, the pilot site was partially used. In addition also the longer daylight period contributes in improving the energy saving. Note that, in this pilot, during the month of September 2013 almost the total energy saving contribution was due to ICT components (the lights have been OFF for almost the total period the school was open).

6-Similarly, in the winter periods, the ICT contribution is a little bit lower because the daylight period is shorter.

7-In October 2014 the ICT components has not given their full contribution due to an excessive use of manual mode in the rooms of the pilot area.

8-Results have been evaluated for the overall running period excluding some summer months (July 2013 and August 2013) when the EDISON data collection system did not collect data due to the summer closure of the Pilot. In addition also in September the school was open only few days.

NURSERY

1-The Pilot had a running period of 15 months, from April 2013 to June 2014.

2-Savings due to the ICT started from September 2013. Initially the data were collected without sensors running, in order to compare results in presence or absence of sensors and to have a realistic estimation of their contribution.

3-The overall savings measured during the running period (with ICT components working) ranges from 45% to 75%. The average energy gain with respect to the baseline data is around 58% as reported in Table 7.

4-The average monthly energy saving of ICT components and DCC approach, over the running period (after EDISON platform implementation with a LED lamps nominal load of 354 KWh/month) is around 36%, ranging from 26% to 51%, as reported in Table 7.

5-In this Pilot the contribution of ICT components to energy saving appears more relevant in the month of September 2013 when, as a consequence of the absence of children in the building due to renovation works of the pilot site, it was partially used. In addition also the longer daylight period contributes in improving the energy saving.

6-In some winter periods, the ICT contribution appears a little bit higher with respect to other pilots due to some vacation periods agreed by the nursery with the local Municipality Administration (mainly due to bad weather conditions or holidays periods).

7-Results have been evaluated for the overall running period excluding some summer months (July 2013 and August 2013) when the EDISON data collection system did not collect data due to the summer closure of the Pilot. In addition also in September the school was open only few days.

8-In this pilot, during some months, the ICT components have not given their full contribution due to an excessive use of manual mode in the rooms of the pilot area.

BELFAST PILOTS

PERFORMANCE RESULTS

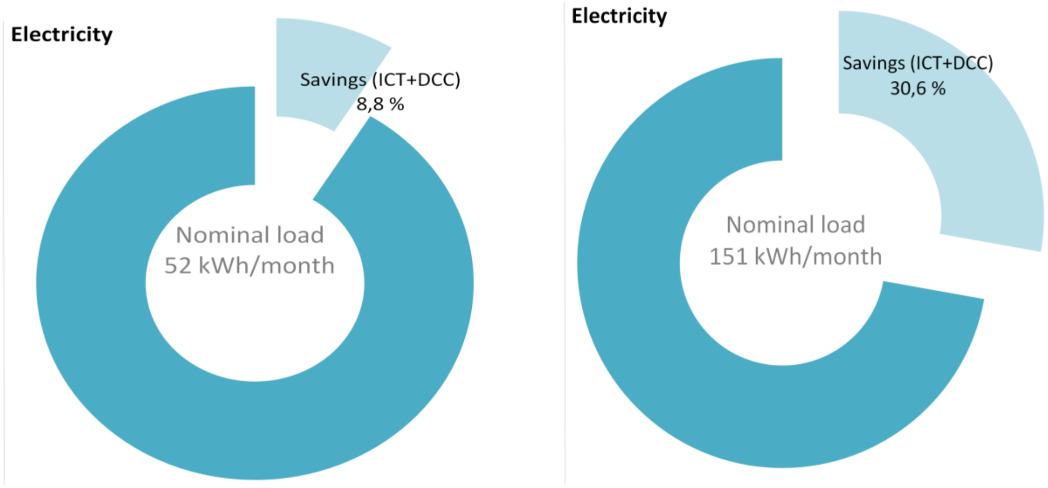


Figure 14 - Energy savings due to ICT components and Centralised DC power supply (DCC) at SHT Bocombra Lodge (left) and Lurgan Hospital (right)

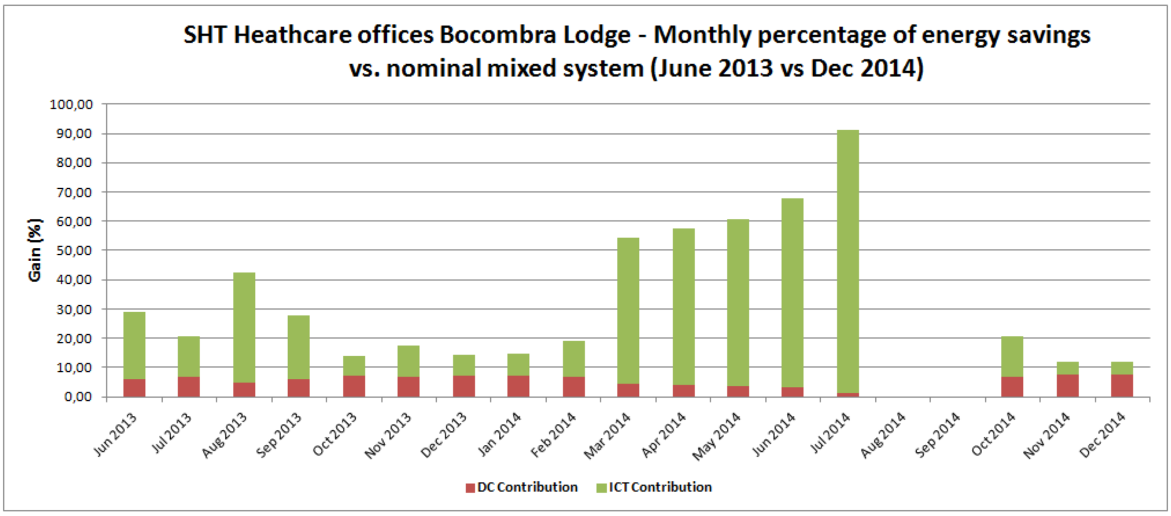


Figure 15 - Monthly energy savings highlighting the contribution due to ICT components and DCC power supply solution[1].

[1] Note that in this pilot the comparison with the previous lighting system was not considered relevant because of the different number of lighting points installed for the EDISON platform

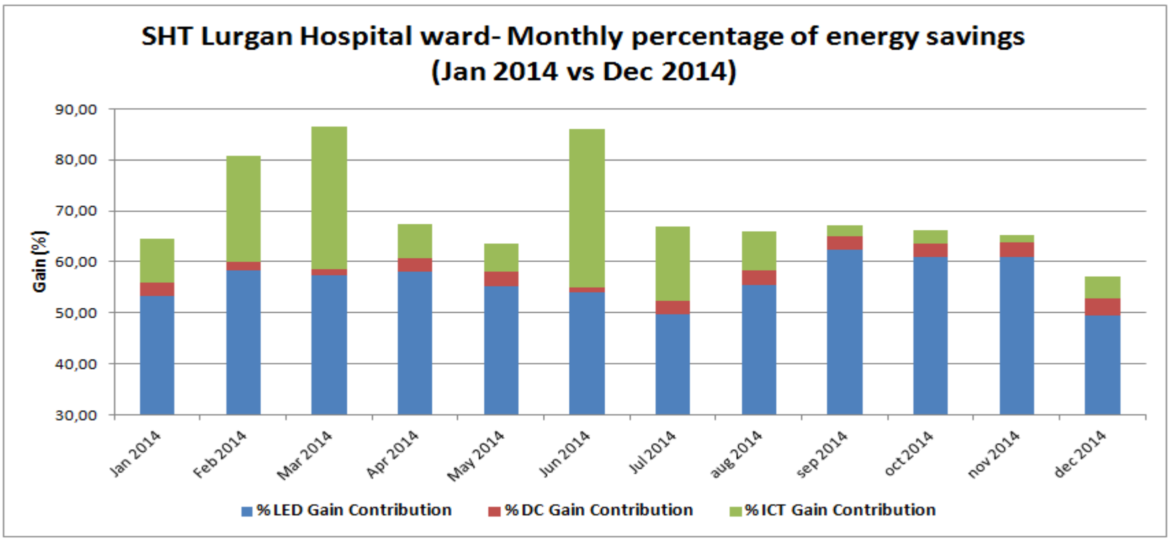


Figure 16 - Monthly energy savings highlighting the contribution due to LED lamps, ICT components and DCC power supply solution at SHT Pilot site

Analysis of Results

Healthcare offices

1-The Pilot had a running period of 19 months, from June 2013 to December 2014.

2-The Administration of this Pilot, taking advantage from the opportunity of the EDISON platform implementation, decided to renew the existing lighting infrastructure increasing the number of lamps installed in the office. For this reason it was not possible to compare the energy consumptions before and after the EDISON platform implementation. In this case, as reference data, the total LED lamps nominal power (52 KWh/month) has been considered.

3-The average monthly energy saving of ICT components and DCC approach, over the running period is around 40%, ranging from 12% to 91% as reported in Table 7.

4-The Pilot results show a significant variation of the contribution of ICT components to energy savings over the running period if compared with other pilots. A remarkable contribution was observed in the spring and summer months as a consequence of the personnel vacation period as well as the longer sunlight time.

5-Results have been evaluated for the overall running period excluding some months (August and September 2014) when the EDISON system had technical problems and data collected were not validated.

Lurgan Hospital Ward

1-Because of the occurrence of some problems such as replacing the Pilot initially planned, the acquisition procedure of LED lamps required by the hospital and the consequent installation in the areas involved in the project, the running period of this Pilot started only in the month of January 2014 and has been operative for 12 months until December 2014.

2-For convenience of the hospital Administration the ICT contribution has begun to occur immediately. In this way it was not possible to gather baseline data with LED lamps and, for this reason, energy consumptions were compared with data collected before the EDISON platform implementation as well as with the total LED lamps nominal power.

3-The overall savings measured in the running period ranges from 58% to 86%. The average energy gain with respect to the baseline data is around 74%, as reported in Table 7.

4-The average monthly energy saving due to ICT components and DCC approach, over the running period (after EDISON platform implementation with a LED lamps nominal load of 151 KWh/month) is around 30%, ranging from 11% to 69%, as reported in Table 7.

5-The contribution of ICT components to energy saving does not seem to be significantly affected by seasonal factors but only by the presence or absence of patients in the wards.

Summary of KPI results from data collected from pilots

The figures reported in the following table are referred to the IPMVP analysis calculated all over the entire running period of the pilots. By analyzing these data in general way it is possible to have an idea about the results of the project not specifically related to the single pilot.

The table includes:

- **The total energy saving in each pilot:** calculated with respect to the previously installed lighting system. Gains are provided in terms of monthly average KWh and percentage;
- **ICT/DCC energy saving in each pilot:** calculated with respect to LED lamps nominal power load installed at the pilot. Gains are provided in terms of monthly average KWh and percentage. Maximum and minimum percentage gains are also highlighted;
- **Reduction of CO_2 emission:** evaluated in terms of Kg/year taking into account country specific factors. Figures are provided with respect to the total energy savings as well as to the ICT/DCC contribution;
- **LENI Gain:** the *Lighting Energy Numeric Indicator* is a parameter used (also in IPMVP analysis) to assess energy performance of buildings as regards lighting. It is calculated as the ratio between the energy consumption for lighting and surface of the environment. The lower this value is, the higher is the contribution of natural light in the rooms of this site.

Pilots			Indicators (KPI)								
			Total Energy saving in each pilot (ref. to baseline)		(*) ICT/DCC Electricity saving in each pilot				Reduction of CO_2 emissions [$kgCO_2$/year]		(+) LENI Gain
					Average		Max	Min			
			[kWh]	(%)	[kWh]	(%)	(%)	(%)	Total	due to ICT/DCC	
VUB	Deans offices and student welcome center	BE/VUB/03	343,82	66	145,13	47,72	72,38	20,43	750	316	18,4
VUB	Restaurant	BE/VUB/02	164,02	65	32,66	30,62	51,25	20,30	358	71	3,0
IDIS	Marie Curie Hall	IT/IDIS/02	488,73	69	141,07	38,96	45,04	33,16	1635	472	9,3
LMP	Municipality	IT/LMP/01	755,93	73	206,28	43,59	58,38	30,06	3951	1078	7,5
LMP	NURSERY and PRIMARY SCHOOL	IT/LMP/02	2877,23	77	661,57	41,54	78,71	16,17	13883	3192	13,7
MNP	PRIMARY SCHOOL	IT/MNP/01	2364,89	88	136,48	26,27	43,21	9,91	8452	488	4,1
MNP	PRIMARY and SECONDARY SCHOOL	IT/MNP/02	736,33	72	131,21	27,66	46,03	9,99	2558	456	2,9
RMP	Municipality	IT/RMP/01	325,49	83	48,75	35,14	56,76	17,12	1242	186	1,2
RMP	PRIMARY and SECONDARY SCHOOL	IT/RMP/02	645,36	72	129,46	36,52	51,47	26,08	3072	616	2,3
RMP	Nursery	IT/RMP/03	120,33	58	25,30	24,03	47,77	6,93	418	88	3,5
SHT	Bocombra Lodge	UK/SHT/01	29,15	40	29,15	40,34	91,22	11,86	131	131	18,7
SHT	Lurgan Hospital	UK/SHT/03	246,35	74	42,00	30,60	69,60	10,80	1349	230	10,6

(*) target: 15 %(Evaluated with respect to nominal LED power load)
*(+) UNI EN 15193 (in kWh/m2*y)*

Table 7 – Summary of KPI results

Note that the total CO_2 gas emission reduction due to ICT/DCC contribution is around 7.324 Kg per year considering all the pilot sites.

Observations about the general results of the project

After the conclusion of the EDISON project, the following results and their impact can be highlighted:

- EDISON project has delivered a refined, integrated, interoperable, replicable and cost-efficient ICT solution for energy efficiency in public buildings, targeting:
  - Awareness and behavioural change of tenants towards energy use. Building managers can use the EDISON ICT solution through intuitive user interfaces which can be accessed through an API interface using a web application running on PCs, tablets or smartphones or any other device with Internet connectivity and standard browser.
  - Provision of adequate information to building owners/managers for remote visualization of aggregated energy consumption and production of the buildings.
- The ICT solution has been successfully deployed in 12 Pilot buildings in three different countries. On top of these, as a very positive result, there have been more than 10 voluntary pilots (without any financial support from the EC) implemented.
- The use of the ICT solution during, at least, one year has yielded tangible results of energy savings achieved through ICT awareness-only tools: in almost all pilot sites energy consumption reduction, due to ICT components and to the peculiar power supply adopted in EDISON, has been reduced, at least of 20%, while the global saving, considering also the contribution of the LED lamps, reached and exceeded, in some pilots, the 80%.
- The engagement with the EDISON project of building managers of the pilot sites can be considered more than satisfactory, even though there is still room for further improvement.
- A comprehensive dissemination plan has been defined and implemented throughout all the phases of EDISON project; its main results have been the periodic update of the public website (www.project-edison.eu), electronic newsletters (4), the participation of project partners in 12 conferences, the organization in collaboration with other ICT PSP projects of 4 workshops with a total audience of 300 attendees, meetings with people from Public Administrations all around Europe, private stakeholders (industrial, condominium, religious buildings, etc.) and standardization bodies (CENELEC, ETSI, etc.).
- EDISON project has delivered, together with other ICT PSP projects, a Common Methodology (eeMeasure) for measuring energy efficiency due to ICT solutions, which have been complemented with the EDISON specific Global Methodology, based on IPMVP

protocol, including guidelines for replication, which represents a body of knowledge which can be re-used for future similar projects.

- EDISON partners have looked into the most appropriate business models which can be used, complemented with feasibility studies, in order to ensure a wider adoption of the ICT solution beyond the end of the project. These studies will support the future replication of the EDISON ICT solution in other private and public buildings in any country in Europe as well as worldwide. Specific individual and joint exploitation plans have been defined for the whole consortium and for each project partner, in order to ensure the commercial exploitation of the project results, as well as its further dissemination to the stakeholders involved in the full value chain of ICT products for energy efficiency in the residential sector.
- The conclusions and lessons learnt in the project can also be considered as one of its main results, as they form a body of knowledge from which EDISON partners will benefit for future exploitation. Other stakeholders, outside of the consortium, could benefit from this knowledge too, as most of the project outcomes are available in the project public deliverables which can be downloaded from the EDISON project website. Thus, conclusions and lessons learnt will support the future replication of the project in other buildings, and an easy and immediate comparison of cost/benefit ratios linked to different technological solutions could be carried out.

From the above mentioned results, it can be inferred that the main technical result of the EDISON project is the development (in the sense of adaptation and enhancement) of an ICT platform, integrated starting from off-the-shelf components, jointly to a series of additional outcomes:

- a communication and data processing system;
- a user interface to access the consumption data in real-time and as historical data base, by discriminating the ICT components contribution (see option: EDISON SAVINGS on the project website);
- a guideline booklet to give evidence of any practical aspect handled in the implementation of the EDISON solution in the Pilot actions, realized in the context of the project, in order to provide all the criteria and the guidelines for replicating the solution in any category of building, considering different environmental constraints, planning alternatives, lighting and energy requirements the building might present;
- a web-based multimedia tutorial to communicate concepts, technologies and results of the EDISON project to both professionals and non-technical managers interested to these topics. The training may enable these target groups to understand peculiar aspects in the area of lighting distribution. In this way it gives them a stimulus for the EDISON approach acceptance, in particular by underlining the following aspects:
    - how the proposed technological solutions are useful to develop new services;

- how positive is the environmental impact of the EDISON solution, especially if compared to existing ones;
- how the results of the user assessment are useful to design accessible and understandable user interaction with the technology;
- how to use the stakeholder-based requirements to define the complex constraints frame of EDISON-based services.

Just to highlight the importance of some technical solutions proposed in the EDISON project, herewith we report the opinion of James Chorlton, the Business Director of Honeywell Electrical Devices and Systems (ED&S). The article appeared on "LED Magazine", November/December 2012 issue.
(Well after the submission of the EDISON project, April 2011)

"*Many retrofit products have appeared on the market designed to replace the popular fluorescent tube – they appear to be a simple, straight-forward solution. But with the European Commission Low Voltage Directive Administrative Co-operation Working Group (LVD ADCO) expressing serious concerns about replacement tubes and the modifications necessary to existing luminaries in order for them to operate correctly, there remains a question mark over whether the retrofit model is as clear cut as it seems. With no specific standards in place, the design of LED lamps varies considerably."... "The issue is that, in principal, the integrated-driver approach appears straightforward. Depending on the type of control gear that has been fitted, the contractor will simply need to modify the existing fluorescent control gear by using a fuse link in place of the starter for magnetic ballasts. Alternatively, the contractor can bypass electronic ballasts completely and wire the lamp end caps directly to mains voltage rather than having to mount and wire up a new LED driver module as well.*
However, apart from the safety implications and the compliance issues caused by uncontrolled luminary's modification, the internal driver approach also requires that all the electronics must be housed within the confines of the LED tube. The lifetime of the LED driver will be directly – negatively – impacted by using smaller de-rated components to fit in the restricted space. In addition, the excess heat generated as a result of putting the driver into the LED tube raises the overall temperature of the tube and reduces the lifespan of the LEDs.
It is also more difficult to incorporate smart features such as 0-10V or DALI controlled dimming. In fact many of these retrofit LED tubes are non-dimmable or rely on inefficient triac-based, phase-cut dimming approaches. Not only that, but the retention of the existing fluorescent ballast can dramatically reduce the lifetime of the fixture. Fluorescent ballasts last a few thousand hours but an LED lamp is designed to last for tens of thousands. By choosing a retrofit solution that retains a used ballast of unknown quality, the luminaries will continue to need costly and frequent maintenance."

And about **Tube lifespan:**

"*Finally, choosing a complete luminaries solution with an external driver means any safety or life concerns are removed. The entire system – the lamp, the lamp holder and the driver are designed to work together.*

From our perspective, many of the retrofit LED lamps in the market are unsafe.

The retrofit tube model with integrated driver just doesn't work in a secure or reliable way. Others would argue against the higher initial investment cost needed for a full replacement and a switch to an external driver model. We would say that the return on investment through energy savings, a longer product life, plus the safer design not only makes that investment preferable, but essential.

The discussion continues.

What is clear though, is that as the industry is about to witness the mass adoption of LED technology, standardization and further regulation is necessary."

It is our opinion that the issue on the LED Magazine gives a lot of answers on how the EDISON solution contributes to innovation, LED application, safety, energy saving, investment, etc..

Potential impact and guidelines for replication

Socio-economic impact

The ICT solution can have an important socio-economic impact. From one side the large number of Public Administration buildings as well as private ones can benefit from the implementation of the ICT solution in terms of energy savings while maintaining comfort and reducing the CO_2 footprint.

Other topics can induce economic effects and their impacts should be considered.

From a safety point of view, the EDISON platform implements a 48 VDC power supply allowing a great increase of safety against electrical shock.

In particular, EDISON power supply infrastructure is a SELV circuit and, as such, the safety is provided by:

- the extra-low voltage;
- the low risk of accidental contact with a higher voltage;
- the lack of a return path through earth (ground) that electric current could take in case of contact with a human body.

Furthermore, the EDISON platform allows using of class-2 wiring and protective-separation devices, reducing sparks and fire hazards, eliminating shock/startle hazards.

Regarding the environmental impact concerning the electromagnetic emissions of the lamp drivers (both for traditional CFL or LED), the independent center for research CRIIREM in France (Centre de recherche et d'information sur les rayonnements electromagnetiques) has demonstrated that the CFLs generate powerful electromagnetic fields at a short distance from the source, up to a meter away. Therefore it is not recommended to use low-energy light bulbs at short distances.

The EDISON solution is strictly based on the use of LED with:

- external DC power supply,
- DC micro-pico grid
- efficient drivers
- and ICT components integrated in a Smart Energy Platform.

Furthermore, electromagnetic emissions are strongly reduced thanks to the DC solution adopted.

Finally, the deployment of such kind of solution can produce the creation of quality jobs and economic growth especially among SMEs. It could be very interesting to have a common European industrial plan focused on LED lamps, smart components, etc. as replacement of the existing lighting systems. The resulting production could give guarantee of quality for components produced and certified in Europe, available on the market at a competitive price thanks to a policy of financial support for innovation. But today this large investment plan is not envisaged.

Assessment of social impact through feedbacks from end users

In order to have an effective feedback from the user assessment activities about the potential advantages of the EDISON solution implementation in a public building like the ones hosting the project Pilot actions, it has been carried out a two-stage survey (pre and post EDISON intervention). The goal of this activity is to know the user satisfaction with respect to the lighting service currently available in the Pilot sites, comparing the results with the ones deriving from the adoption of the EDISON idea. Both quantitative and qualitative data have been collected through structured questionnaires, differentiating questions about the user perception and experience in respect of the lighting system currently operating in the Pilot sites and in respect of the EDISON solution implemented.

Each participant to this assessment activity was additionally asked about their impressions and attitudes towards energy consumptions, paying special attention to environmental aspects linked to the use of the EDISON solution. In particular, it has been tried to emerge key topics dealing with changes caused by the innovations introduced by the project. Furthermore, questions about the functionality, manageability, perceived effectiveness, etc. of the system have found the right space.

Questionnaire responses have been gathered on a five-point Lickert scale and assessed on the basis of a targeted comparison between the two stages of the investigation.

Participants were mainly aged between 25 and 60, but due to the strong concentration on a single choice of the answers provided for the most relevant questions, in the analysis reported they have been grouped only into two categories (less than 39, more than 40).

Female and male participants had a different distribution over age ranges, but both categories were well enough represented and balanced in each range (see Figure 17).

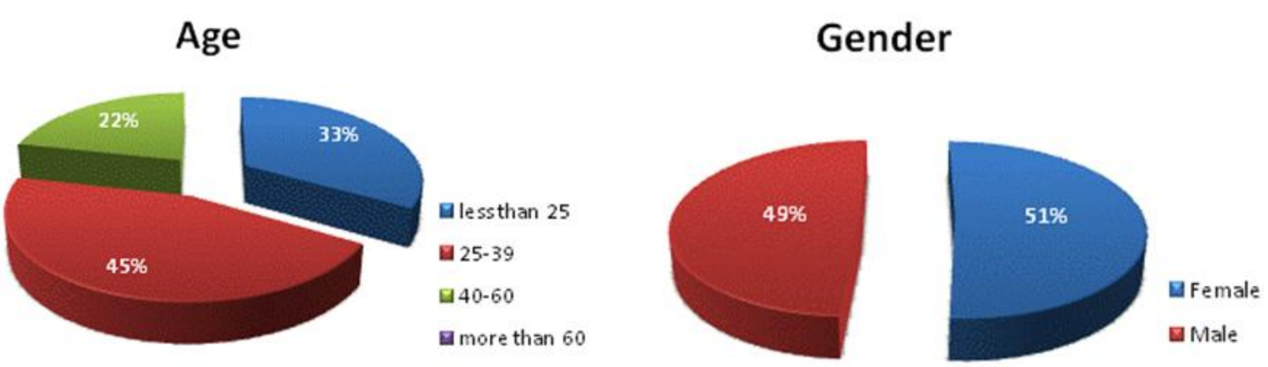


Figure 17 - Age and Gender distribution for post-intervention questionnaires

The analysis of some questionnaire feedbacks is reported in Figure 18, 19 and 20.

The results show that, in some cases, apart from the users who preferred not express a well defined opinion about the proposed issues, a well-defined orientation towards the positive effects in terms of energy savings due to the ICT contribution seems evident.

At the same time, a significant effort must be made in the direction to induce users to change their habits, encouraging them to a more convinced use of the automatic operational mode, which is one of the most important factors to consider in order to achieve the expected energy savings.

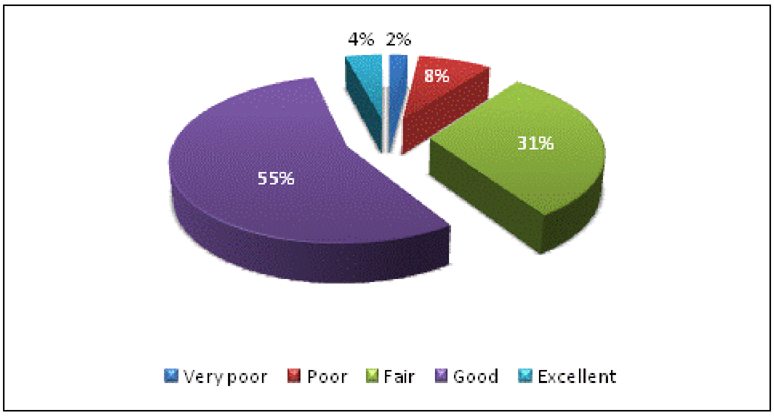


Figure 18 - User satisfaction with the overall quality of the lighting system in the Pilot site (post-intervention questionnaire)

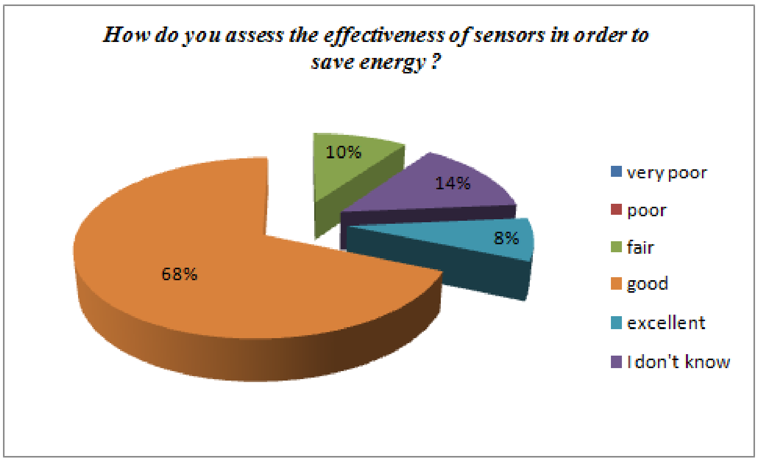


Figure 19 - User feedbacks about the effectiveness of the contribution of sensors in order to save energy in the Pilot site

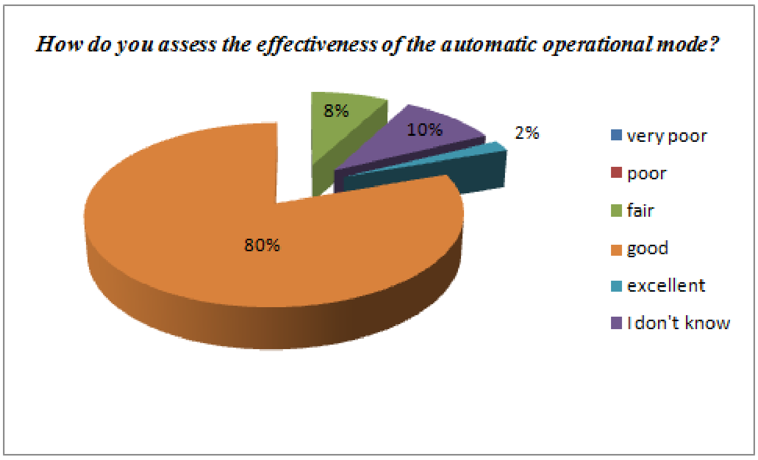


Figure 20 - User perception about the effectiveness of the automatic operational mode

Methodology and guidelines for replication

The global methodology developed by EDISON aims to promote replication beyond the pilot buildings and countries covered by the project, encouraging stakeholders in other countries to adopt the EDISON solution or, alternatively, to adapt and integrate it into their own strategy of energy efficiency.

Figure 21 presents the four phases of the EDISON realization methodology useful for a possible replication. It starts from the survey to collect information about the lighting infrastructure and the building in general, thus passing to the solution design, to the implementation and finally to the monitoring and control of the overall platform, by analyzing the performance results. The lessons learnt during the real implementation of such methodology gave to the consortium important hints on how to customize it on different environments and how to make it more flexible and adaptive to different contexts.

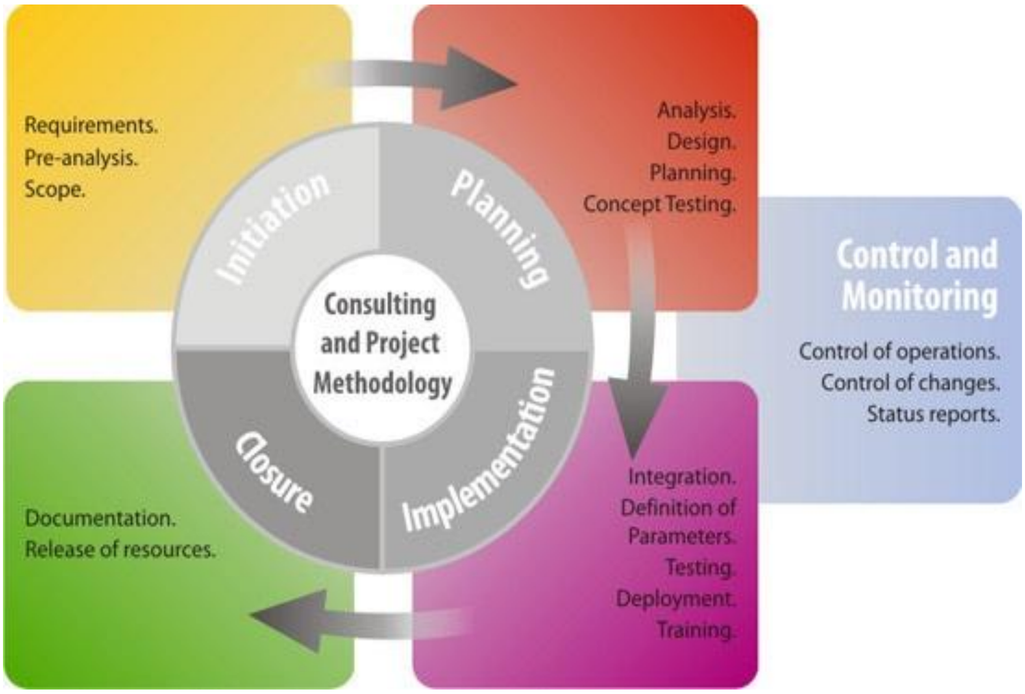


Figure 21 - Four phases of the EDISON realization methodology

Items of special interest to highlight in the above figure are the following:

- The methodology begins and ends with the final user (building owners/managers and tenants), from the analysis of requirements to the assessment of users' acceptance of the solution;
- The methodology is a process that customizes ICT solutions for tenants, building owners/managers, and other stakeholders' needs;

- Energy audits are essential because it is recognized that an audit with the intent of designing ICT solutions needs to include different aspects than what is typically conducted/reported using only Energy Performance of Buildings Directive (EPBD) as a guideline;
- The methodology includes a "pre-monitoring" phase to characterize the baseline;
- IPMVP appears in two different places, the development of a measurement and verification plan, and then the calculations and assessment of energy savings;
- Awareness, training, and engaging stakeholders and tenants is present throughout the methodology to trigger and sustain changes in users' behavior.

MAIN HIGHLIGHTS OF THE METHODOLOGY FOR DESIGN

The first and second methodology steps (survey and methodology for design) are addressed to the design of the overall ICT system, taking into consideration specific requirements of users, constraints of the building, technical and non-technical limitations and available resources. The methodology for design encompasses the following aspects:

- Users' requirements:
  - Stakeholders' needs analysis: In the very preliminary step, it is crucial to clearly identify who are the involved stakeholders (building owners, buildings managers, utilities, etc.) and how they interact, among them and with the building manager.
  - Building managers' survey: at the beginning of activities, a survey shall be conducted with the building managers, in order to extract user requirements for the definition of the ICT solution: profiling of people working or visiting the building, collection of billing information, familiarity with ICT, current habits related to energy consumption, etc.
  - Preliminary awareness and training: preliminary explanation to the tenants of the plans for the installation of the ICT solution is crucial for several reasons, as the EDISON experience revealed, in order to promote, since the beginning, positive attitudes towards habits improvement, and to increase the acceptance of the solution which will be implemented.

- Building's requirements
  - Building typology analysis: this methodological step consists of identifying the typology of the building and specifies the requirements and constraints impacting the design of adapted ICT solutions (Region, climate, typology of dwellings, living surface, etc.).
  - Energy audit: in the specific framework of this methodology, a Level 1 audit – Simple Audit is recommended: a remote investigation of the dwellings using past energy invoices, tenants information, equipment inventories, and usual occupation of the dwelling.
  - Technical visit to the site: the aim of the technical visit is to get a clear picture of the environment where the ICT solution will be implemented and, in particular, to get evidence

of possible installation, structural or architectural limitations that have been not noticed before.

- ICT solution design
  - analysis: this first methodological step consists in analyzing the requirements of the pilot and the report prepared after the technical visit, for identifying the installation constraints that have an impact on the design of the ICT infrastructure. The main outcome of this step is a list of actions to be performed, taking into account a cost-effective ICT solution.
  - Indicators definition: following a top-down approach, a list of indicators shall be defined, with a two-fold purpose: for the identification of indicators to be shown on tables/charts as part of the ICT solution, and for evaluation of the efficiency of the ICT solution and awareness actions with regard to energy savings achieved.
  - Development of Measurement & Verification Plan: the International Performance Measurement & Verification Protocol (IPMVP) defines standard terms and suggests best practices for quantifying the results of energy efficiency investments. IPMVP Volume 1 suggests a 13 step planning process, which have been simplified and synthesized in four steps, according to Figure 22, as a way to organize the completion of the M&V plan for social housing and in general for any energy efficiency project. This initial plan will be the basis for the last step of the methodology: the methodology for monitoring.

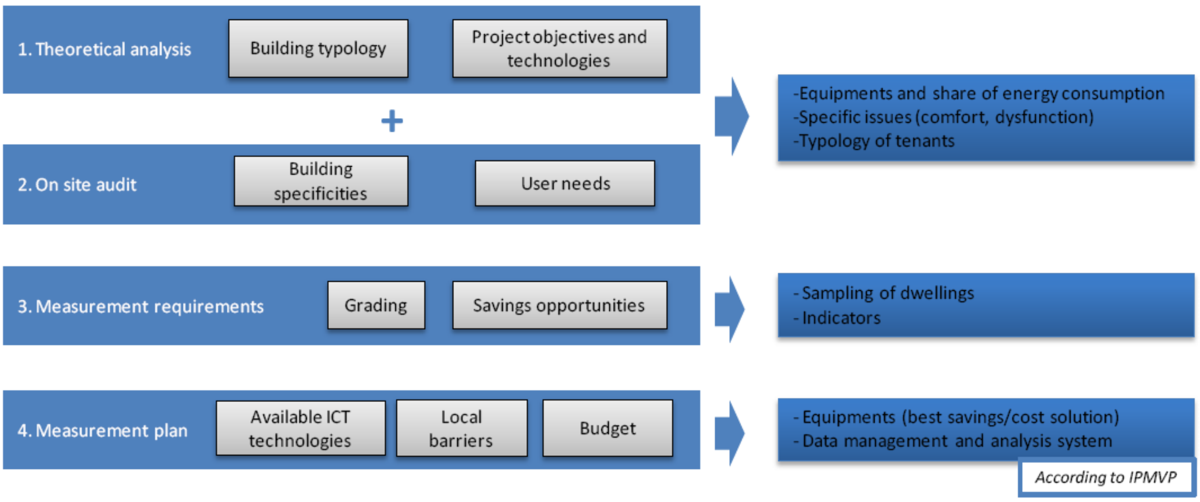


Figure 22 – Four steps synthesis of the IPMVP planning process

MAIN HIGHLIGHTS OF THE METHODOLOGY FOR IMPLEMENTATION

The second methodology step (methodology for implementation) consists of the following aspects:

- Pre-monitoring phase: this step deals with the implementation in the pilots of ICT solution for pre-monitoring. The actions included in this step are: preliminary contacts with tenants and gathering of necessary authorizations; deployment of pre-monitoring devices (smart meters, sensors, etc.); data collection without user awareness actions (preferably for 2 months at least), and pre-monitoring data analysis.

- ICT solution implementation: second step of the deployment, installing the specific ICT solution on top of the pre-monitoring solution already available in the pilot.

The Methodology for implementation has been carried out from the experience matured in the pilots (see [RD-6] and [RD-10]). The pilots have been presented as individual case studies by gathering, for each of them, the specific problems which have been considered and settled up. Therefore this methodology results from the actions conducted at each of the 12 EDISON pilot sites; for each pilot an analysis in terms of key partners involved, key activities, key resources, costs and lessons learned was performed.

In particular, from the difference found between the forecast installation activity (initial methodology) and pragmatic implementation on site (final methodology), the main lessons learned about monitoring practices are presented hereafter.

- **Specificity of evaluating the impact of ICT and Power systems**: Energy savings generated by ICT and Power systems are quite interesting even if lower compared to the impacts generated by the power energy reduction generated by the use of LED light technology. This leads to conclude that the implementation of the EDISON platform it is a very interesting investment when combined with a proper behavior of people working or visiting the site (use of automatic mode instead of manual one). These savings can reach figures around 80%. However the EDISON experience indicates that it requires further research on methodological aspects regarding human behavior, to generate new services (e.g. doors opening) associated to lighting (or better to human presence) and give the opportunity for new services controlled by the ICT platform.
- **Size and representativeness of the sample of buildings**: pilot sample size in EDISON was defined as a compromise between the need to have representative public buildings and the affordability of the project. It appeared that the pilot sites were selected cautiously to be representative of a large range of buildings.
- **Monitoring strategy**: the EDISON project used three main monitoring strategies: monitoring the same lighting infrastructure of pilot sites, before the implementation of the EDISON platform (baseline); after the implementation but without ICT components; and finally the fully operative EDISON platform. Only in two pilots (VUB Restaurant and Lurgan Hospital) were possible to compare energy consumptions, in real time, thanks to the presence of smart meters in similar areas. With regard to the reference period, data treatment showed the importance of having a consolidated baseline to identify the issues that might occur during the reporting period, in terms of quality of data and exploitation process, in order to be able to anticipate such difficulties.

- **Monitoring plan**: The choice of sensors is critical in order to achieve the right balance of usefulness, cost and building occupancy. A lesson therefore is to devise beforehand what are the most appropriate sensors.
- **Mix use of bills and measurements**: The use of energy consumption bills for long term assessment and the measurements for analyzing the consumptions week per week, day per day in the pilot site buildings, gave a good balance of information and allowed to ensure the collected data quality through cross comparison. However, it is sometimes difficult to collect the bills from building owners with energy consumptions separated between lighting and appliances.
- **Data assessment and interpretation**:

  -Savings were evaluated in EDISON on the basis of a comparison of different periods

  -The development of a software tool for a better evaluation of the ICT contribution.
- **Stability of consumption patterns**: It appeared, during the project, that the results were highly sensitive to two aspects: individual behavior (highly variable from one pilot site to another), and month to month evolution. For this reason it has been useful to extend pre-monitoring and/or monitoring periods over more than six months.
- **Practical implementation issues**: in some pilot sites the existing electrical infrastructures presented some problems that were even unknown to the building managers. In fact in the junction boxes, the technical EDISON team found that the lighting networks were not completely separated, at Earth wire level, from the power network (EMF). As consequence, a preventive action aimed at making the electrical infrastructures compliant with the most recent norms has been necessary.
- **Stakeholders involved**: During the running period, in some pilots, the efficiency gain due to the EDISON smart solution has been sometimes falsified by the incorrect use of the auto/man switch, set in manual position. It was necessary to provide a training course in order to change the behavior of the involved personnel.

  In addition:

  - in the running phase several inspections to the Pilot sites have been required in order to verify the proper functionality of the EDISON system and to control the data storage into the database. A periodic check in each Pilot site has been performed by PM, SIE, TSI and SMK. During the inspections some problems have been noticed due to the fact that the remote monitoring system has sometimes been switched off during the weekend or holidays.

MAIN HIGHLIGHTS OF THE METHODOLOGY FOR MONITORING

The last step is the monitoring phase, in which the results obtained during the monitoring period (i.e. period in which the complete ICT solution is running in the pilot, at least for 12 months) in terms of energy savings and behavioral evolution will be assessed. The following aspects shall be considered:

- Monitoring, Measurement: monitoring the ICT platform for energy efficiency allows the evaluation of performance from the point of view of generation of information for the building users. Measurements refer to the process of collecting raw data using hardware tools, mainly meters and sensors, or through energy bills collection. These data combined with the monitoring results permit to validate the ICT approach.
- Overall monitoring strategy: mostly derived from the IPMVP protocol, it is based on the following approaches:
  - *Size of the sample*: address an intermediate number of rooms
  - *Multi-level analysis*: year-to-year comparisons, but also seasonal analysis, typical week, typical day, etc.
  - *Multi-source data*: combination of measurements and energy bills
  - *Two approaches for evaluation*: comparison of reference period – baseline period, or similar pilots.
  - *Setup of a plan for user behavior evaluation*: based on regular interviews of the tenants about their use of the ICT system and their own behavioral perception

- Indicators:
  - *Energy related indicators*: energy consumption per lighting,
  - *Comfort indicators*: Luminance in the rooms; intensity of external natural light source
  - *Progress indicators*: Global energy consumption (and savings) indicators and ICT components percentage of use

- Analysis procedure and results calculation: indicators shall be evaluated relatively to their context (exterior lighting, rooms areas, occupation rate) and to specific periods (summer or winter, holidays or high activity, etc.), with the relative evolution between the reference period and the monitoring period (in % relative to the reference period).

Target groups

The results of the EDISON project can be relevant for the following target groups:

- **Public and Private building providers (owners/managers)**: following the same approach used in the project, one of the most efficient ways of reaching a high number of end users is to offer the EDISON solution to public or private organizations which own and/or manage buildings for rental, which can decide to undertake large scale deployments of ICT solutions for energy efficiency in their housing stock and would then offer the service to their tenants.
- **Private owners under a community of owners' framework**: the EDISON solution could be offered to communities of owners in order to install it in common areas and within all the dwellings whose owners want to use the service and pay for it.
- **Facility managers and building maintenance companies, ESCOs**: Companies in charge of the management of facilities of different types (residential, commercial or public buildings) are increasingly assuming the role of implementing action plans for the improvement of energy efficiency in these facilities. This responsibility will normally be reflected in the facility management contracts through specific clauses related to this topic. Therefore, facility management and building management companies as well as ESCOs is another target group for the EDISON solution.
- **ICT solutions & BEMs and metering providers**: ICT-based solution providers could enter in the business of BEMs by providing the EDISON solution, either directly to building owners, to construction companies, to facility managers or through other BEMs/BAS providers. The EDISON solution can also be associated to the market of smart metering systems which are currently being massively deployed throughout Europe.
- **Energy Efficient Building construction & refurbishment companies, energy consulting companies, architects and engineering companies**: these stakeholders can foster the integration of the EDISON solution either in new real estate developments, or in building retrofitting projects. This could be done in partnership with specialized SMEs, especially the ones participating to the EDISON project, providing installation, maintenance and consultancy services for the operation of the solution.
- **Utilities**: utilities shall be addressed as they can offer the EDISON solution as an added value service to their customers, which will run on top of the smart metering deployments which are currently in process.
- **Smart Cities, Smart City community**: municipalities involved in smart cities developments, and the communities formed around these, shall be addressed in order to promote large scale uptake and replication of the EDISON solution as a means of achieving significant energy savings at city level.

- **Policy makers at European, National and Regional level**: the EDISON solution, together with other similar solutions developed in other European projects and already available in the market, is one of the enablers to be considered by policy makers in order to achieve the objectives of the 2020 strategy.

Dissemination

Conferences

Although EDISON is not a research project, one of the requirements imposed by the corresponding Call was the development of adequate dissemination and communication activities, addressed to both experts and relevant stakeholders, which could contribute to the future deployment or replication of the envisaged solution as much as possible.

To this aim, four papers have been developed during the project lifetime, and presented to the conferences listed in the table below.

Date	Venue	Conference name	Title
August 17-21, 2013	Madison, Wisconsin, USA	IEEE CASE 2013	9th IEEE International Conference on Automation Science and Engineering
October 29-31, 2013	-	IEEE Online GreenComm 2013	2013 edition of the conference dedicated to addressing the challenges in energy-efficient communications and communications for green technologies
May 13-16, 2014	Dubrovnik, Croatia	IEEE ENERGYCON 2014	Third edition of the conference dedicated to experts carrying out research activities focused on energy and power systems
November 3-6, 2014	Venice, Italy	IEEE SmartGridComm 2014	5th edition of the conference which provides a forum to discuss all aspects that are relevant to smart grid communication and information technologies

Publications

EDISON project partners have produced a set of publications addressing different dissemination channels, including mass media (e.g. newspaper, TV news) and video interview available on a dedicated YouTube channel.

Date	Where	Publication
March 2012	Regional Italian newspaper “Il Centro”	Article on the interview done to the Pilot manager of Manoppello Municipality
June 2013	TVBrussel channel (BE)	Video report about the project (http://www.brusselnieuws.be/nl)
June 2013	Online newspaper of the Italian Municipalities, “Il Giornale dei Comuni”	Interview at the PM of the EDISON project
October 2013	Online newspaper of the Italian Municipalities, “Il Giornale dei Comuni”	Interview at some EDISON partners representatives in occasion of the 2nd EDISON Workshop in Perugia (Italy)
April 2014	Online newspaper of the Italian Municipalities, “Il Giornale dei Comuni”	Interview at the Sales Executive of the ENEL Sole company, a partner of the EDISON Consortium
June 2014	Online newspaper of the Italian Municipalities, “Il Giornale dei Comuni”	Interview at some EDISON partners representatives in occasion of the 3th EDISON Workshop in Manoppello (Italy)
September 2014	Project website	Interview at users of the Belfast Pilot (UK) about their experience with the EDISON platform
November 2014	National Italian newspaper “Il Sole 24 Ore”, n. 445, the newspaper of the main association representing manufacturing and service companies in Italy (Confindustria)	Article titled “L’ Europa s’ illumina di LED”, by Alessandro Longo (http://nova.ilsole24ore.com/progetti/leuropasilluminadiled)
December 2014	Online newspaper of the province of Viterbo (Italy)	Web news about the adoption of the EDISON platform in several schools of the Ronciglione Municipality (http://www.tusciaweb.eu/2014/12/scuola-comunale-35mila-euro-per-risparmio-energetico/)

In addition, a specific project profile has been created and continuously monitored on the most popular social networks (Facebook and Twitter), providing support to all the requests proposed by followers and highlighting all the initiatives that have been progressively conducted.

National & International workshops

Workshops have represented a powerful dissemination tool used by EDISON Consortium in order to guarantee the largest diffusion of the project idea to potential stakeholders. Three workshops have been organized in Italy during the project, some of them in cooperation with other FP7 and sister ICT PSP projects. Besides, one European workshop has been organized in Brussels.
The table below provides the basic information of all these workshops.

Date	Place	Event
September 2012	Brussels (BE)	1st EDISON Workshop (WS1)
October 2013	Perugia (IT)	2nd EDISON Workshop (WS2)
June 2014	Manoppello (IT)	3rd EDISON Workshop (WS3)
December 2014	Rome (IT)	4th EDISON Workshop (WS4)

National workshops were excellent opportunities to increase awareness of the project in the countries where the pilot sites were mainly located. They offered opportunities to hold discussions related to EDISON solution performance and applicable business models, taking into account National specific contexts: National building and energy regulations, National incentives for energy refurbishment and/or related to social housing, etc.

In addition, EDISON members have participated to other workshops as speakers, in order to disseminate the main concepts and results of the project in the most appropriate contexts.

Date	Place	Event
April 2012	Frankfurt (DE)	Light+Building Exhibition
May 2012	Perugia (IT)	2012 Perugia Green Days
May 2012	Brussels (BE)	Workshop on the methodology for energy-efficiency measurements applicable to ICT in buildings
November 2012	Modena (IT)	Bioarchitecture and Home Automation week
December 2013	Vallo della Lucania (Salerno, IT)	"Energy Saving and Energy Efficiency "

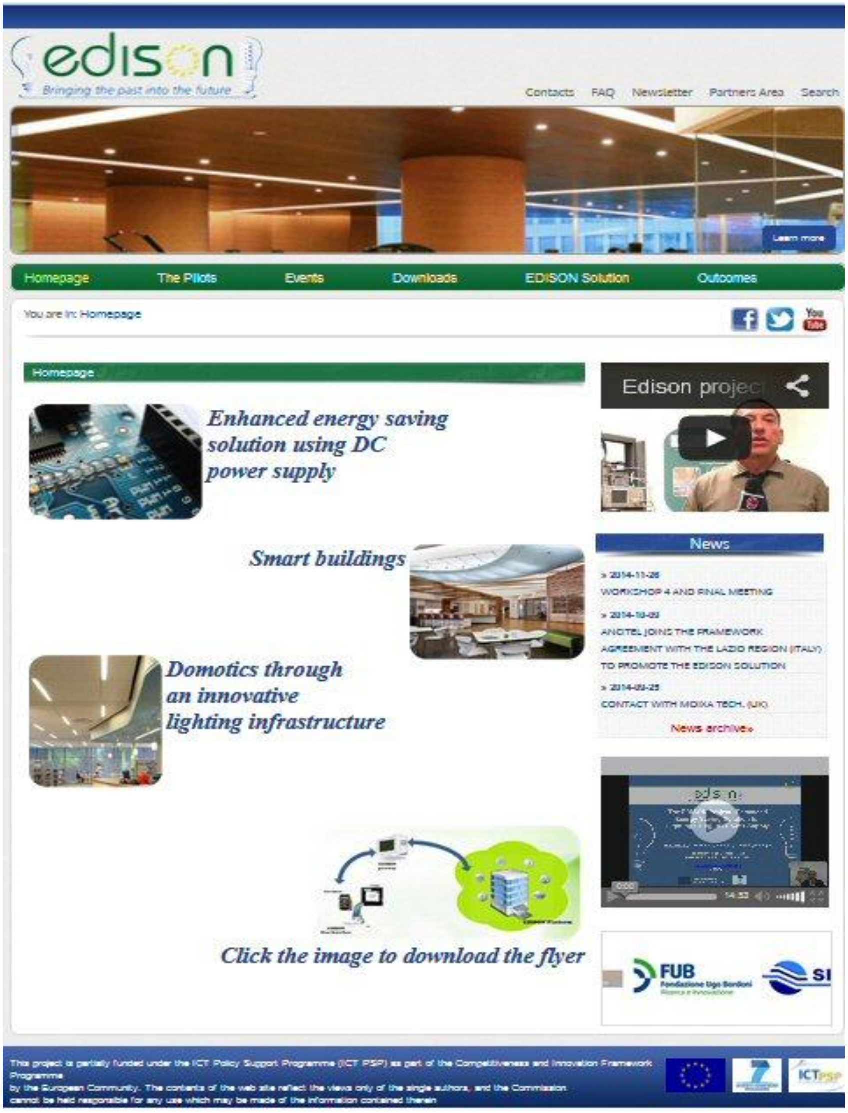
		Workshop

EDISON Project website and electronic newsletters

All the information concerning the project have been collected and made available through a dedicated website, which represents a focal point for creating project visibility. This website includes both a public and a private restricted area, in order to disseminate the project initiatives towards external stakeholders and support the sharing of project materials among the Consortium partners, respectively.

More in detail, through the public section of the EDISON website is possible to access to:

- general description of the project,
- information about the pilot sites and the project partners,
- project flyers and videos,
- a collection of past relevant events,
- a simulation tool that can be used by people interested in verifying the effectiveness of the EDISON solution, when implemented in a building of their interest,
- information about energy savings results gained in the Pilot actions,
- electronic newsletters which have been published periodically by the consortium.



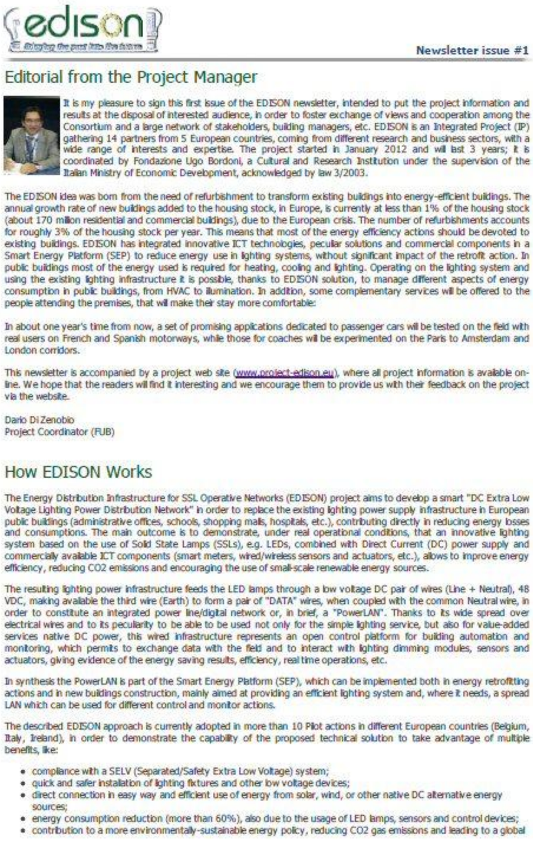
Obviously, as a dissemination tool, the public website has been continuously updated during the whole project lifetime, and will be kept active also for further months after the project conclusion in order to support the exploitation activities that will be realized successively.

With regards to the electronic newsletters, they have been all realized following a predetermined template, including:

- an editorial edited by the leader of the WP mainly involved by the activities in progress at the moment of the newsletter's publication;
- a section devoted to the description of the technical activities carried out in the project period in which the newsletter was published or to the description of the physical implementation of the EDISON platform in one of the foreseen Pilot site;
- a section focused on the description of a specific partner of the Consortium, highlighting its peculiarities that make it essential for the project, specifying its role;

- a section devoted to the provisioning of information about the dissemination and exploitation events in which the project has been involved or will be involved in the future;
- a final section related to news and events concerning both the field of interest for the project and other European projects dealing with topics similar to EDISON.

Table 8 collects the front pages of all the published newsletters.



Newsletter issue #1

Editorial from the Project Manager

It is my pleasure to sign this first issue of the EDISON newsletter, intended to put the project information and results at the disposal of interested audience, in order to foster exchange of views and cooperation among the Consortium and a large network of stakeholders, building managers, etc. EDISON is an Integrated Project (IP) gathering 14 partners from 5 European countries, coming from different research and business sectors, with a wide range of interests and expertise. The project started in January 2012 and will last 3 years; it is coordinated by Fondazione Ugo Bordoni, a Cultural and Research Institution under the supervision of the Italian Ministry of Economic Development, acknowledged by law 3/2003.

The EDISON idea was born from the need of refurbishment to transform existing buildings into energy-efficient buildings. The annual growth rate of new buildings added to the housing stock, in Europe, is currently at less than 1% of the housing stock (about 170 million residential and commercial buildings), due to the European crisis. The number of refurbishments accounts for roughly 3% of the housing stock per year. This means that most of the energy efficiency actions should be devoted to existing buildings. EDISON has integrated innovative ICT technologies, peculiar solutions and commercial components in a Smart Energy Platform (SEP) to reduce energy use in lighting systems, without significant impact of the retrofit action. In public buildings most of the energy used is required for heating, cooling and lighting. Operating on the lighting system and using the existing lighting infrastructure it is possible, thanks to EDISON solution, to manage different aspects of energy consumption in public buildings, from HVAC to illumination. In addition, some complementary services will be offered to the people attending the premises, that will make their stay more comfortable:

In about one year's time from now, a set of promising applications dedicated to passenger cars will be tested on the field with real users on French and Spanish motorways, while those for coaches will be experimented on the Paris to Amsterdam and London corridors.

This newsletter is accompanied by a project web site (www.project-edison.eu), where all project information is available on-line. We hope that the readers will find it interesting and we encourage them to provide us with their feedback on the project via the website.

Dario Di Zenobio
Project Coordinator (FUB)

How EDISON Works

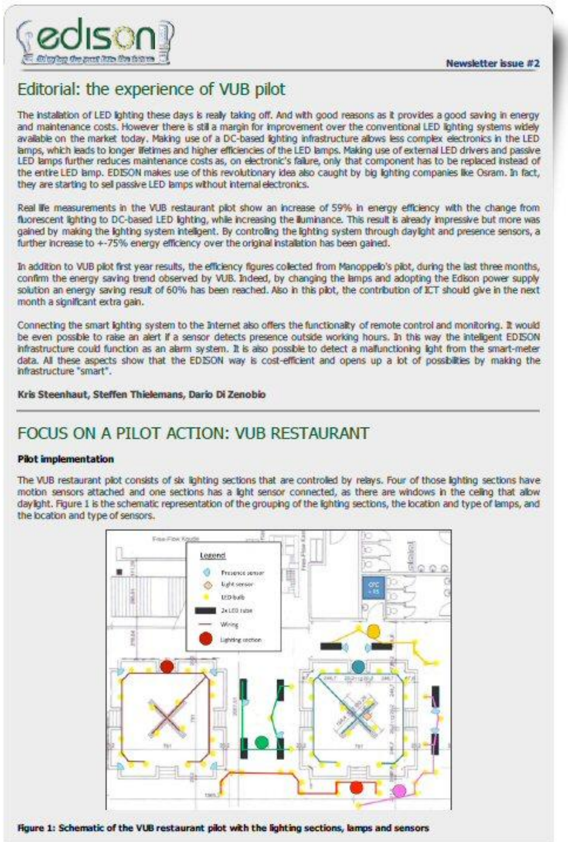
The Energy Distribution Infrastructure for SSL Operative Networks (EDISON) project aims to develop a smart "DC Extra Low Voltage Lighting Power Distribution Network" in order to replace the existing lighting power supply infrastructure in European public buildings (administrative offices, schools, shopping malls, hospitals, etc.), contributing directly in reducing energy losses and consumptions. The main outcome is to demonstrate, under real operational conditions, that an innovative lighting system based on the use of Solid State Lamps (SSLs), e.g. LEDs, combined with Direct Current (DC) power supply and commercially available ICT components (smart meters, wired/wireless sensors and actuators, etc.), allows to improve energy efficiency, reducing CO2 emissions and encouraging the use of small-scale renewable energy sources.

The resulting lighting power infrastructure feeds the LED lamps through a low voltage DC pair of wires (Line + Neutral), 48 VDC, making available the third wire (Earth) to form a pair of "DATA" wires, when coupled with the common Neutral wire, in order to constitute an integrated power line/digital network or, in brief, a "PowerLAN". Thanks to its wide spread over electrical wires and to its peculiarity to be able to be used not only for the simple lighting service, but also for value-added services native DC power, this wired infrastructure represents an open control platform for building automation and monitoring, which permits to exchange data with the field and to interact with lighting dimming modules, sensors and actuators, giving evidence of the energy saving results, efficiency, real time operations, etc.

In synthesis the PowerLAN is part of the Smart Energy Platform (SEP), which can be implemented both in energy retrofitting actions and in new buildings construction, mainly aimed at providing an efficient lighting system and, where it needs, a spread LAN which can be used for different control and monitor actions.

The described EDISON approach is currently adopted in more than 10 Pilot actions in different European countries (Belgium, Italy, Ireland), in order to demonstrate the capability of the proposed technical solution to take advantage of multiple benefits, like:

- compliance with a SELV (Separated/Safety Extra Low Voltage) system;
- quick and safer installation of lighting fixtures and other low voltage devices;
- direct connection in easy way and efficient use of energy from solar, wind, or other native DC alternative energy sources;
- energy consumption reduction (more than 60%), also due to the usage of LED lamps, sensors and control devices;
- contribution to a more environmentally-sustainable energy policy, reducing CO2 gas emissions and leading to a global



Newsletter issue #2

Editorial: the experience of VUB pilot

The installation of LED lighting these days is really taking off. And with good reasons as it provides a good saving in energy and maintenance costs. However there is still a margin for improvement over the conventional LED lighting systems widely available on the market today. Making use of a DC-based lighting infrastructure allows less complex electronics in the LED lamps, which leads to longer lifetimes and higher efficiencies of the LED lamps. Making use of external LED drivers and passive LED lamps further reduces maintenance costs as, on electronic's failure, only that component has to be replaced instead of the entire LED lamp. EDISON makes use of this revolutionary idea also caught by big lighting companies like Osram. In fact, they are starting to sell passive LED lamps without internal electronics.

Real life measurements in the VUB restaurant pilot show an increase of 59% in energy efficiency with the change from fluorescent lighting to DC-based LED lighting, while increasing the luminance. This result is already impressive but more was gained by making the lighting system intelligent. By controlling the lighting system through daylight and presence sensors, a further increase to +-75% energy efficiency over the original installation has been gained.

In addition to VUB pilot first year results, the efficiency figures collected from Manoppello's pilot, during the last three months, confirm the energy saving trend observed by VUB. Indeed, by changing the lamps and adopting the Edison power supply solution an energy saving result of 60% has been reached. Also in this pilot, the contribution of ICT should give in the next month a significant extra gain.

Connecting the smart lighting system to the Internet also offers the functionality of remote control and monitoring. It would be even possible to raise an alert if a sensor detects presence outside working hours. In this way the intelligent EDISON infrastructure could function as an alarm system. It is also possible to detect a malfunctioning light from the smart-meter data. All these aspects show that the EDISON way is cost-efficient and opens up a lot of possibilities by making the infrastructure "smart".

Kris Steenhaut, Steffen Thielemans, Dario Di Zenobio

FOCUS ON A PILOT ACTION: VUB RESTAURANT

Pilot implementation

The VUB restaurant pilot consists of six lighting sections that are controlled by relays. Four of those lighting sections have motion sensors attached and one sections has a light sensor connected, as there are windows in the ceiling that allow daylight. Figure 1 is the schematic representation of the grouping of the lighting sections, the location and type of lamps, and the location and type of sensors.

Figure 1: Schematic of the VUB restaurant pilot with the lighting sections, lamps and sensors

Newsletter issue #3

Editorial: Energy savings evaluation criteria and preliminary results

The Energy Saving Methodology adopted in EDISON was developed paying attention to accuracy and practicality aspects, and taking into account the framework of the so called "International Performance Measurement and Verification Protocol" (IPMVP) Measurement and Verification (M&V) Guideline, applied to lighting retrofitting actions. The aim of the IPMVP is to assess the energy saving resulting from the EDISON solution implementation, in particular by highlighting the energy saving due to ICT components (daylight and presence sensors). The Key Performance Indicators (KPI's) identified at the beginning of the EDISON project will allow a direct comparison of EDISON results, collected in different typologies of building and countries. The EDISON methodology for assessing energy saving has been designed in order to:

- reduce uncertainties to reasonable levels;
- monitor equipment performance;
- evidentiate potential extra savings;
- improve the behavioral end user habits;
- verify that the planned cost savings are met;
- confirm that the equipment/systems installed have the potential to generate predicted savings;
- verify that the installed equipment/systems continue to have the capacity to yield the predicted savings over time.

In every Energy Efficiency Programme, a Measurement and Verification Plan is required to determine the savings achieved by the implementation of energy saving solution. Energy Saving COs (ESCO's) in the European Association of ESCOs have adopted the above mentioned Protocol (IPMVP) as their preferred guideline to write the M&V Plan within the Energy Performance Contracts. IPMVP is not only the most known M&V protocol around the world, but it is also the most prestigious within the international technical community.

When Public Building Managers (PBM) invest in energy efficiency they want to know how much they have saved and how long their savings will last. The determination of energy savings requires both accurate measurement and replicable methodology (the above mentioned M&V protocol).

The IPMVP defines general procedures to achieve reliable and costeffective determination of savings. The longterm success of energy management projects is often hampered by the inability of project partners to agree on an accurate, successful M&V Plan. EDISON goal has been as much compliant as possible with a M&V Protocol providing procedures that, when implemented, help buyers, sellers and financiers of energy projects to agree on an M&V Plan and quantify savings from Energy Conservation Measure (ECM).

In case of Energy Performance Contract (EPC) as proposal for future EDISON implementations, the M&V Plan, which has to be reviewed and accepted by the customer prior to project implementation, will become part of the contract's terms and will define the measurements and computations to determine payments or demonstrate compliance with a guaranteed level of performance.

EDISON technical partners considered M&V Option A as the most suitable methodology for assessing the energy saving.

Option A is intended for retrofits where key performance factors (e.g., enduse capacity, demand, power) or operational factors (e.g., lighting operational hours, cooling tonhours) can be spotor shorttermmeasured during the baseline and post-installation periods. Any factor not measured is estimated based on assumptions, analysis of historical data, or manufacturer's

Newsletter issue #4

Edison Project: participation and interest in the closing workshop

The squalls that hit the Eternal City did not prevent local administrators and other stakeholders to participate in the workshop-final event- of the Edison project, which was held on December 16th in Rome at the national headquarters of ANCI. The representatives of the municipalities coming from all over the Peninsula (mostly responsible for the environmental sector and innovation) have assisted with interest to the illustration of the technological system of advanced smart lighting for public buildings - developed thanks to a three-year project funded by the EU under the 7th Framework Programme, which will end next December 31st. Organized by on behalf of the Consortium that implemented and tested the Edison solution in twelve pilot buildings in different European countries, the conference touched on all major issues relating to energy saving measures, particularly with respect to the efficiency operations of buildings. In other words, thanks to the contribution of the project leader, Mr. Dario Di Zenobio of the Ugo Bordoni Foundation, were deeply discussed both the technical aspects as well as those related to finding the resources to finance the installation of the system in the buildings reported by potential customers. About this point especially useful has been the intervention of Dr. Andrea Gallo, publisher of Fasi.biz (online magazine specialized in financial facilities), which outlined a brief, but comprehensive, overview on funding opportunities offered by the Funds and Programmes of the European Union, as well as related effects at national and regional level. Not surprisingly, several interventions from the audience asked clarification just on the issues concerned. "Our solution - reiterated with conviction repeatedly Mr. Di Zenobio - allows a reduction in energy consumption, which ranges between 60% and 70%. A lot of money can be saved thanks to a so lighter bill. In particular the municipalities, currently penalized by heavy cuts, can take advantage of the savings achieved by freeing up resources for services for citizens. However, the solution can be adopted by all involved parties and not only by public entities (companies, professionals, commercial centers, associations, etc.). For this reason, after the formal conclusion of the project, the Consortium intends to open a new phase of promotion/commercial deployment of our "product" on large scale. The Consortium is able to provide, "turnkey", a practical tool that helps to break down, at the same time, energy costs and CO2 emissions. A tangible example of green economy capable of harmonically decline the "environment" and "development" words. The ball goes now to stakeholders and their real willingness to turn the page on the past, proving to be innovative in facts and not just in words. In this endeavor we will involve all partners of the Edison consortium. Relevant will be the role that can and will play as "gateway" to the privileged system of local authorities, because of its twenty-year of support action to municipalities", concluded Di Zenobio.

The second part of the workshop was devoted to pilot experiences, giving voice to those who actually (in Belgium, UK, Italy) have adopted, installed and tested the Edison platform. Particularly significant statements have been provided by Professor Chris Steenhaut from Vrije University of Brussels, by Pierpaolo Caselli from Città della Scienza of Naples, from Romeo Ciammaichella, councilor to the budget of the City of Manoppello and representatives of SMK British company who managed the project in Belfast. All provided data extremely positive that, in some cases, have gone results better than expected: reduced energy consumption by 60-70%; flexibility and adaptability of the system; interoperability with further energy systems to improve efficiency (photovoltaic, heating / cooling, etc.); safer installations, thanks to the use of DC current instead of AC. Works ended with the announcement of a new global energy consulting service that, in collaboration with other partners, Ancitel, from January 2015, will provide to the interested municipalities.

EDISON results and performances

In the third period of the project, after more than one year of Pilots running and collection of energy consumption data, including ICT contributions, it was possible to analyze EDISON platform results in terms of relevant key performance indicators. Data analysis was conducted adopting the International Performance Measurement and Verification Protocol (IPMVP) as it is the preferred guideline to write the Measurement and Verification (M&V) Plan within the Energy Performance Contracts. IPMVP is not only the most known M&V protocol around the world, but it is also the most prestigious within the international technical community. In particular the IPMVP - Option A has been adopted as it allows, in simple lighting retrofit, a more accurate estimation of savings. In fact Option A approach:

*Ensures that baseline conditions have been properly defined

*Confirms that the proper equipment/systems were installed and that they have the potential to generate predicted savings

*Verifies that the installed equipment/systems continue to have the capacity to yield the predicted savings during the term of the contract.

Table 8 - Newsletters first pages

Public deliverables

As an exploitation tool, the EDISON website provides all the project public deliverables, and makes accessible most of the conclusions and lessons learnt in the project, and therefore can be used as reference material for future replication.

The table below provides, in chronological order of publication, a list of all the public deliverables available for download. This table includes also a brief description of the contents of each deliverable.

On the other hand, the EDISON website is used as the main contact channel for any external stakeholder who would like to retrieve additional information from the consortium, or is seeking guidance or establishment of partnerships for replicating the project results in other buildings. Enquiries received through the project public website is managed and answered directly by the project coordinator, or forwarded to specific project partners, if needed.
A contact from TSItalia is provided in the public website for any enquiry related to the technical EDISON ICT solution. Other partners also take the responsibility of managing enquiries from specific countries, for instance TOM manages contacts from UK and Ireland organizations, BKT

manages contacts from Greece organizations, and VUB is the first contact point for Belgium and France.

EDISON Public Deliverables		
Deliverable number	**Title**	**Contents**
D6.1.1	**Dissemination Plan**	The document sets out a coherent dissemination strategy and describes activities and techniques that have been used by the Consortium to ensure a far-reaching awareness of the Project achievements to a widest possible audience, helping it in developing an understanding of the opportunities that arise from it.
D6.1.2	**EDISON website and project promotional material**	Description of the design, structure and contents of the project website activated during the first year of the project in order to represent a source of information for all interested parties outside the project, as well as to provide access to a private area to the project partners for sharing technical and administrative materials.
D2.2.1	**Analysis of Best Practices**	Description of the methodology identified to measure and assess energy savings before and after the implementation of the EDISON solution, taking into account of energy efficiency indicators, standards and best practices shared with other ongoing or completed Projects in the fields of smart lighting solution, which result functional to the EDISON scenario.
D2.1.1	**Pilot Description and EDISON model**	Collection of all the information of the Pilot locations necessary to design specific EDISON solutions inside each Pilot site on the basis of the survey model, which is described in the document as well.
D3.1.1	**EDISON hardware & software design**	Overview of the EDISON platform network architectures implemented in the Pilot sites according to the features of the existing lighting infrastructures, integrated with technical description of the components, both hardware and software, selected to implement the corresponding EDISON solution.
D1.2.1	**Progress Report to the EU**	Description of the progress carried out in each workpackage in the first year of the project lifetime, detailing the activities developed by each partner, as well as reporting the economical analysis of the corresponding incurred expenses.
D4.1.2	**EDISON hardware & software implementation and integration**	Description of the design solution implemented in each Pilot action, including detailed information about software/hardware components installed in the corresponding site.
D6.1.4	**Exploitation Plan**	Description of the approach adopted to exploit the EDISON platform, analyzing specific aspects like: the market context in

		which the EDISON exploitation strategy should be rolled out, examples of ROI calculation as well as typical business plan considering typical public administration buildings, information about the procedure that public and private Administrations should follow in order to adopt the EDISON solution.
D1.2.2	**Progress Report to the EU**	Description of the progress carried out in each workpackage in the second year of the project lifetime, detailing the activities developed by each partner, as well as reporting the economical analysis of the corresponding incurred expenses.
D5.1.1	**Analysis of socio-economic aspects**	Assessment of both energy saving results obtained in the Pilot actions and of potential success factors of the EDISON platform resulting from feedbacks gathered through end user questionnaires, integrating the analysis with some relevant business cases addressing typical building typologies. Additionally, the most important practical aspects of intervention that need to be considered in order to replicate the solution in any category of building are highlighted in an annexed guidelines booklet.
D5.2.1	**Interoperability description**	Description of the hardware/software interoperability features of the EDISON platform that make it able to integrate with different systems and services addressed to reduce energy usage, operating in the same building.
D4.4.1	**Running of the Pilots and Results**	Description of the features of the data acquisition system and of the guidelines followed to store the data collected in field, including the presentation of a first analysis of the EDISON energy performance achieved in each Pilot action.
D2.3.1	**Standardization Activity Report**	Overview of the results of relationships established with other EU projects operating in the field of energy saving and with international standardization bodies and working groups, giving evidence of the international regulations analyzed and adopted to define the final EDISON platform architecture.
D5.2.2	**EDISON Architecture assessment**	Overview of the main improvements to the basic version of the EDISON platform introduced during the system implementation in the Pilot actions, in order to make the solution replicable in any building typology, considering different environmental constraints as well as lighting and energy requirements. It also provides details about the possibility to make the system an “Interoperable Architecture” ready to integrate interchangeable hardware components available in the market, as well as to interact with other BEMS systems.
D6.1.3	**Workshops & exhibition events**	Summary of the dissemination activities carried out in the context of the EDISON project, with specific focus on workshops and other relevant exhibition events that have been

		held in some of the countries involved in the project in order to make the EDISON solution as much shared as possible with appropriate stakeholders.
D6.2.1	**EDISON training Activities description document**	Overview of guideline instructions and web-based multimedia tutorials developed to support the cross-fertilization of both professionals and non-technical managers having an interest in this field with concepts, technologies and results of the EDISON project.
D1.2.3	**Progress Report to the EU**	Description of the progress carried out in each workpackage in the third year of the project lifetime, detailing the activities developed by each partner, as well as reporting the economical analysis of the corresponding incurred expenses.
D1.2.4	**Final Report to the EU**	Summary report covering the results, conclusions and socio-economic impact of the project.

Conclusions and lessons learned

Conclusions and lessons learned have been derived by all the members of the consortium from all the phases of the project, from its conception to its finalization. Some of the most important lessons are reported below.

Consortium Composition

- The active participation of Building Managers (owners of the buildings) and Energy Service Companies ("ESCOs") as partners is absolutely necessary from the pilot conception and mobilization of users, to the impact analysis and further exploitation activities (identification of the most appropriate contractual arrangement aimed at allowing the adoption of the EE solution by the Building Manager; calculation of the Return Of Investment (ROI) for a specific Pilot, etc.).
- Voluntary users involvement is a mandatory for the success of the project.
- The selection of the pilots is a key issue before starting a pilot project. An energy efficiency audit before starting is convenient for an initial check of the energy savings potential of the building.
- It is very recommendable, if possible, to incorporate utilities as partners or have a collaboration agreement with them to develop this kind of projects, in order to have a valuable contribution in the exploitation actions as well as in the analysis of energy savings results obtained in the pilot buildings.
- A larger duration of the project is recommended (about 3 years, instead of the usual 2 years), mainly because the pre-monitoring period and the monitoring period should be running at least 12 months each, which leaves only another 12 months for requirements analysis, solution design and testing, evaluation of results, etc., which could be short.

Social & acceptance issues

- A better understanding of actual behaviors of public buildings users towards energy efficiency
- Target stakeholders (e.g. ESCO companies) that should be involved for a full exploitation of the project

- Building managers as main actors that can play a key role in optimizing management strategies and user behavior towards energy efficiency
- The EDISON solution can contribute to meet the 4 targets endorsed by the European Council in the 2030 policy framework for climate and energy [RD-21]:
    - a binding EU target of at least 40% less greenhouse gas emissions by 2030, compared to 1990
    - a binding target of at least 27% of renewable energy used at EU level
    - an energy efficiency increase of at least 27%
    - a completion of the internal energy market by reaching an electricity interconnection target of 15% between member states and pushing forward important infrastructure projects.
- Although the users are not massively convinced of the reliability of the LED solution, they can maybe change mind being confronted with the EDISON advantages that improve the lifetime of the lamps thanks to the external DC power supply.
- Building managers, involved in the project, are satisfied with the solution after considering functionalities and installation process (even if they suffered technical problems, mainly due to the features of the pre-existing lighting infrastructures)

Training sessions are fundamental for end users involvement, to understand the functionalities and to profit from the ICT platform.

<u>Technical Point of View</u>

- Development of a global methodology for design, implementation and monitoring, including guidelines for replication, is a key factor
- An interoperable solution integrating off-the shelf commercial devices and tools from different vendors can facilitate the solution’s acceptance.
- The definition of a baseline starting point and the target to be achieved are key to understanding the economic feasibility of the solution, and to making necessary adjustments to improve its impact
- Standardization and interoperability among equipment of different manufacturers are also key enablers for exploitation. EDISON has taken these factors into account in order to design an ICT solution capable of integrating different hardware and software modules, and to ease interoperability with 3rd party systems, such as Building Management Systems
- Adoption of appropriate communication protocols is a critical point for a fully operative working solution

- Control of occupancy is an independent parameter that needs to be monitored to properly evaluate savings and it can also be exploited to manage HVAC systems. The experience of the project suggests to carefully evaluate the contribution of presence sensors in the estimation of energy savings gained in the building.
- The capacity of the monitoring system to automatically detect errors and to evaluate the accurateness of the treated data (i.e. missing data or data indicating a wrong value) should be reinforced in order to improve the trustworthiness of the data collected through the ICT solution
- The fact that the EDISON solution is a SELV system and makes possible quick and safe installations of lighting fixtures, without new certifications, facilitates the adoption of new lighting solutions.

Energy savings strategies & Potential

- Necessity of increasing the target of energy efficiency through the use of smart lighting solutions in respect to the simple lamps retrofitting.
- Important energy savings opportunities (potential) could be obtained integrating in the ICT platform the monitoring and control of HVAC systems, as done in an EDISON pilot. This operation requests the predisposition of the HVAC system to be controlled and sometimes an important investment.
- A goal is to maintain the cost of ICT solution deployed in the pilots very low, considering that the threshold cost proper of an electronics platform has a direct impact on the cost/benefit balance of the ICT implementation; this cost is essential for replicability and exploitation of the solution in a very large market, involving any kind and typology of buildings.

Feasibility of investment

- Prior to the investment it is necessary to carry out at least a quick audit in order to assess the possible savings to be achieved, combining traditional retrofitting actions with the use of ICT awareness tools
- The feasibility of an investment in an ICT solution for lighting energy efficiency depends on a wide variety of factors, such as: the actual and expected consumption levels, features of the building, users' profiles, energy cost, etc.
- The ICT solutions developed in EDISON project and the trend of cost reduction in the

supporting technologies (smart meters, LED lamps, interfaces, communication equipments, etc.) could allow the provision of affordable solutions that can be amortized in a reasonable period

- The cost of EDISON Smart Energy Platform is not linear with the number of controlled lighting sections, but grows step by step, with an initial step predominant to the others. As a consequence, the EDISON solution should be addressed to large public buildings in place of very small offices, because the largest is the number of lighting sections to be involved, the lower is the impact of ICT components on the investments and, consequently, the lower is the corresponding payback period
- The history of increasing price of energy, considering the future forecast as well, represents a valid driver for the development of energy efficient ICT solutions, as the EDISON one

Political drivers are needed to improve financial opportunities through strengthening the regulatory framework for energy efficiency to stimulate more and more effective investments, improving access to financing.

Market & Competitors

- The market of public and private entities that can adopt the EDISON ICT solution is large, especially thanks to its peculiarity of being able to be implemented in any type of building, both in energy retrofitting actions and in new buildings construction
- The ICT solution can be marketed through many intermediaries such as: Energy efficiency general contractors, ICT solutions & BEMs providers, ESCOs, Utilities, etc.
- There is a large number of ICT tool providers for energy consumption awareness and management (including control) at building level, but the solutions for energy saving at dwelling level, targeting individual consumers, are still in the early phases of their development
- The building lighting transformation towards LED illumination is occurring more rapidly than it did for other lighting technologies, such as fluorescent and compact fluorescent lighting. With decline in prices of LED packages and availability of higher LED efficiency in terms of luminosity, the LED market is growing quickly
- According to this scenario, the EDISON ICT solution, compatible with almost all the LED lamps available on the market and operating with a power supply module external to the lamp body, has great possibilities to be applied in large scale
- The smart meters roll-out can boost the wide spread of the ICT solutions

- Lighting control systems, widely used on both indoor and outdoor lighting of commercial, industrial and residential spaces, offer concrete opportunity of managing lighting systems and reducing energy consumption; the solutions today available on the market, based on direct (230Vac) retrofitting actions, are not often respecting the rules, because the fixtures were not certified for LED but for neon or CFL lamps, operating at 230Vac.
- In order to be successful in the energy efficiency market, EDISON partners should stress key differentiation aspects of the EDISON solution in respect to the ones proposed by competitors, and should identify new efficient channels for commercialization in each market sector addressed

Strategy for commercialization

The Exploitation Plan set out strategies and techniques that the Consortium use and will use in order to make EDISON project a successful and replicable solution.
In particular the goal of the Consortium has been to provide :

1. the guidelines for the Edison platform integration and installation, including the list of the most appropriate ICT components and LED lamps;
2. a simple business plan that could be easily customized to the requests of the building manager;
3. the list of partners supplying the components (BKT, TSI, TOM, ENSO);
4. the list of partners providing the integration of the platform and the technical assistance (TSI, SIE, SMK, TOM, ENSO).

- The exploitation activities conducted by the EDISON Consortium are addressed to guarantee a strong cooperation with the Public Authorities (PAs) that intend to improve Energy Efficiency in their buildings stock, thereby forming a Public-Private Partnership (PPP). In that sense, actions have been promoted by ANCI and ANCITEL in Italy (in progress), by AICCRE in Europe (in progress) and other PA associations contacted by the Consortium (e.g. German Association of CEMR, RGRE), through the financial support of the ESCOs associated to the Consortium
- EDISON partners have looked into the most appropriate business models which can be used, complemented with feasibility studies, in order to ensure a wider adoption of the ICT solution beyond the end of the project

- Traditional business models, such as ownership model (direct purchase of the system by the owner), can be applied, but also Energy Performance Contracts(EPCs) to support the expenses linked to lighting efficiency action of Public Entities are considered.
- Intensive awareness and dissemination campaigns are necessary in order to inform Public Entities of the benefits derived from the establishment of an EPC, like:
    - the avoidance of upfront costs through third-party financing or on-bill repayment schemes
    - payment is on results allowing the transfer of technical risk from the public partners to the ESCO
    - economic efficiency, through the installation of ICT systems and controls, reducing utility bill costs and providing a funding source for building renewal projects
    - offer complete energy services (called "life-cycle approach" in PPP terms), including marketing, design capability, installation, financing, maintenance and measurement of energy management technologies
    - offer shared-savings contracts (called "payment mechanisms" and "incentives" in PPP terms) where clients effectively pay for energy services from a portion of the actual energy bill savings
- Identification of appropriate subjects for the commercialization of the solution under the EDISON brand, whose main task is to carry out preliminary actions in order to support the exploitation phase, like:
    - identify cheap commercial products responding to the EDISON requirements in order to propose a more attractive solution to the target audience
    - pave the way to the marketing of EDISON solution as an "integrated solution", demonstrating through dissemination actions that the ICT components (and the DC power supply specifically) contribute to energy saving significantly, on the basis of consolidated energy saving data
    - emphasize EDISON system main advantages for users and business developers
- IPR issues among the partners have been clearly defined together with a specific definition of products/services to be exploited, time to market, targeted customers, routes for exploitation and associated business models
- Ideally, the installation of the ICT solution should be decided in the design phase of new buildings. For this purpose, appropriate actions with the prescriptors (architects, engineers and owners) will be undertaken.

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