# ECO net

low Energy COnsumptionNETworks

# DELIVERABLE D7.7

## THIRD ECONET INFORMATION DISSEMINATION PLAN

| Grant Agreement Number: | **258454** |
|---|---|
| Project Acronym: | **ECONET** |
| Project Title: | **low Energy COnsumption NETworks** |
| Funding Scheme: | Collaborative Project |
| Starting Date of the Project: | 01/10/2010 *dd/mm/yyyy* |
| Duration: | 36 months (original), 39 months (amendment request) |
| Project Coordinator: | Name: Raffaele Bolla<br>Phone: +39 010 353 2075<br>Fax: +39 010 353 2154<br>e-mail: raffaele.bolla@unige.it |

| Due Date of Delivery: | M39 *Mx* (31/12/2013 *dd/mm/yyyy*) |
|---|---|
| Actual Date of Delivery: | 24/01/2014 *dd/mm/yyyy* |
| Workpackage: | **WP7 – *Dissemination, training and standardisation*** |
| Nature of the Deliverable: | R |
| Dissemination level: | PU |
| Editors: | WUT, CNIT, ALU, MLX, TEI, TELIT, GRNET, NASK, DCU, VTT, NVR, LQDE |
| Version: | 1.0 |

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# Table of contents

# 1. Executive summary

This document contains the third year update of the dissemination plan for the ECONET project. The plan aims at promoting scientific and technical progress in low energy consumption networks related research, communicating project results to the widest possible audience, supporting the implementation of project results and fostering their impact on the European society.

Dissemination activities follow the ECONET communication strategy and implement actions raising the awareness and maximizing the adequate exploitation of project results, communicating the vision and the goals of the ECONET project and promoting a novel standard for green networking. Specifically, the dissemination strategy of ECONET includes:

- Liaison with related research initiatives and expert working groups

- Contacts with standardisation bodies

- Cooperation with other RTD initiatives

- Creation and maintenance of a public website

- Media relations (press conferences, press releases at appropriate time-points)

- Scientific publications in leading scientific journals

- Talks and lectures at national and international conferences

- Seminars targeting interested companies, academic groups and/or stakeholders

- Dialogue with policy makers, stakeholders, citizen's associations, to demonstrate benefits for the industry and community

The purpose of this document is to give the description of the activities in 2010-2013 concerned with transfer of knowledge about ECONET project results and technologies to the public, stakeholders, potential users, experts from industry and research, and the third overview of the dissemination roadmap. The information included in the deliverables D7.3, D7.5 and D7.6 was modified in the course of the project development due to the natural progress of the research. The dissemination and training events were extended to focus on more practical information related to the active exploitation.

# 2.  Dissemination activities

## 2.1  *Liaisons with related research activities and expert working groups*

The ECONET partners, along the whole duration of the project, have activated cooperation initiatives with the following projects, organizations and communities:

- "Energy-Aware Radio and neTwork technologies – EARTH" project, funded by the European Commission (EC), linked by the ECONET partners ALU and TELIT[*].
- "Green Touch" initiative by Bell Labs of Alcatel-Lucent, linked by the ECONET partner ALU. The cooperation has been exploited by informing and updating the GT group about ECONET and its topics and results with specific presentations and seminars (see Sect. 2.9.1)
- "ICT for Energy Efficiency – ICT4EE" forum, linked by the ECONET partner TELIT.
- Future InterNet Energy Efficiency (FINE 2), project funded by the Italian Ministry of Foreign Affairs for supporting collaborations with USA research entities and realized by CNIT with Portland State University and the University of South Florida.
  o Portland State University (PSU) as collaborating institution has concretized the relationship with contributions inserted in common publications with the consortium (see the list of publications), a visiting period of Prof. Suresh Singh and one of his PhD student, and a period at PSU of a Genoa/CNIT PhD student (see Sect. 2.9.1).
- "Towards Real Energy-efficient Network Design – TREND" Network of Excellence (NoE), funded by the EC, linked by the ECONET partner CNIT. The cooperation has been exploited by the common effort in events such as cross participation and presentations at internal meetings of both projects, and in common events organized by one of the partners (see Sect. 2.7.1).
- "Cognitive radio and Cooperative strategies for POWER saving in multi-standard wireless devices – C2POWER" project, funded by the EC, linked by the ECONET partner LQDE. The cooperation has been exploited by the common participation in events (see Sect. 2.9.1).
- Generalised Architecture for Dynamic Infrastructure Services – GEYSER, linked by the ECONET partners TELIT and CNIT.
- Scalable, Tuneable and Resilient Optical Networks Guaranteeing Extremely-high Speed Transport– STRONGEST, linked by the ECONET partner ALU. The cooperation has been exploited by the common participation in events (see Sect. 2.9.1).
- "The green GÉANT team – GN3 project", co-funded by European National Research & Education Networks (NRENs) and the EC, linked by the ECONET partner GRNET. GRNET is disseminating ECONET work within the team and also takes the responsibility of the liaison between the two projects.
- "ECONHOME" project, French national funded initiative contacted by TELIT and LQDE through HGI and Sagemcomm members. The collaboration has been exploited by means of some discussion and a remote common meeting (see Sect. 2.9.1).
- NetFPGA Community to promote ECONET activity on NetFPGA in the research community, by means of a liaison managed by LTH and DCU.

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[*] Up to the conclusion of this project, i.e. June 2012.

- Future Internet Cluster; the ECONET project has participated in the initiative of these EU clustering activities by contributing to organized events with presentations and proposals (see Sect. 2.7.1).
- IEA (International Energy Agency), an autonomous organisation that works to ensure reliable, affordable and clean energy for its 28 member countries and beyond. The IEA's four main areas of focus are: energy security, economic development, environmental awareness, and engagement worldwide. It has been contacted by TELIT and CNIT and some preliminary discussions have been done for future collaborations.
- Strict relationships with ITU-T, ETSI, HGI, JVRS, EU-JRC entities were also created; however, these institutions being standardization bodies the ECONET liaisons with them were specifically reported in the deliverable D7.6 and in Sect. 1.2 in this document.

For each of these projects/initiatives one or more partners take the responsibility of the liaison throughout the project duration.

The cooperation with such initiatives, forums and RTD project aims at:

- Exchanging and comparing perspectives on next-generation energy-efficient networks, technical knowledge and results and main achievements.
- Creating synergies for enhancing the impact on standardization bodies in an as much as possible effective way.
- Participating in forum activities (e.g., ICT4EE) in order to create consensus and common visions and make the impact on standardization easier.
- Creating inter-workable energy-efficient solutions, protocols and technologies for future networks (e.g., between ECONET wired solutions and EARTH wireless ones).
- Organizing and/or participating in common events, workshops and open panels/discussions in order to maximize the impact and the soundness of EC efforts in the field of energy-efficient Information and Communication Technology (ICT).

The final part of the project dissemination activities was oriented to support new projects or to "fertilize" new proposals in the field. For this purpose, both a number of events (such as workshops and congresses) and direct contacts created by the partners have been used.

In particular, two of the most relevant events that have been realized with (also) this aim were the **24th Tyrrhenian International Workshop on Digital Communications (TIWDC 2013)**, held in Genoa from 23rd to 25th September 2013, organized by CNIT and supported by ECONET, and the **Green and Energy-efficient Networking Workshop**, realized by ECONET jointly with the GreenTouch initiative and the TREND project at the Future Networks 12th FP7 Concertation, the 22th October 2013. TIWDC, among others, hosted as keynote speaker Dr Chip Elliott, the Principal Investigator for GENI [1], a USA nationwide suite of experimental infrastructure being created by the National Science Foundation for at-scale research in future Internet architectures, services, and security. During the congress, concrete relationships have been consolidated among GENI and ECONET partners with the perspective of future possible collaborations.

Regarding interactions with new projects by means of partners, ALU has created links with two new projects related to energy efficiency in the ICT field in which it is involved, namely:

- COMBO [2]
- IDEALIST [3]

The first one started at the beginning of 2013 and it is focused on the convergence of fixed and mobile networks themselves, combining both an optimal and seamless quality of experience for the

end user together with an optimized network infrastructure ensuring increased performance, reduced cost and reduced energy consumption. To achieve this target, COMBO proposes and investigates new integrated approaches for Fixed/Mobile Converged (FMC) broadband access/aggregation networks for different scenarios (dense urban, urban, rural).

The COMBO architecture is based on joint optimisation of fixed and mobile access / aggregation networks around the innovative concept of Next Generation Point of Presence (NG-POP). This leads to a better distribution of all essential functions, equipment and infrastructures of convergent networks.

Instead, the motivation and key objective behind IDEALIST is to research in detail the most promising technology to meet the demands of the next generation optical transport network. It started on 2012 proposing an elastic optical network architecture, based on the combination of new technologies such as BVT (Bitrate Variable Transponder), *flexgrid* transmission and switching technologies, capable of fulfilling the requirements in terms of capacity and dynamicity of future core networks. The intention is that the elastic optical network proposed and developed in IDEALIST will be easily standardized and industrialized. Network architecture design: multilayer-network optimization tools enabling both off-line planning and on-line re-optimization in elastic optical networks.

In addition, IDEALIST aims at designing and developing innovative transport solutions, compatible with new bandwidth consuming applications (e.g. 3D video, cloud, etc.) based on elastic optical networks equipped with a multi-domain and multi-technology control plane enabling adaptive networking and service interworking. The advantages of this architecture are:

- Reduced Total Cost of Ownership (TCO)
- High scalability and flexibility
- Guaranteed end-to-end performance and survivability
- Increased energy efficiency

## 2.2  *Future plan*

Given that most of the above-mentioned projects are coming to completion more or less in the same period of ECONET, the future plan is focused on two main aspects:

- Continue the promotion of project results through new standardization activities such as, for example, the GAL one, for which, in addition to being published as ETSI Standard in the first part of 2014, a new proposal is expected to be submitted to the ITU-T (see Section 2.3 for more details).
- Use the results derived from the joint activities with the other projects mentioned above (like TREND) in order to support new projects and/or initiatives where energy efficiency in the ICT sector has a significant role, with a specific attention to the COMBO and IDEALIST projects.

## 2.3  *Standardization*

The present section describes the main actions of the ECONET project towards standardization bodies and forums, as well as the possible future actions after the end of the project.

Subsection 2.3.1 contains a general recap of the main goals and scheduled activities for the entire three-years of the project. The general reports D7.4 [4], D7.5 [5] and, in particular, D7.6 [6] include most of the standardization info related to the first two years. As described in D7.6, the ECONET

partners selected four organizations as main targets for focusing and finalizing the outcome of project activities in this area:

- European Telecommunications Standards Institute (ETSI) [7]–Technical Committee (TC) Environmental Engineering (EE) [8]
- International Telecommunication Union (ITU) [9] Telecommunication Standardization Sector (ITU-T) [10]
- Home Gateway Initiative (HGI) [11]
- European Commission (EU) –Joint Research Centre (JRC) [12]

Finally, Section 2.3.2 reports in detail all the main specific actions/initiatives carried out toward these institutions. Such actions/initiatives include:

- Contributions and liaisons towards standardization working groups. In particular, the main topics brought to the attention of the selected organizations are:
    - Standardization of the Green Abstraction Layer (GAL) by the ETSI TC-EE
    - Network Connection Proxy (NCP)
    - Suggestion of requirements for the Code of Conduct on Broadband Equipment (BB-CoC) [13] owned by EU-JRC
- Participation in conferences and workshops specifically oriented to standardization activities and contributions, typically organized by the relevant standardization bodies.

## 2.3.1  Goals and Scheduled Actions towards Standardization

One of the goals of the ECONET project is to bring its main outcomes into the most relevant standardization bodies. The importance of this objective is that the standardization typically represents one of the most effective ways to speed up the finalisation of products/services. In particular, this fact is true for the improvement of energy efficiency in telecommunication networks.

In the last recent years, the topic of energy efficiency and sustainability has gained an ever-growing attention on the part of quite a few stakeholders, especially considering the huge rise in the energy costs. More specifically, this behaviour has led to a plethora of initiatives in many different areas (fixed and mobile access networks, core networks, data centres, office buildings, etc.) by standardization bodies and industrial forums, as shown in the GeSI [14] standardization map.

Considering the limited resources involved in the ECONET project, there has been the need to perform an analysis covering:

- Main focus area
- Degree of commitment
- Strategic weight
- Existing connections with the ECONET partners.
- A large part of partners of the ECONET consortium already acts in standardization groups, bodies and industrial forums as first-rank players and many of them are working on their own in the field of energy-efficient protocols and network architectures. Table 1 shows the ECONET partners that contribute to standardization bodies and industrial forums

**Table 1. Contributions of ECONET Partners to standardization bodies and industrial forums.**

| Standardization bodies and industrial forums | | Partners |
|---|---|---|
| ETSI | linked by ECONET | CNIT |
| | | ALU |
| | | GRNET |
| | | LQDE |
| | | TEI |
| | | TELIT |
| ITU-T | linked by ECONET | CNIT |
| | | LQDE |
| | | ALU |
| | | TEI |
| | | TELIT |
| ETNO/HGI | linked by ECONET | LQDE |
| | | TELIT |
| ATIS | linked by ECONET | ALU |
| | | TEI |
| | | TELIT |
| Broadband Forum | linked by ECONET | LQDE |
| | | TEI |
| | | TELIT |
| GeSI | linked by ECONET | TELIT |
| EU BB-CoC Group (for version 5) | liaised by ECONET | LQDE |
| | | TELIT |

As described in the previous subsection, the ECONET project selected four organizations: ETSI, ITU-T, HGI and EU-JRC. While the first three are indeed standardization bodies, the latter has anyway been taken into account considering that the JRC is the owner of the BroadBand-Code of Conduct (BB-CoC), which is an European document containing the power consumption targets for fixed and wireless broadband access network devices. Such document is a reference in Europe as far as the power consumption targets are concerned. The EC-JRC has been selected within the above shortlist considering that the performed analyses, the different prototypes of energy-aware equipment and, last but not least, the technologies of dynamic consumption adaptation and smart standby defined and tested within the ECONET project enable the elaboration of proposals concerning future devices in terms of power consumption targets and characteristics.

Starting since the end of 2011, the ECONET project performed many actions towards the selected organizations with relevant results. Figures 1, 4, 5, and 6 summarizes the schedule involving all the three years of the ECONET project, while the remaining part of this section provides the details of these actions.

## 2.3.2 Standardization Activities Performed by the ECONET Project

The following subsections describe the most important actions performed by the ECONET consortium during all the three year of the project towards the ETSI EE, ITU-T, .HGI, and EU-JRC standardization bodies, respectively.

### 2.3.2.1   ETSI EE

ETSI produces globally applicable standards for the ICT, including fixed, mobile, radio, converged, broadcast and Internet technologies. It is an independent, not-for-profit organization based in the technical park of Sophia Antipolis in the south of France. It is committed to serving its members (more than 700 member organizations drawn from 62 countries worldwide) and to assisting in the development of their market potential. The European Union (EU) officially recognizes ETSI as a European Standards Organization (ESO).

This body is also active in vital areas related to standardization such as interoperability, including protocol testing and methodology, and offering forum-hosting services. ETSI members include Manufacturers, Network operators, National Administrations, Service providers, Research bodies, User groups, Consultancies. The ETSI standards cover different areas in mobile, fixed, and radio communications. The most important ones are:

- Security, Satellite
- Broadcast
- Human Factors
- Testing & Protocols
- Intelligent Transport
- Power-line Telecoms
- eHealth
- Smart Cards
- Emergency Communications
- GRID & Clouds
- Aerospace

The ETSI Technical Committee "*Environmental Engineering*" (ETSI TC-EE) covers four main areas of responsibility in standardization for ICT:

- Specifications for environmental and infrastructural aspects for telecommunication equipment and its environment (WG-EE1)
- Specifications of power supply interface requirements and grounding for telecommunication/data-communication equipment (WG-EE2)
- Specifications for mechanical structure and physical design of telecommunication equipment
- Eco-Environmental affairs (WG-EEPS)

For more details about the areas covered by the ETSI EE, see its official web site [8] and report D7.6.

In addition, ETSI EE produces deliverables on energy efficiency of ICT, specifically for equipment in wire-line and wireless broadband access, customer premises, core network, transport, switching and routing. ETSI EE produces deliverables on environmental impact assessment of ICT, too. Finally, ETSI EE works in liaison with the other main standardization bodies such as ITU-T Study Group 5 (SG5) and ICT&CC [15], ATIS-NIPP [16], CENELEC [17], IEC TC111 [18], BBF[19], HGI [11], 3GPP [20], GSMA [21], BRAN [22], IETF EMAN [23], GeSI [14], EU Research projects [24], and EC-JRC.
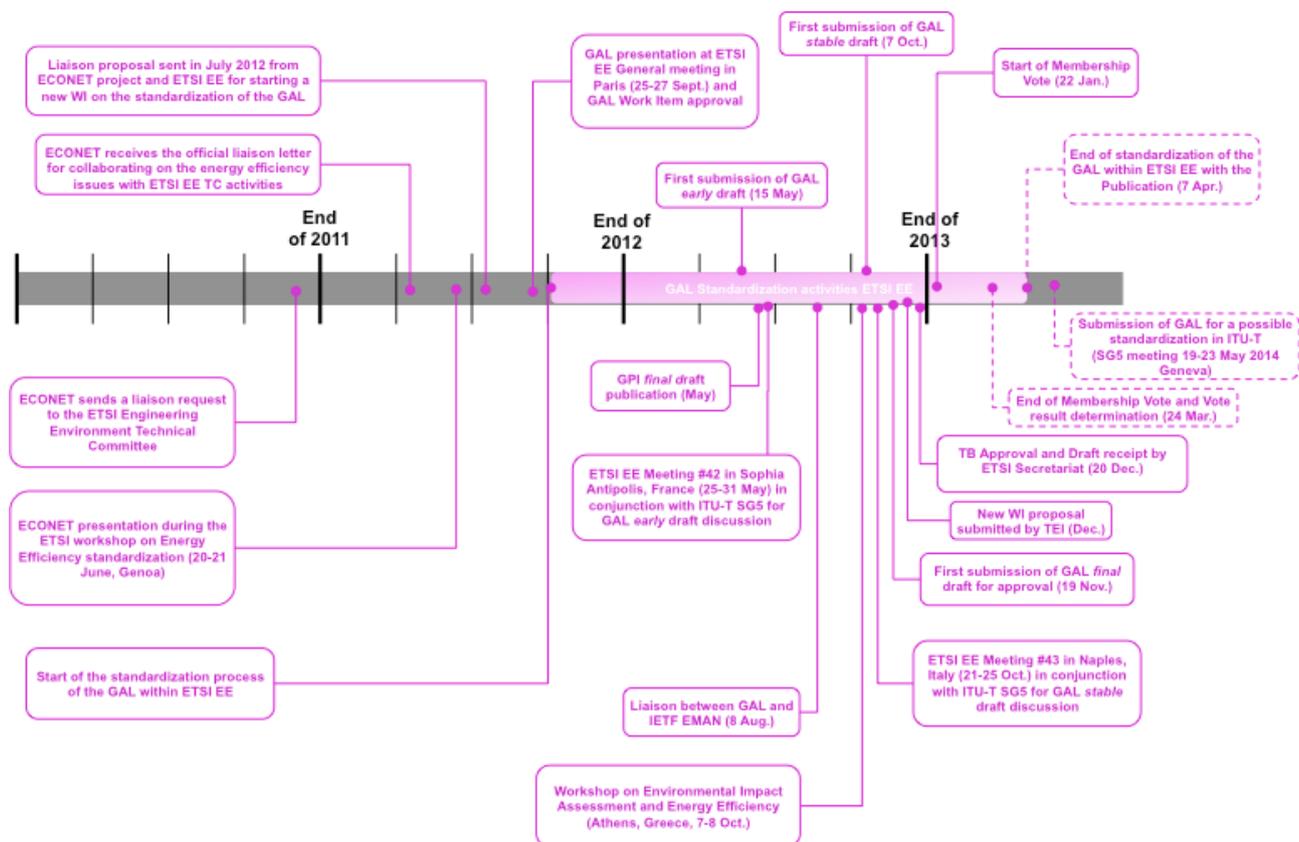


**Figure 1 – Schedule of the main actions performed by the ECONET project towards the ETSI EE standardization body.**

Figure 1 shows the main actions performed towards this standardization body during all the three years of the project. The first contacts of ECONET with ETSI date back to the very beginning of the project with the ETSITC-EE. In November 2011, an official request finalized the creation of a liaison between the ETSITC-EE and the project. The request was accepted in March 2011 with an official liaison letter from the EE Chairman Mr. Beniamino Gorini (see Fig. 3 of D7.6). In the beginning of 2011, Prof. Raffaele Bolla was invited to participate in the ETSI Specialist Task Force (STF) 439 charged with developing a standard for "*Global Key Performance Indexes (G-KPIs) for energy efficiency of broadband Deployed*".

Four experts composed this STF, and Prof. Bolla, together with their personal knowledge and experience, was explicitly bringing the collective experience and the proposals of the project in this context. The first phase of the work finished at the beginning of 2013. It included the general

definition of G-KPI concepts and the specific definitions for data centres and cellular radio access. The output of this phase was the publication of the standard in two different drafts: "*Global KPIs – Part 1: General Requirements*" [25], and "*Global KPIs – Part 2: Specific requirements – Sub-part 1: Data centres*" [26]. The publication of these requirements was made in May 2013.

Instead, the second phase, focused on fixed networks, was not realized. For this reason, ETSI TC-EE-expected to request a new ETSI STF specifically conceived for the second phase of the G-KPI standard development. Also for this SFT, if the request will be accepted, Mr. Beniamino Gorini, as EE Chairman, would make the official creation of a new liaison between ETSI TC-EE and the ECONET project through the drafting of a new liaison letter.

During the first phase of the relationship with the ETSI TC-EE, Prof. Bolla and some of the partners of the project involved in this group (from TELIT, ALU and ETI) contributed in the organization of the first ETSI Workshop on Energy Efficiency [27], which took place on the 20th-21st of June 2012, in Genoa, Italy. The University of Genoa hosted such workshop with official support of the ECONET project. The workshop emphasized the design and the use of ICT to reduce the environmental impact. In addition, it enabled the 80 delegates to share views on ongoing work on energy efficiency standards in ETSI and among other Standards Development Organizations (SDOs) and research projects, with the purpose to identify any potential gaps and overlaps and future requirements for the energy efficiency standardization of ICT equipment and networks. It is worth to highlight, among all the activities performed, the concept of the GAL introducing for the very first time the proposal for its standardization. Such proposal has been positively welcome, both by the Workshop attendees and by the ETSI TC-EE and therefore a specific liaison request was sent on the 18th of July 2012.

As introduced above, another output of the ECONET project was the GAL standardization. Prof. Bolla was invited to participate in the ETSI TC-EE meeting held in Paris on 25th-27th of September to present the GAL standardization proposal in more detail. During the meeting, this proposal was deeply discussed by the board members and, finally, the creation of a specific ETSI Work Item (WI) for the GAL standardization was approved.

The 28th September 2012, the ETSI Work Group (WG) / Technical Board (TB) created the WI with the official name DES[†]/EE-0030. The selected rapporteur was Prof. Bolla (the coordinator of ECONET), while Mr Marcello Pagnozzi was designated as Technical Officer (TO).

The GAL is an architectural interface/middleware that will give flexible access to the power management capabilities of future energy-aware telecommunication fixed network nodes. The WI defines the GAL design interface with the purpose of effectively exploiting the capability of adapting the energy consumption of the network nodes with respect to the load variations.

The main objective is to standardize the interface between the network control processes specifically designed for energy efficiency purposes and the power modulation capabilities of network devices. In particular, the GAL considers three principal aspects:

- Making explicit the trade-off between energy consumption and network performance.
- Mapping the power consumption of the hardware blocks with virtual and logical network resources.

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[†] Draft ETSI Standard.

- Hiding the details and complexity of internal power modulation mechanisms.

In this respect, the GAL shall be composed of two main parts:

- Green Standard Interface (GSI) that exchanges power management data among data-plane elements and processes realizing control plane strategies in a simplified way.
- Energy Aware States (EASes), which describe the different configurations and corresponding performance with respect to the energy consumption of the devices.

Instead, the WI contains:

- Definition of the GAL general architecture (Figure 2);
- Definition of the interoperable interface (GSI) between the energy-aware control processes (NCPs and LCPs – Local Control Policies) and the power management capabilities of the fixed network devices (Figure 2);
- Definition of the EASes describing the different configurations and corresponding performance with respect to the energy consumption of the devices (Figure 3).
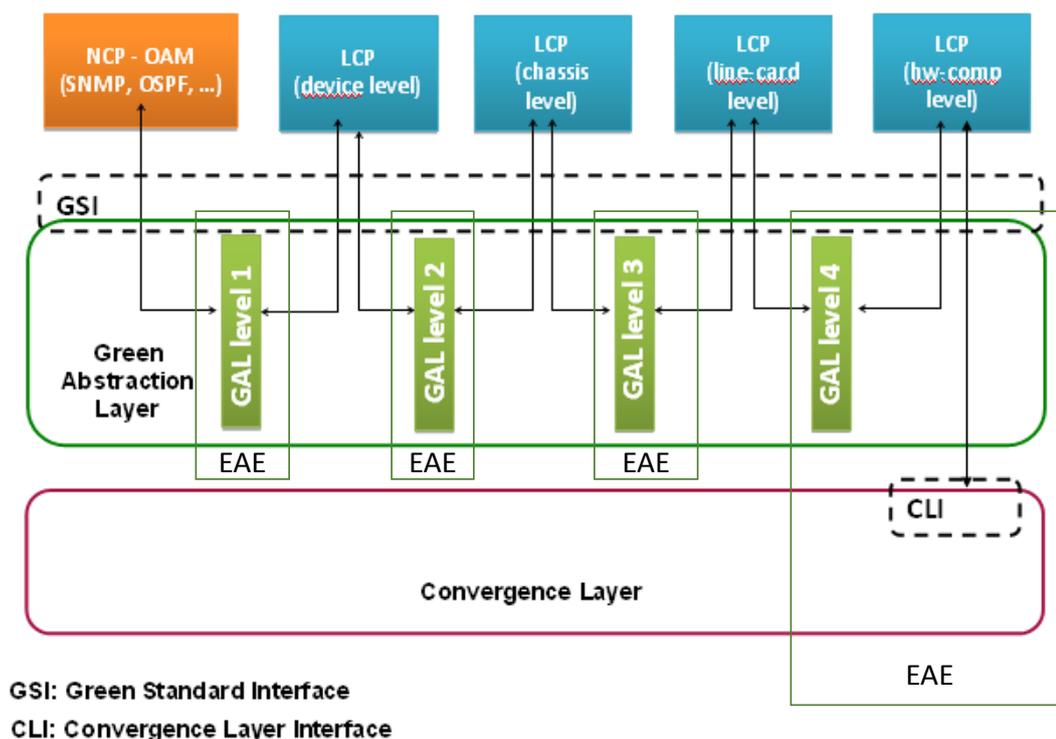


**Figure 2 - GAL architecture.**

For more details about the GAL definition and implementation (including prototypes), see the reports D4.1 [28], D4.2 [29], and D4.4 [30].
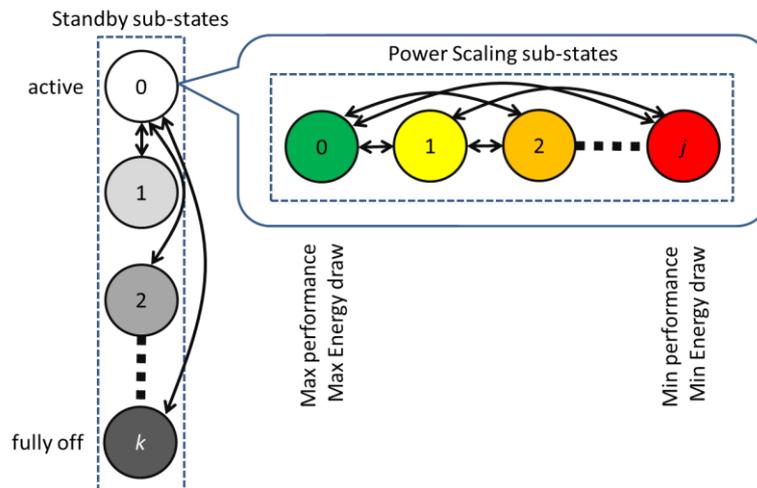
**Figure 3 - Organization of the Power Scaling and Standby States composing EASes.**

Table 2 shows the GAL WI schedule with the most relevant events. Prof. Bolla submitted the first contribution, derived mainly from the ECONET work, as early draft (version 0.0.1) on 15th May 2013. The ECONET partners supporting this WI were ALU, TELIT, TEI, CNIT, and GRNET. In addition to these partners, other participants contributed to this WI including the interactions with other related standards in the area of the ICT energy efficiency (e.g., IETF EMAN, see later on).

**Table 2. Details of WI Schedule with the current status in green and the next ones in red.**

| Event | Date |
|---|---|
| **WI Creation by WG/TB** | **28th September 2012** |
| **Early draft (version 0.0.1) submitted** | **15thMay 2013** |
| **Early draft (version 0.1.2) submitted** | **20thJune 2013** |
| **Liaison with IETF Energy Management (EMAN)** | **8th August 2013** |
| **Stable draft (version 0.7.1) submitted** | **7th October 2013** |
| **Stable draft (version 0.7.2) submitted** | **25th October 2013** |
| **Final draft for approval (version 0.7.3) submitted** | **19th November 2013** |
| **Final draft for approval (version 0.7.4) submitted** | **27th November 2013** |
| **TB approval** | **20th December 2013** |
| **Draft receipt by ETSI Secretariat** | **20th December 2013** |
| **Start of Membership Vote** | **22nd January 2014** |
| **End of Membership Vote** | **24th March 2014** |
| **Vote result determination (adopted)** | **24th March 2014** |
| **Publication** | **7th April 2014** |

From 27th to 31st May 2013, Prof. Bolla was invited to participate as WI rapporteur in ETSI EE Meeting #42 held in Sophia-Antipolis, France in conjunction with ITU-T SG5. In this meeting, the partners contributed to the discussion for the preparation of a new GAL draft. Indeed, following these discussions, a new version (0.1.2) was updated the 20th June 2013, again as *early* draft.

In addition, the meeting was also useful to interact with proponents of other relevant standardization in the area of the energy-management for telecommunications infrastructures.

One of these related standard initiatives was the IETF Energy Management (EMAN) [23, 31]. The EMAN addresses a different (larger) range of devices with respect to the GAL and it is oriented towards the collection of detailed data about the consumption and power states of the devices but not to the power control of them. Nevertheless, given the different objectives, the GAL and the EMAN proposals can be implemented within the same network and even in the same device with little effort. In particular, the GAL might be applied "above" and/or "below" the EMAN to bind hardware and virtual/logical resources. In addition, given that the information model of EMAN allows the use of existing power states and describes a suggested set of states for control, administrators can use these states to create autonomic control systems for energy-aware applications by means of the GAL interface.

With these meetings, an operative relationship with EMAN (IETF) started with the purpose to better define the interactions between the two standards and to receive indications for GAL potential improvements. The outcome of some common virtual calls was the preparation of a Liaison on the theme of energy efficiency monitoring in telecommunication network infrastructures between the two standards submitted by ETSI TC-EE on 8th August 2013 [32]. Moreover the EMAN group proposed some modifications to the GAL definition with the aim (among others) to make it more compatible with EMAN definitions. The proposals were discussed and refined inside the WI group and most of them finalized and finally inserted in a new GAL draft. J. Parello, Beinot Claise, N. Brownlee and B. Nordman from the EMAN working group expressed their definitive appreciation for the common work and the obtained results.

At this stage, GRNET, with the support of ECONET, hosted the 2nd ETSI workshop on Environmental Impact Assessment and Energy Efficiency that took place on 7th-8[th]October 2013, in Athens, Greece. Among the participants, Prof. Bolla, and the ETSI TC-EE Chairman, Beniamino Gorini as part of the Programme Committee attended this workshop, too. In this context, effectively disseminated by ETSI (together with the ECONET support, see http://www.etsi.org/images/files/ETSInewsletter/etsinewsletter_sept2013.pdf at the bottom of page 15), Prof. Bolla presented the status of the GAL standardization initiative, including the exchanges with EMAN to the many attendees of the Workshops, by obtained very positive feedback and support indications.

In the month of October 2013, from 21st to 25th, another ETSIEE Meeting (#43) was held in Naples, Italy, in conjunction with ITU-T SG5. Also in this meeting, Prof. Bolla participated as WI rapporteur together with some partner delegates (from Telecom Italia, Ericsson and Alcatel). The main result of this meeting was the definition of a *stable* GAL draft. Indeed, on the 25th October 2013, at the end of the meeting, a new version (0.7.2) was submitted as *stable* draft.

The next month was used for the finalization of the *final* draft submitted on 19th November 2013. With the final draft submission, the GAL WI changes its denomination to ES[‡] 203 237. Immediately after the submission, the document was opened to the approval by the partners involved in the standardization. Any change must be notified and updated in order to complete this

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[‡] ETSI Standard.

approval step. Precisely for this reason and as a result of a change request, a new version (0.7.4) has been re-submitted on 27th November 2013 [33] for the TB approval.

The process of the TB approval successfully ended on 20th December 2013. The same day, the ETSI Secretariat started the formal revision phase with the rapporteur and the *final* standard version was emitted on 21st January 2014.

The final voting phase of the ETSI Membership began on the 22nd January 2014, and it will end on 24th March 2014 with the results of these votes. The publication of the draft standard is scheduled for 7th April 2014.

Additionally, at the end of year, a WI for a new deliverable on the energy aware measurements was presented by TEI with the support of ECONET. The idea of this WI consists on the adaptation of the performance and power consumption according to the traffic load. Actual energy-efficiency measurement procedures are unsuitable to determine the equipment's ability to adapt performance and power consumption to traffic load needs; hence, a novel measurement method is required. The WI will focus on fixed access and transport nodes. It was explicitly supported by TELIT, CNIT, Telecom Italia and Alcatel from the ECONET project.

### 2.3.2.2   ITU-T

Study Group 5 (SG5) is the ITU-T Study Group in charge of studies on methodologies for evaluating the ICT effects on climate change and publishing guidelines for using ICT in an eco-friendly way. SG5 is also responsible for studying design methodologies to reduce environmental effects, for example recycling of ICT facilities and equipment.

In addition to its activities focused on climate change, the recommendations, handbooks and other publications produced by SG5 have four main objectives:

1. Protect telecommunication equipment and installations against damage and malfunction due to electromagnetic disturbances, such as those from lightning. In this field, SG5 is the most experienced and competent standardization body.
2. Ensure the safety of personnel and users against currents and voltages used in telecommunication networks.
3. Avoid health risks from Electromagnetic Fields (EMF) produced by telecommunication devices and installations.
4. Guarantee a good QoS for high-speed data services, by providing requirements on characteristics of copper cables and on the coexistence of services delivered by different providers.

An energy-efficient one-charger-fits-all new mobile phone solution is the most well-known output of SG5 in the last recent years. Every mobile phone user will benefit from the new Universal Charging Solution (UCS), which enables all future handsets, regardless of make and model, to use the same charger.

Several outcomes of the ECONET project have been brought into the ITU-T towards SG5, JCA-ICT&CC, as well as different Workshops and Symposia. In particular, the first contacts with ITU-T SG5 happened with the occasion of the ITU-T Workshop "*Moving to a Green Economy through ICT Standards*" held in Rome in September 5–9, 2011 [34]. TELIT hosted such Workshop with the purpose of bringing together leading specialists in the field, from top policy-makers to engineers, designers, planners, government officials, regulators, standards experts and others. Its main purpose was to raise awareness of the importance and opportunities of using ICT standards to build a green economy.
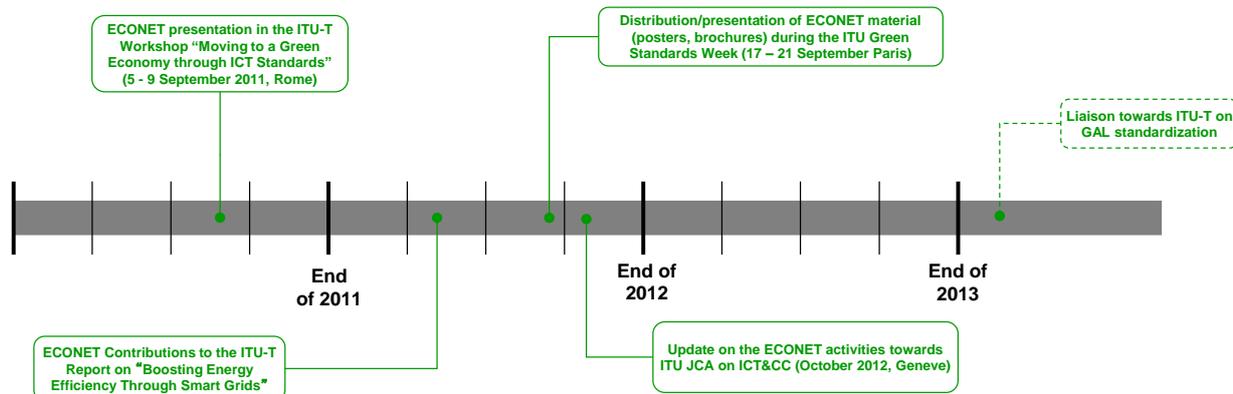
**Figure 4 – Schedule of the main actions performed by the ECONET project towards the ITU-T standardization body.**

The body of the talks comprised three workshops:

- Methodologies for Environmental Impact Assessment of ICT, jointly organized with the European Commission.
- Moving to a Green Economy through ICT Standards, jointly organized with TELIT.
- Submarine Cables for Ocean/Climate Monitoring and Disaster Warning: Science, Engineering, Business and Law, organized with the World Meteorological Organization (WMO) and UNESCO.

In particular, the second workshop had Prof. Raffaele Bolla as speaker from the ECONET Project, who had the opportunity to describe the Project and its main outcomes.

After this first successful workshop, the cooperation of the ECONET project with ITU-T was enforced through the ITU-T Report on "*Boosting energy efficiency through smart grids*" [35]. Such report has been officially released in September 2012 with a discussion of the role of ICT in the smart grid, a view of energy efficiency, and the ultimate goal of hindering climate changes. To this purpose, several power consumption estimations have been provided using the previous ECONET evaluations to assess the energy footprint of ICT for Smart Grids.

Moreover, also in these workshops, the definition of the GAL was highlighted as suitable abstraction to represent energy-aware capabilities of the device (or its components) toward the network control plane. The report also emphasises the risks that, without careful action, ICT for Smart Grids could add up very high-energy consumption, in particular at the customer premises. ECONET activities can prove to be applicable to the Smart Grid environment, too.

The third opportunity for the ECONET project to be promoted within ITU-T happened thanks to the 2nd ITU Green Standards Week, held in Paris on September 17–21, 2012 [36]. In this occasion, a distribution/presentation of ECONET materials (posters, brochures) was organized. For more details, see the D7.6 report.

During the Eleventh Meeting of JCA on ICT and Climate Change dedicated to "Climate Change Adaptation and ICTs" in Geneva on 11th October 2012, Prof. Bolla and Ing. Griffa (from Telecom Italia) presented the ECONET project to the participants.

During the already cited Joint ITU-ETSI meetings #42 and #43 in Paris and Naples, and during the 2012 and 2013 ETSI Workshop on Energy Efficiency a representation of the projects discussed with the reference people from ITU (e.g., Mr Ahmed Zeddam and Ms Cristina Bueti) about the opportunity of submitting the GAL also in the ITU context. This discussion was extended to an

email exchange with the final general agreement for submitting a proposal (on the part of Telecom Italia) just after the ETSI final acceptance of the standard.

### 2.3.2.3   HGI

The major Broadband Service Providers (BSPs) founded the HGI forum in 2004. Leading vendors of digital home equipment joined this forum, which is working on how to deliver IP services to the home. The HGI publishes requirements for digital home building blocks. Those building blocks are the hardware and software in the digital home that connect consumers and services including:

- Home Gateways (HGs)
- Home Networks
- Home Network Devices

The HGI welcomes BSPs and vendors from across the globe. The BSP members trigger HGI projects by means of their services vision of BSP members, with the technical collaboration of all HGI participants. These members represent the entire spectrum of players in the broadband home area.
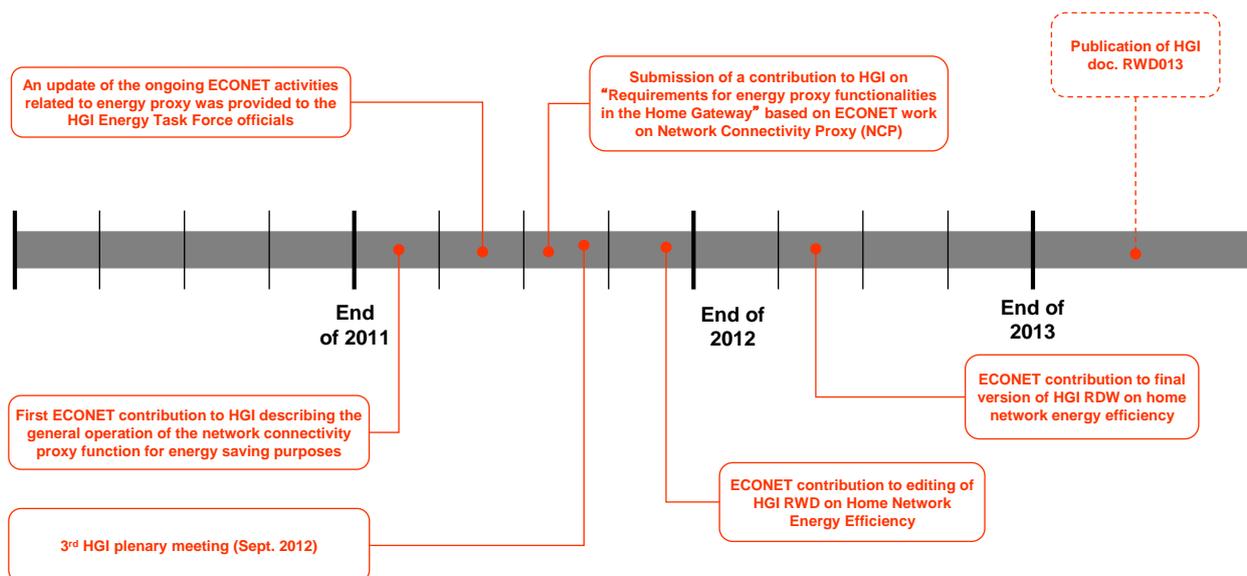


**Figure 5 – Schedule of the main actions performed by the ECONET project towards the HGI standardization body.**

HGI's initial role was to specify requirements and test plans for HGs that support QoS and the rollout of triple play, broadband services. That work established the key functional requirements needed to support managed services in the home, and it continues to provide an invaluable reference for the industry. Recently, the scope has now been expanded to cover the entire spectrum of requirements for devices and service support in the digital home. There are two main project themes:

- Connecting Homes
- Enabling Services

Connecting Homes covers the infrastructure requirements for delivering telecoms and Internet services in the home. This work builds on the original HG "*Residential Profile*", by defining

extensions covering higher speeds and performance attributes, and updating the functionality to include such things as IPv6 support. HGI also publishes test plans for much of its defined functionality, and holds an annual Test Event where these tests can be independently carried out. In addition, going beyond the Gateway itself, HGI specifies requirements for home network "*infrastructure devices*" (bridges, wireless access points, etc.) addressing real-world home network performance, end-to-end diagnostics, and energy efficiency.

Enabling Services has now moved beyond triple play to encompass a delivery framework for Smart Home services. This architecture includes support for a standard, general-purpose software execution environment in the HG (for third party applications), Application Programming Interface (API) definitions, device abstraction, and interfacing with cloud-based platforms. HGI's published use cases for Home Energy Management (HEM) are the first in a range of Smart Home services that the HGI architecture will support.

The published outputs of HGI include functional requirements, test specifications, and white papers on the digital home infrastructure. The service providers can use them in formal procurement activities. Instead, digital home equipment can use these outputs vendors to understand service providers' needs.

The first ECONET contribution to HGI was presented in March 2012 to describe the general operation of the home-network-connectivity proxy function for energy saving purposes. In this presentation the mechanism for sharing information and controlling the status of the energy consumption on various home-networking devices via the home gateway has been proposed. For more information about this presentation, see D7.6.

A more detailed contribution to HGI on "*Requirements for energy proxy functionalities in the Home Gateway*" based on ECONET work on the Network Connectivity Proxy (NCP) has been submitted in June 2012 (2nd HGI plenary meeting of 2012). This contribution was inserted into the draft official document HGI-RWD031 "*Requirements for Power Management of Home Network Devices*". The contribution included:

- An introduction about the concept of proxy as functionality to be supported by the home gateway, as central node of the home network and main coordinator of the connectivity and service enablement
- A detailed description of the sub-functions
- A number of specific requirements for the inclusion in the HGI draft

A new contribution, revising and integrating previous TELIT and France Telecom's contributions, was then submitted to the 3rd HGI plenary meeting in September 2012.

As mentioned in report D7.6, TELIT has been designed as editor of the HGI doc RWD031 to be published in the first half of 2014. Input from the ECONET project was used in HGI doc RWG031 to define mechanisms for the energy consumption optimization in the Home Network.

This document describes, among others, a device named the Network Connectivity Proxy (NCP), as one of the possible solutions that can be envisaged for the implementation of home network-wide energy-saving policies. This device carries out the same functions of the NCP developed in ECONET. The description contains an overview of the home network architecture where the NCP could fit, followed by the HGI requirements for this device. Requirements are abstracted from the description of the ECONET NCP operation and generalized to make them technology independent and possibly consider a slightly different range of solutions than ECONET was focused on. This document avoids placing any constraints about technology to leave implementers free to select the solution they think is most suitable. Taking into account, though, that UPnP is, and for the

foreseeable future will remain, the most suitable technology to base a solution, the document also contains some hints about possible impacts of the NCP on UPnP / DLNA standardization. As future activities, the inclusion of the NCP into the UPnP body of standards can be possible.

### 2.3.2.4 EU-JRC

The EU-JRC is the scientific and technical arm of the EU. It provides the scientific advice and technical knowledge to support a wide range of EU policies. It has the status of a Commission service, which guarantees independence from private or national interests. In particular, as the Commission in-house science service, the JRC mission is to provide EU policies with independent, evidence-based scientific and technical support throughout the whole policy cycle. Working in close cooperation with policy Directorates-General, the JRC addresses key societal challenges while stimulating innovation through developing new methods, tools and standards, and sharing its know-how with the Member States, the scientific community and international partners. Key policy areas include, among others, environment, climate change and energy.

In particular, starting since 2004, the JRC has developed the **Code of Conduct on Energy Consumption of Broadband Equipment** (BB-CoC), which aims at reducing energy consumption of broadband communication equipment, without hampering the fast technological developments and the service provided. More precisely, such document defines a set of power consumption limits for a wide range of equipment for broadband services both on the customer side as well as on the network access side. In such wide range, the main technologies within the scope of the ECONET project are:

- HGs - Customer Premise Equipment (CPE) - ADSL, ADSL2, ADSL2plus, VDSL2.
- Simple broadband access devices - DSL, CPE powered by USB.
- DSL Network equipment - ADSL, ADSL2, ADSL2plus, VDSL2.
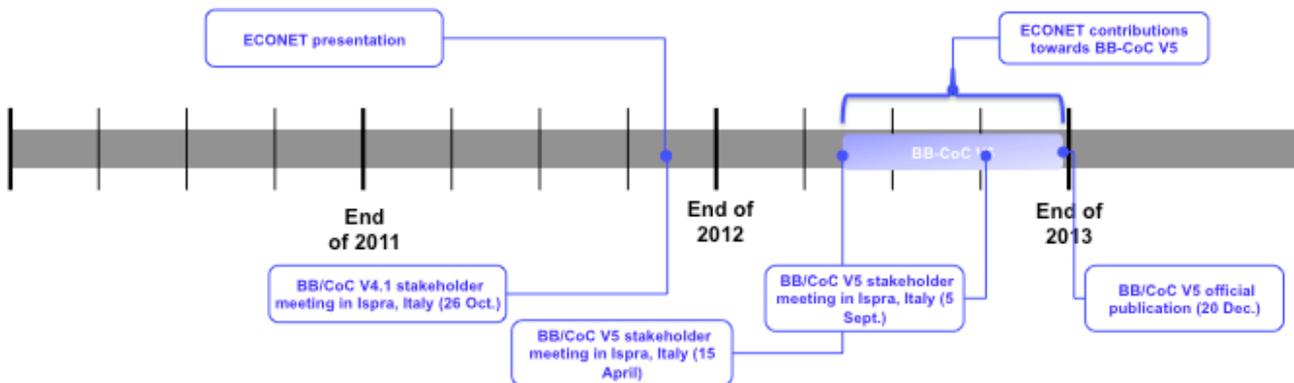


**Figure 6 – Schedule of the main actions performed by the ECONET project towards the EU-JRC standardization body.**

In the last years, the BB-CoC has become a real "*standard de facto*" for many stakeholders, especially after the Global CoC Signature Event, organised in Brussels in September 2010 by GeSI and the EC, with the support of TELIT and the participation of Commissioner Neelie Kroes. In particular, such event was dedicated to the signatures of two CoCs, on Broadband and Data Centres, respectively. The addition of the new signatories greatly increased the scope of the CoCs. In more details, this signature increased the coverage of the EU broadband market from the previous 32% to roughly 75% (analysis by Arthur D. Little). The inclusion of non-EU companies in the list of signatories also gave the CoCs a push towards becoming global standards for energy efficiency.

Some contacts have been set up, through Telecom Italia, with Mr Paolo Bertoldi, who is the JRC person in charge for the CoCs. Considering the studies performed on power consumption of broadband equipment, as well as prototypes of energy-aware equipment, already realised or under preparation, the ECONET project was invited to present itself to the working group and, later on, the project started to actively contribute to the definition of the BB-CoC (V5), together with Telecom Italia, Telekom Serbia and Swiss Telecom. Indeed, the results of ECONET allowed the elaboration of useful proposals concerning future power-consumption targets for tier 2015-2016 and generated a lot of discussion. The studies performed by ECONET contribute to push the new thresholds towards more restrictive values in order to speed-up the reduction of the energy consumption in the next telecommunications network devices. Moreover, the project succeeded in obtaining the insertion in the document of Appendix G (p. 50, [38]) named "Evolution of power saving for broadband equipment", in which the importance of dynamic adaptation and energy aware management techniques is highlighted. In this part the Network Proxy techniques and especially the GAL interface have been explicitly described and listed as key and reference technologies.

Moreover, before starting the CoC revision process towards Version 5.0, the ECONET coordinator, Prof. Bolla, was selected to support Mr Bertoldi in the process of identification of new target values for the period 2015/2016, with activities related, among others, to the analysis of the current device consumptions.

More in detail, Prof. Bolla presented the ECONET project at the stakeholder meeting in Ispra (Italy) on the 26th of October 2012. The main goal of such meeting was starting the activity about a small revision of the version (V4), as far as tier 2013-2014 is concerned. This action produced the BB-CoC V4.1 document during the first part of 2013, with target values for the tier 2013-2014 [37]. During the successive physical meeting at Ispra, the 15th April 2013, the work about the next version (V5) of the BB-CoC for tier 2015-2016 started in a more concrete way and during this event Telecom Italia presented the joint contribution of ECONET, Serbia Telecom and Swiss Telecom.

In a successive meeting in Ispra (Italy) on the 5th of September 2013 the ECONET support highlighted new technologies related to Smart Grids and sensor networks, together with NT and other functionalities for the access network equipment. Among the ECONET contributions, the power scaling mechanisms were introduced, in order to differentiate equipment with and without such functionalities. Specifically, the contribution asked for the introduction of the GAL concept as a strong enabler of global energy saving. After an initial rejection (because at the beginning of the process some of the participants considered this technology promising, but not yet mature), the GAL has been included in the BB-CoC version 5 (see above).

The different partners and stakeholders discussed the BB-CoC version 5 during the last months of 2013 by means of emails and many virtual meetings and the role of the project in pushing towards more effective consumption threshold (where feasible) has been concretely effective. The new BB-CoC version 5 [38] has been officially emitted on the 20th December 2013.

### 2.3.3 Future Activities towards Standardization

The present section aims at providing a brief list of the future actions foreseen towards the selected reference standardization bodies.

Following with ITU-T SG5, there are currently some concrete contacts to launch the proposal of standardizing the GAL also within ITU-T as a future next step. The current agreement among the relevant ECONET partners involved in the ITU-T activities (e.g., Telecom Italia, Alcatel, Ericsson) is in the direction of submitting the proposal during the ITU-T SG5 meeting, to be held in Geneva, 19-23 May 2014.

For what concerns the interaction with ETSI, another future activity will be the possible contribution to the new WI proposed by TEI with the support of TELIT and CNIT.

## 2.4 *The website*

Internet websites represent one of the primary media for the dissemination of project activities. The Internet domain "**www.econet-project.eu**" is active since the start of the project.

The ECONET website is intended to be used for both internal consortium communication and public dissemination; it is an effective communication channel where information and knowledge produced by the project can be shared among partners and/or published to be available for the general public.

For external dissemination, publicly accessible website sections have been set up. Through these sections, the general public can access the common information about the project, i.e.:

- contact data of the coordinator,
- the list of the partners with links to their own websites,
- a short description of the project underlining the objectives and key ideas, etc.,
- the introductory dissemination material, such as the ECONET leaflet, written in an appropriate language and style,
- the videos of the different demos realized by the project (see the next Section for additional details about videos).

Moreover, results and outcomes of the project, as well as all the publications of the project, are available (subject to copyright and IPR conditions).

The list of project deliverables contains:

- the list of project deliverables,
- the list of internal reports.

The list of publications contains:

- papers in scientific journals,
- book chapters,
- papers in scientific conferences, symposia and workshop proceedings.

The list of dissemination actions contains:

- attended conferences, symposia, workshops and exhibitions,
- panel discussions and invited speeches,
- attended seminars, meetings and other dissemination events,
- tutorials and lectures.

Links to download the relevant files are provided for the documents that have been classified as publicly available.

The website has been also heavily used for internal communication: project resources like minutes of meetings, deliverable templates, presentations, scientific papers or general guidelines are

published on the repository area, only viewable by consortium members. Moreover, officially released deliverables are at disposal of the Project Officer and the Project Reviewers through the private section of the website.

For making the results of the project visible and effective also after the end of the project itself, the public section of the web site has been revised with the aim to put more emphasis on the final results and news.

One of the most relevant enhancements is represented by a specific portal of the final demo of the project, which has been created to aggregate the whole demo results and display them in an interactive way. As can be seen in the screenshot below (Figure 7), the web page network topology of the demo is depicted: users can click on a specific "cloud" of the network (i.e., a significant portion of the network, highlighted with a red box in the scheme) to visualize the related results and run a simulation that displays the data according to the sliding time of the day. Moreover, two videos are shown: one contains an interview to the responsible researchers, who explain the selected cloud characteristics and functionalities, and the other is the recording of the live demo that took place in Turin, on December 2013, the last month of the project.
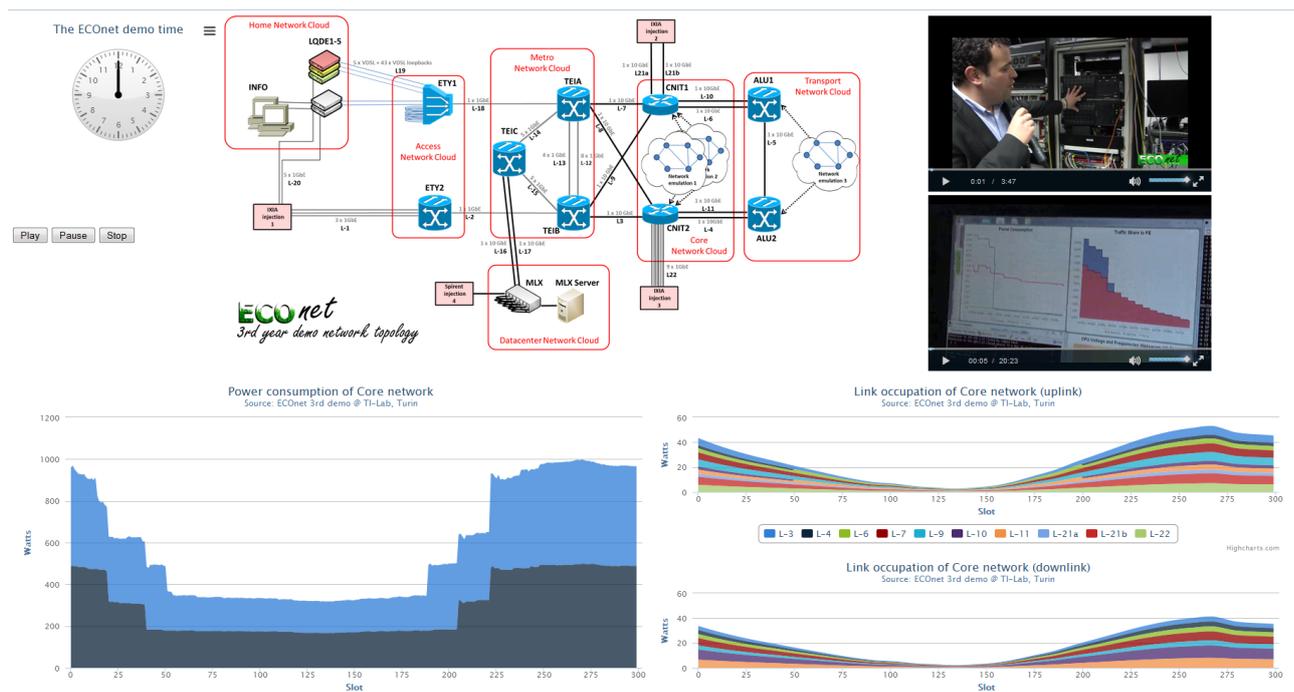


**Figure 7 – Screenshot of the interactive ECONET demo web page.**

Finally, a new LinkedIn group named "ECONET (low Energy COnsumptionNETworks)" has been created under the project umbrella, with the aim to extend beyond the duration of the project the interactions between the project participants and the external people on the issues of reducing the energy consumption of the network equipment. The LinkedIn group page can be accessed through the following link: http://www.linkedin.com/groups/ECONET-low-Energy-COnsumption-NETworks-7447206.

## 2.5 *Dissemination materials*

### 2.5.1 Leaflet

A project leaflet (English and Italian versions) was prepared and distributed. It contains:

- basic information about the ECONET project,

- the contact data of the coordinator,

- the list of all the partners of the consortium.

This leaflet informs on the purpose of the project. The main goal is to make the reader - regardless of he/she being a scientist, an expert in the field, a student or just a citizen - aware of the project, of the emerging green networking technologies and of the advantages that could be offered by the energy efficiency solutions applied to the network in a comprehensive way.

The leaflet has been updated to reflect the status of the project and to include results obtained in the third year. It has been already distributed and will be distributed at conferences, workshops, seminars and events, etc. An electronic version of the leaflet was uploaded to the project website. Hence, it is at disposal to be downloaded by any interested users.

### 2.5.2 Posters

An A0-format poster was prepared during the first year to be used at various events where the ECONET consortium and the results of the project will be present. During the second and third years a few additional posters have been prepared.

The first one contains the ECONET general information and depicts the overall idea of the project, with the main purpose to arouse curiosity and induce persons to ask more information. The poster in itself is generic, so that all dissemination targets could be addressed: it is mainly used as an instrument to stimulate live discussions and to help in disseminating the ECONET vision and/or outcomes, by letting the speaker tune the level of details as appropriate.

The other ones, developed during the second and third years, are updated versions of the original poster with new additional information about the project (i.e., current status in terms of specific technical adopted solutions, preliminary and final results, …) or they are specifically focused on one of the main aspects studied in the project itself (e.g., Green Abstraction Layer, Network Connectivity Proxy, Test bed Networks). Depending on the context and on the specific goal, a different mix of these posters has been (and will be) used (e.g., during the ETSI Workshop, where one of the main goals was to promote the standardization of the GAL, two posters were exposed, one general and the other focused on the GAL; during the KSTiT and SECURE conferences three posters with green strategies at the Control Plane were exposed).

### 2.5.3 Banner

The consortium realized a banner (i.e., large stripe), which contains the project website address and the ECONET logo together with the logos of all the partners, in order to increase the visibility of the project during the participation at workshops, conferences or other dissemination events that provide assigned spaces to participants, such as desks or booths.

### 2.5.4  Videos

The ECONET consortium has produced promotional/descriptive videos for improving the impact of the vision, results and the key ideas of the project or help wider communication and deeper explanation of proposed/developed solutions within the ECONET activities.

For each prototype realised in the Task 6.2 "Single device integration & demonstration", one or more videos has been produced and put at disposal of the public on the project website. The list of the available videos and the related links is the following:

1) CNIT: Drop software distributed router

2) Alcatel Lucent: 20Gb Ethernet Card – Power monitoring and control

3) Mellanox: Power Saving Features in Mellanox Products

4) Lantiq: Vectoring

5) Ericsson: Energy aware SPO 1400

6) Lightcomm and Dublin City University: Software switch

7) Lightcomm and Dublin City University: NetFPGA and GAL

8) Lightcomm and Dublin City University: Frequency Scaled Router

9) Infocom: Network connectivity proxy

10) VTT: Ethernet interface using Flash FPGA

11) WUT-NASK: Energy-aware network control system

Moreover, the integrated final demo, set up by ECONET at the end of the project within the activities of the Task 6.3 "Integration & demonstration of network-wide green strategies", has been filmed by a professional video operator. The huge amount of raw material recorded during the live demo has been edited to produce several videos, which describe in details the structure of the demo and the obtained results. Such videos have been uploaded to a dedicated section of the ECONET website (see section 2.4).

## 2.6  *Scientific publications*

The members of the consortium have strong commitment in publishing their work in relation to the ECONET themes and research topics in both national and international high quality journals and books. Technical documents, such as whitepapers, research reports, specifications or contributions to standards, are also a valuable dissemination channel of the project outcomes (either towards the external world or, at least, within the consortium partners, should the IPR rules not allow to disclose some of such technical documents outside the project). In this respect, it is also worth noting that all the public deliverables of the project are and will be publicly available through the repository of the ECONET website.

The list of targeted journals is presented below:

- ACM SIGCOMM Computer Communication Review

- Communications & Strategies Journal

- Computer Networks Journal

- International Journal of Network Management

- International Journal of Future Generation Communication and Networking

- IEEE Transactions on Network and Service Management

- IEEE/ACM Transactions on Networking

- IEEE Communications Magazine

- IEEE Network Magazine

- IEEE Communications Surveys and Tutorials

- Infocommunications Journal

- Journal of Network and Systems Management

- Telecommunications Policy Journal

- Journal of Telecommunications and Information Technology

- Concurrency and Computation: Practice and Experience

- Computer Communications Journal

- International Journal of Communication Systems

- Future Generation Computer Systems

- Science

- Telecommunication Review – Telecommunication News
  (Przegląd Telekomunikacyjny – Wiadomości Telekomunikacyjne)

The list of all papers and documents that have already been produced by ECONET partners has been inserted and regularly updated in the scheduled "ECONET information dissemination plan". The scientific publications in journals, book contributions and conference proceedings that have already been published by the partners are shown in Tables 3 and 4, respectively.

At the time of writing, the total number of journal and book chapter publications is **24**, while the total number of conference/workshop contributions is **46**.

**Table 3. Scientific publications (journals and book chapters).**

| Authors | Title of the publication | Journal or Book | Reference details |
|---|---|---|---|
| R. Bolla, F. Davoli, R. Bruschi, K. Christensen, F. Cucchietti, S. Singh | *The Potential Impact of Green Technologies in Next-Generation Wireline Networks: Is There Room for Energy Saving Optimization?* | IEEE Communications Magazine - Feature Topic on Energy Efficiency in Communications | Vol. 49, No. 8, pp. 80-86, 2011 |

| Authors | Title of the publication | Journal or Book | Reference details |
|---|---|---|---|
| R. Bolla, R. Bruschi, F. Davoli, F. Cucchietti | *Energy Efficiency in the Future Internet: A Survey of Existing Approaches and Trends in Energy-Aware Fixed Network Infrastructures* | IEEE Communications Surveys and Tutorials | Vol. 13, No. 2, pp. 223-244, 2011 |
| R. Bolla, R. Bruschi, A. Cianfrani, M. Listanti | *Enabling Backbone Networks to Sleep* | IEEE Network Magazine (Special Issue on "Energy-Efficient Networks") | Vol. 25, No. 2, pp. 26-31, 2011 |
| A. Lombardo, D. Reforgiato, V. Riccobene, G. Schembra | *NetFPGA Hardware Modules for Input, Output and EWMA Bit-Rate Computation* | International Journal of Future Generation Communication and Networking | Vol. 5, No. 2, pp. 121-136, 2012 |
| A. P. Bianzino, L. Chiaraviglio, M. Mellia, J.-L. Rougier | *GRiDA: Green Distributed Algorithm for Energy-Efficient IP Backbone Networks* | Computer Networks, Elsevier | Vol. 56, No. 14, pp. 3219-3232, 2012 |
| M.Kamola, P. Arabas, P. Jaskóła, A. Sikora, E. Niewiadoms ka-Szynkiewicz, K. Malinowski, M. Marks, M. Mincer, K. Daniluk | *Econet – Energy Efficient Technologies for Wired Networks "Econet – energooszczędne technologie dla przewodowych sieci komputerowych" (in Polish)* | Telecommunication Review – Telecommunication News | Vol. 3, pp. 1-7, 2012 |
| R. Bolla, R. Bruschi, A. Carrega, F. Davoli, D. Suino, C. Vassilakis, A. Zafeiropoulos | *Cutting the Energy Bills of Internet Service Providers and Telecoms Through Power Management: An Impact Analysis* | Computer Networks, Elsevier | Vol. 56, No. 10, pp. 2320-2342, 2012 |
| J. Huang, O. Ormond, D. Ma, X. Wang | *Optimizing energy-efficiency for program partitioning and mapping onto multi-core packet processing systems* | Journal of China Universities of Posts and Telecommunications | Vol. 19, No. 1, pp. 79-86, 2012 |

| Authors | Title of the publication | Journal or Book | Reference details |
|---|---|---|---|
| F. Guo, O. Ormond, L. Fialho, M. Collier, X. Wang | *Power consumption analysis of a NetFPGA based router* | Journal of China Universities of Posts and Telecommunications | Vol. 19, No. 1, pp. 94-99, 2012 |
| R. Bolla, R. Bruschi, F. Davoli, P. Lago | *Trading off Energy and Forwarding Performance in Next-Generation Network Devices* | Green Communications: Theoretical Fundamentals, Algorithms and Applications, Chapter 24, J. Wu, S. Rangan, and H. Zhang Eds. | CRC Press, Taylor & Francis, pp. 693-716, 2012 |
| R. Bolla, R. Bruschi, A. Lombardo | *Standard Methodologies for Energy Efficiency Assessment* | Green Communications: Theoretical Fundamentals, Algorithms and Applications, Chapter 4, J. Wu, S. Rangan, and H. Zhang Eds. | CRC Press, Taylor & Francis, pp. 83-101, 2012 |
| C. Hu, B. Liu, M. Zhang, B. Zhang, X. Wang | *Architectural Design of An Energy-efficient Router* | Green Communications and Networking, F. R. Yu, X. Zhang and V. C. M. Leung Eds. | CRC Press, Taylor & Francis, 2012 |
| K. Daniluk | *Energy-Efficient Protocols in OMNeT++ Simulation Environment* | International Book Series Information Science and Computing | 2012 |
| E. Niewiadomska-Szynkiewicz, A. Sikora, P. Arabas, J. Kołodziej | *Control System for Reducing Energy Consumption in Backbone Computer Network* | Concurrency and Computation: Practice and Experience (CCPE), John Wiley & Sons, Ltd | Vol. 25, No. 12, pp. 1738-1754, 2013 |
| M. Karpowicz | *Project ECONET: energy-aware CPU frequency control for Linux software routers (in Polish)* | Biuletyn NASK | 2013 |

| Authors | Title of the publication | Journal or Book | Reference details |
|---|---|---|---|
| M. Kamola, P. Arabas, P. Jaskóła, A. Sikora, E. Niewiadomska-Szynkiewicz, K. Malinowski, M. Marks, M. Mincer, | *ECONET – energy-aware networks (in Polish)* | Telecommunication Review – Telecommunication News | Vol. 8-9, pp. 964-970, 2013 |
| Yaron Hagai Nir Strugo | *Power Saving Features in Mellanox Products* | Mellanox Technologies, White Paper | 2013 |
| R. Bolla, M. Giribaldi, R. Khan, M. Repetto | *Design and Implementation of Cooperative Network Connectivity Proxy using Universal Plug and Play* | The Future Internet A. Galis and A. Gavras Eds. | LNCS, Springer, Vol. 7858, pp. 323-335 2013 |
| R. Bolla, R. Bruschi, F. Davoli, F. Cucchietti | *Setting the course of green Internet (letter to the Editor)* | Science | Vol. 342, No. 6164, AAAS, 1316 Dec. 2013 |
| E. Niewiadomska-Szynkiewicz, A. Sikora, P. Arabas, M. Kamola, M. Mincer, J. Kołodziej | *Dynamic power management in energy-aware computer networks and data intensive computing systems* | Future Generation Computer Systems | 2013 (online, publication in 2014) |
| R, Bolla, R. Bruschi, A. Carrega, F. Davoli | *Green networking with packet processing engines: Modeling and optimization* | IEEE/ACM Transactions on Networking | To appear (published online in 2013) doi: 10.1109/TNET. 2013.2242485 |

| Authors | Title of the publication | Journal or Book | Reference details |
|---|---|---|---|
| R. Bolla, R. Bruschi, F. Davoli, L. Di Gregorio, P. Donadio, L. Fialho, M. Collier, A. Lombardo, D. Reforgiato Recupero, T. Szemethy | *The Green Abstraction Layer: A standard power management interface for next-generation network devices* | IEEE Internet Computing | Vol. 32, No. 1, pp. 16-27, Jan. 2014. |
| R. Bolla, R. Bruschi, A. Carrega, F. Davoli, P. Lago | *A closed-form model for the IEEE 802.3az network and power performance* | IEEE Journal on Selected Areas in Communications | Vol. 32, No.1, pp. 16-27 2014 |
| R. Bolla, R. Bruschi, F. Davoli, P. Donadio, L. Fialho, M. Collier, A. Lombardo, D. Reforgiato, V. Riccobene, T. Szemethy | *A northbound interface for power management in next generation network devices* | IEEE Communications Magazine | Vol. 52, No. 1, pp. 149-157 2014 |
| R. Bolla, R. Bruschi, C. Lombardo, S. Mangialardi | *Dropv2: Energy-Efficiency through Network Function Virtualization* | IEEE Network, Special Issue – Open Source for Networking | To appear 2014 |

**Table 4. Scientific publications (conference proceedings).**

| Authors | Title of the publication | Proceedings of | Year |
|---|---|---|---|
| R. Bolla, R. Bruschi, A. Carrega, F. Davoli | *An Analytical Model for Designing and Controlling New-Generation Green Devices* | IEEE Globecom 2010, 3rd Int. Workshop on Green Communications (GreenCom'10), pp. 1388-1393 [**Best Paper Award**] | 2010 |
| R. Bolla, R. Bruschi, A. Carrega, F. Davoli | *Theoretical and technological limitations of power scaling in network devices* | Australasian Telecommunication Networks and Applications Conf. 2010 (ATNAC 2010), Auckland, New Zealand, Nov. 2010, pp. 37-42. | 2010 |
| R. Bolla, R. Bruschi, C. Lombardo, D. Suino | *Evaluating the Energy-Awareness of Future Internet Devices* | 12th IEEE Conference on High Performance Switching and Routing (HPSR'11), pp. 36-43. | 2011 |
| A. Lombardo, C. Panarello, D. Reforgiato, E. Santagati, G. Schembra | *A Flexible Router for On-Fly Dynamic Packet Management in NetFPGA Platform* | GTTI (Italian Association of Telecommunications and Information Technologies Group), Proc. On line. | 2011 |
| R. Bolla, R. Bruschi | *Energy-Aware Load Balancing for Parallel Packet Processing Engines* | 1st IEEE Online Green Communications Conference (GreenCom'11), pp. 105-112. | 2011 |
| R. Bolla, R. Bruschi, C. Lombardo | *State of the Art of Existing Standards for the Evaluation of Network Performance and Energy Consumption* | SCS International Symposium on Performance Evaluation of Computer and Telecommunication Systems (SPECTS'11), pp. 62-68. | 2011 |
| R. Bolla, R. Bruschi, A. Cianfrani, M. Listanti, O. Jaramillo | *Energy-Efficient Sleeping Modes for Next-Generation Core Networks* | Future Network & Mobile Summit 2011, pp. 111-118. | 2011 |

| Authors | Title of the publication | Proceedings of | Year |
|---|---|---|---|
| R. Bolla, R. Bruschi, A. Carrega, F. Davoli | *Green Network Technologies and the art of Trading-off* | IEEE INFOCOM 2011, Green Communications and Networking Workshop, pp. 331-306 | 2011 |
| A. P. Bianzino, L. Chiaraviglio, M. Mellia | *GriDA: a Green Distributed Algorithm for Backbone Networks* | IEEE Online Green Communications Conference (GreenCom 2011), pp. 113-119 | 2011 |
| R. Khan, R. Bolla, M. Repetto, R. Bruschi M. Giribaldi | *Smart Proxying for Reducing Network Energy Consumption* | SCS International Symposium on Performance Evaluation of Computer and Telecommunication Systems (SPECTS 2012), pp. 1-8. | 2012 |
| A. Carrega, S. Singh, R. Bruschi, R. Bolla | *Traffic Merging for Energy-Efficient Datacenter Networks* | SCS (IEEE) International Symposium on Performance Evaluation of Computer and Telecommunication Systems (SPECTS 2012), pp. 1-5. | 2012 |
| R. Bolla, R. Bruschi, F. Davoli | *A Steady-State Model for Energy-Efficient Packet Processing Engines Under Mixed Traffic* | Fourth International Conference on Communications and Electronics (ICCE 2012), Special Session on Energy-Efficient Networking, pp. 251-256. | 2012 |
| P. Arabas, K. Malinowski, A. Sikora, | *On Formulation of a Network Energy Saving Optimization Problem* | Fourth International Conference on Communications and Electronics (ICCE 2012), Special Session on Energy-Efficient Networking, pp. 227-232. | 2012 |

| Authors | Title of the publication | Proceedings of | Year |
|---|---|---|---|
| E. Niewiadomska-Szynkiewicz, A. Sikora, P. Arabas, J. Kolodziej | *Control Framework for High Performance Energy Aware Backbone Network* | European Conference on Modelling and Simulation (ECMS 2012) | 2012 |
| V. Riccobene, A. Lombardo, D. Reforgiato, G. Schembra | *Modeling Temperature and Dissipation Behavior of an Open Multi-Frequency Green Router* | GTTI (Italian Association of Telecommunications and Information Technologies Group) 2012, Proc. On line | 2012 |
| A. Lombardo, D. Reforgiato, V. Riccobene, G. Schembra | *Modeling Temperature and Dissipation Behavior of an Open Multi-Frequency Green Router* | IEEE Online Green Communication Conference (GreenCom 2012) | 2012 |
| D. Reforgiato, A. Lombardo, F. Davoli, L. Fialho, M. Collier, P. Donadio, R. Bolla, R. Bruschi | *Exporting Data-Plane Energy-Aware Capabilities from Network Devices toward the Control Plane: The Green Abstraction Layer* | 17th European Conf. on Network and Optical Communications (NOC 2012), pp. 1-6. | 2012 |
| A. Lombardo, C. Panarello, D. Reforgiato, G. Schembra | *Power Control and Management in the NetFPGA Gigabit Router* | Future Network & Mobile Summit | 2012 |
| A. Carrega, S. Singh, R. Bolla, R. Bruschi | *Applying Traffic Merging to Datacenter Networks* | e-Energy 2012, ACM | 2012 |
| A. Cianfrani, V. Eramo, M. Listanti, M. Polverini | *Introducing Routing Standby in Network Nodes to Improve Energy Savings Techniques* | e-Energy 2012, ACM | 2012 |
| R. Bolla, R. Bruschi, C. Lombardo | *Dynamic Voltage and Frequency Scaling in Parallel Network Processors* | 13th IEEE Conf. on High Performance Switching and Routing (HPSR 2012), pp. 242-249. | 2012 |

| Authors | Title of the publication | Proceedings of | Year |
|---|---|---|---|
| A. P. Bianzino, L. Chiaraviglio, M. Mellia | *Distributed Algorithms for Green IP Networks* | IEEE INFOCOM'12, Workshop on Communications and Control for Sustainable Energy Systems: Green Networking and Smart Grids,pp. 121-126. | 2012 |
| R. Bolla, R. Bruschi, F. Davoli, L. Di Gregorio, L. Giacomello, C. Lombardo, G. Parladori, N. Strugo, A. Zafeiropoulos | *The low Energy Consumption NETworks (ECONET) Project* | Second IFIP Conference on Sustainable Internet and ICT for Sustainability (SustainIT 2012) | 2012 |
| R. Bolla, R. Bruschi, P. Donadio, G. Parladori | *Energy Efficiency in Optical Networks* | 15th IFIP/IEEE Internat. Telecom. Network Strategy and Planning Symp. (NETWORKS'12) | 2012 |
| F. Guo, O. Ormond, M. Collier, X. Wang | *Power Measurement of NetFPGA Based Router* | Greencomm 2012, IEEE, 26-28 Sept 2012 | 2012 |
| P. Arabas, K. Malinowski, A. Sikora | *On formulation of a network energy saving optimization problem* | 4th International Conference on Communications and Electronics ICCE2012, IEEE | 2012 |
| R. Bolla, R. Bruschi, F. Davoli | *Designing Optimal Energy Profiles for Network Hardware* | Globecom, IEEE, December 2012, USA | 2012 |
| T. Molloy, X. Zheng, O. Ormond, F. Guo, X.Wang | *Power consumption in a zfilter publish/subscribe based forwarding node* | International Conference on Information and Communications Technologies, IET, Beijing, pp.1-6 | 2013 |

| Authors | Title of the publication | Proceedings of | Year |
|---------|--------------------------|----------------|------|
| E. Niewiadomska-Szynkiewicz, A. Sikora, M. Mincer, P. Arabas | *Simulation of Energy-Aware Backbone Networks* | 27th European Conference on Modelling and Simulation, ECMS, Alesund, Norway, pp. 483-489 | 2013 |
| R. Bolla, M. Giribaldi, R. Khan, M. Repetto | *Cooperative Proxying: An Approach to Reduce Network Energy Waste (Poster Paper)* | 32nd IEEE International Conference on Computer Communications, IEEE INFOCOM, Turin, Italy | 2013 |
| R. Bolla, M. Giribaldi, R. Khan, M. Repetto | *Smart Proxying: An Optimal Strategy for Improving Battery Life of Mobile Devices* | 4thInternational Green Computing Conference, IGCC, Arlington, USA pp. 1-6 | 2013 |
| R. Bolla, R. Bruschi, O. M. Jaramillo Ortiz, P. Lago | *The Energy Consumption of TCP* | 4thACM/IEEE Internat. Conf. on Future Energy Systems (e-Energy 2013), Berkeley, CA, USA, pp. 203-212 | 2013 |
| R. Bolla, M. Giribaldi, R. Khan, M. Repetto | *Design of Home Energy Gateway Boosting the Development of Smart Grid Applications at Home* | 4thInternational Conference on Energy Aware Computing Systems&Applications, ICEAS, IEEE, Istanbul, Turkey | 2013 |
| R. Bolla, R. Bruschi, P. Lago | The Hidden Cost of Network Low Power Idle | IEEE International Conference on Communications (ICC '13), Budapest, Hungary, June 2013, pp. 4148-4153 | 2013 |
| R. Bolla, R. Bruschi, C. Lombardo, F. Podda | *OpenFlow in the small* | IEEE International Conference on Communications (ICC '13), Budapest, Hungary, June 2013, pp. 3509-3513 | 2013 |

| Authors | Title of the publication | Proceedings of | Year |
|---|---|---|---|
| R. Bolla, R. Bruschi, F. Davoli, P. Donadio, L. Fialho, M. Collier, A. Lombardo, D. Reforgiato, V. Riccobene, T.Szemethy | *Exposing Energy-Aware Capabilities in Next Generation Network Devices* | IEEE ICC 2013 Workshops -Second IEEE Workshop on Telecommunications Standards: From Research to Standards, Budapest, Hungary, pp. 1286-1290 | 2013 |
| R. Bolla, M. Giribaldi, R. Khan, M. Repetto | *Network Connectivity Proxy: An Optimal Strategy for Reducing Energy Waste in Network Edge Devices* | 24th Tyrrhenian International Workshop on Digital Communications (TIWDC 2013), Genoa, Italy | 2013 |
| A. Lombardo, V. Riccobene, G. Schembra | *An Analytical Tool to Design a Router Governor Controlling Energy Consumption and Temperature* | 24th Tyrrhenian International Workshop on Digital Communications (TIWDC 2013), Genoa, Italy | 2013 |
| R. Bolla, R. Bruschi, M. Chiappero, L. D'Agostino, P. Lago, C. Lombardo, S. Mangialardi, F. Podda | *EE-DROP: An Energy-Aware Router Prototype* | 24th Tyrrhenian International, Workshop on Digital Communications (TIWDC 2013), Genoa, Italy | 2013 |
| R. Bolla, R. Bruschi, O. M. Jaramillo Ortiz, R. Rapuzzi | *Enabling the TCP Segmentation Offload to Save Energy* | 24th Tyrrhenian International, Workshop on Digital Communications (TIWDC 2013), Genoa, Italy | 2013 |
| R. Bolla, M. Giribaldi, R. Khan, M. Repetto | *Network connectivity proxy: An optimal strategy for reducing energy waste in network edge devices* | 24th Tyrrhenian International, Workshop on Digital Communications (TIWDC 2013), Genoa, Italy | 2013 |

| Authors | Title of the publication | Proceedings of | Year |
|---|---|---|---|
| R. Bolla,<br>R. Bruschi,<br>F. Davoli,<br>P. Lago | *Optimizing Power Delay Product in Energy-Aware Packet Forwarding Engines* | 24th Tyrrhenian International Workshop on Digital Communications (TIWDC –2013), Genoa, Italy | 2013 |
| M. Kamola,<br>P. Arabas | *Shortest Path Green Routing and the Importance of Traffic Matrix Knowledge* | 24th Tyrrhenian International Workshop on Digital Communications TIWDC - Green ICT, Genoa, Italy | 2013 |
| M. Karpowicz | *On the design of energy-efficient service rate control mechanisms: CPU frequency control for Linux* | 24th Tyrrhenian International Workshop on Digital Communications TIWDC - Green ICT, Genoa, Italy | 2013 |
| E. Niewiadomska-Szynkiewicz,<br>A. Sikora,<br>P. Arabas,<br>M. Kamola,<br>K. Malinowski,<br>P. Jaskóła,<br>M. Marks, | *Network-wide power management in computer networks* | 22nd International Teletraffic Congress Specialist Seminar on Energy Efficient and Green Networking, Christchurch, NZ<br>**[Best Paper Award]** | 2013 |
| S. Khan,<br>J. Saastamoinen,<br>J. Huusko,<br>J. Korpi,<br>J. Nurmi | *Estimating Energy Efficiency of Data-Link Layer in System Level Performance Evaluation* | The Fifth International Conference on Advances in System Simulation (SIMUL 2013) | 2013 |

## 2.7  *Conferences and symposia*

Possible influence of power saving technologies and ideas and results of the ECONET project have already been presented and discussed in national and international conferences. The main attention was devoted to IEEE and ACM conferences. Other events, national and international conferences, symposia and workshops were addressed as well. The final results of the ECONET project will be submitted for presentation also in conferences in the networking field after the end of the project.

### 2.7.1 Attended conferences and symposia (presentation of contributions, keynotes, invited speeches, panels, …)

The partners, beside the participation in all the conferences shown in Table 4 (to present the corresponding published contributions), have done also the following additional presentations reported in Table 5.

**Table 5. Attended conferences.**

| Acronym | Conference and title of presentation | Date | Location |
|---|---|---|---|
| ATNAC 2010 | **Australasian Telecommunication Networks and Applications Conference.** <br> ***Invited keynote*** <br> *Energy Efficiency in the Future Internet: Current Status and Trends* <br> F. Davoli (CNIT) | Nov., 2010 | Auckland, New Zealand |
| VTC2011 | **IEEE 73$^{rd}$ Vehicular Technology Conference** <br> **Workshop on Cognitive radio and Cooperative strategies for POWER saving (C2POWER)** <br> ***Invited panellist*** <br> *Energy Efficiency in Future Telecommunications: Technical Issues, Standardization Activities and Business Requirements* <br> R. Bolla (CNIT) | May, 2011 | Budapest, Hungary |
| IEEE GreenCom 2011 | **1$^{st}$ IEEE Online Green Communication Conference (GreenCom 2011)** <br> ***Invited Keynote*** <br> *Enabling Fixed Network Energy Efficiency Optimization Through Dynamic Adaptation-Research Challenges and European Project Efforts.* <br> R. Bolla (CNIT) | Sept, 2011 | Online |

| Acronym | Conference and title of presentation | Date | Location |
|---|---|---|---|
| FOTONICA2011 | **13ᵗʰItalian National Conference of Photonic Technologies.**<br>***Invited Speech***<br>*ECONET's overview and goals*<br>R. Bolla (CNIT)<br>Notes:<br>ECONET participated with its stand including poster and leaflets.<br>During the Conference a meeting was held with the project Geysers, for info exchanges and possible collaborations | May, 2011 | Genoa, Italy |
| IEEE C2POWER | **IEEE 73ʳᵈ Vᵉʰicular Technology Conference –Workshop on Cognitive radio and Cooperative Strategies for POWER saving**<br>***Invited panel***<br>*Energy Efficiency in Future Telecommunications: Technical Issues, Standardization Activities and Business Requirements*<br>R. Bolla (CNIT) | May, 2011 | Budapest, Hungary |
| WoWMoM | **First International Workshop on Sustainable Internet and Internet for Sustainability (SustaInet 2011)**<br>co-located with **WoWMoM 2011**<br>***Invited keynote***<br>*Green Networking Technologies for a Sustainable Future Internet*<br>F. Davoli (CNIT) | 20 June, 2011 | Lucca, Italy |
| HOTI 2011 | **IEEE 19ᵗʰAnnual Symposium on High-Performance Interconnects**<br>***Invited speech***<br>*Paving the Road to Exascale*<br>E. Zahavi (MLX) | August, 2011 | Santa Clara, USA |

| Acronym | Conference and title of presentation | Date | Location |
|---|---|---|---|
| CCW 2011 | **25 th IEEE Annual Computer Communications Workshop** *Invited panel* *Energy Efficient Networking: The Views of Leaders of International Research Projects. Energy Efficient Networking: The ECONET Project (low Energy ConsumpitonNETworks)* F. Davoli (CNIT) | October, 2011 | Hyannis, Cape Cod. MA, Usa |
| IEEE INFOCOM 2012 | **The 31st Annual IEEE International Conference on Computer Communications (INFOCOM 2012)** *Invited panel on "Green Communication and Computing"* *Energy-Efficiency in Next Generation Wire-line Networks* R. Bruschi (CNIT) | March, 2012 | Orlando, USA |
| NOC 2012 | **17th European Conf. on Network and Optical Communications** *Invited paper* *Exporting Data-Plane Energy-Aware Capabilities from Network Devices toward the Control Plane:* *The Green Abstraction Layer* D. Reforgiato, A. Lombardo (LGT), L. Fialho, M. Collier (DCU), P. Donadio (ALU), R. Bolla, R. Bruschi, F. Davoli (CNIT) | June, 2012 | Vilanova i laGeltrú, Spain |
| NGI 2012 | **Eighth Euro-NF Conference on Next Generation Internet NGI 2012** *Invited keynote* *Energy Efficiency in the Present and Future Internet: An Evolutionary Approach* F. Davoli (CNIT) | June, 2012 | Karlskrona, Sweden |

| Acronym | Conference and title of presentation | Date | Location |
|---|---|---|---|
| Future Network & Mobile Summit | **Future Network & Mobile Summit 2012**<br><br>**Workshop on Green Communications and Networks**<br>***Invited talk***<br>*A Smart Proxy Architecture for Power Consumption Reduction in the Home Environment*<br>R. Bruschi (CNIT)<br><br>**Workshop on Fostering Programmability of Wireless Networks**<br>***Invited talk***<br>*ECONET – Network Programmability for Green Networking*<br>R. Bruschi (CNIT)<br><br>**Session 8d: Scalable Architectures for the Real World Internet**<br>***Presentation***<br>*Power Control and Management in the NetFPGA Gigabit Router*<br>D. Reforgiato (LGT) | 4-6 July, 2012 | Berlin, Germany |
| IFIP WG 7.6 | **The 12th Conference of the IFIP Working Group 7.6 "Advanced Analytics"**<br>***Presentation***<br>*Joint routing and bandwidth allocation strategies in energy aware networks*<br>P. Jaskóła (NASK) | 29-31 August, 2012 | Aachen, Germany |
| KSTiT | **Polish National Telecommunication Symposium**<br>***Invited speech***<br>Econet– Energy Efficient Technologies for Wire Networks<br>M. Kamola (NASK) | September, 2012 | Miedzeszyn, Poland |
| INFOS | **XV Joint International Scientific Event on Informatics**<br>***Invited speech***<br>*Energy-Efficient protocol in OMNET++ Simulation Environment*<br>K. Daniluk (WUT) | September, 2012 | Rzeszów, Poland |

| Acronym | Conference and title of presentation | Date | Location |
|---|---|---|---|
| ITU-T GSW | **ITU-T Green Standards Week**<br>***Poster exhibition***<br>*ECONET project*<br>R. Bolla (CNIT) | September, 2012 | Paris, France |
| ICCE 2012 | **The 4th International Conference on Communications and Electronics**<br>***Special session***<br>*Energy Efficient Networking*<br>F. Davoli (CNIT) | August, 2012 | Hue, Vietnam |
| SustainIT 2012 | **The Second IFIP Conference on Sustainable Internet and ICT for Sustainability**<br>***Panel presentation***<br>*The low Energy COnsumptionNETworks(ECONET) Project - http://cnd.iit.cnr.it/sustainit2012/t-program.html*<br>F. Davoli (CNIT) | October, 2012 | Pisa, Italy |
| TEEF | **5th Annual Telecoms Energy Efficiency Forum**<br>***Presentation***<br>*International Activities Towards Energy Efficiency*<br>G. Griffa | April, 2013 | Prague, Czech Republic |
| IEEE INFOCOM | **32nd IEEE International Conference on Computer Communications**<br>***Student poster***<br>*FREE - Fast Reroute for Energy Efficiency*<br>D. Reforgiato, V. Riccobene | April, 2013 | Turin, Italy |
| FUNEMS 2013 | **Future Networks and Mobile Summit**<br>***Demonstration***<br>*Live demonstration of the Network Connectivity Proxy (NCP) prototype*<br>M. Giribaldi | July, 2013 | Lisbon, Portugal |

| Acronym | Conference and title of presentation | Date | Location |
|---------|--------------------------------------|------|----------|
| KSTiT | **Polish National Telecommunication Symposium**<br>***Invited speech***<br>*An energy-aware multi-level control system for a network of Linux software routers.*<br>M. Karpowicz (WUT) | September, 2013 | Gdańsk, Poland |
| IEEE Online GreenComm'13 | **IEEE Online Conference on Green Communications**<br>***Demonstration***<br>*Smart Proxying: Reducing Energy Waste in Network Devices During Idle Periods*<br>R. Bolla (CNIT), M. Giribaldi, R. Khan, M. Repetto | October, 2013 | On line |
| 22 ITC SSEEGN | **22th International Teletraffic Congress Specialist Seminar on Energy Efficient and Green Networking, in conjunction with the Australasian Telecommunication Networks and Applications Conference (ATNAC 2013)**<br>***Invited keynote speech***<br>*Green Networking and Network Programmability: a Paradigm  for the Future Internet?*<br>F. Davoli (CNIT)<br>***Panel discussion – presentation***<br>*Enablers and Roadblocks for Green Networking*<br>F. Davoli (CNIT) | November, 2013 | Christchurch, New Zealand |

Finally, it should be highlighted that the estimated energy saving in 2015-2020 perspective telecommunication networks by the ECONET project has been referred to in the presentation of Mr. Flavio Cucchietti "Overview of the ITU Report on "Boosting Smart Grids through Energy Efficient ICT" shown during the ITU Symposium on ICTs, the Environment and Climate Change (Montreal, Canada, 29-31 May 2012, programme of the symposium available online at: http://www.itu.int/ITU-T/worksem/climatechange/201205/programme.html).

## 2.8 *Workshops and exhibitions*

### 2.8.1 Organized workshops and meetings

The ECONET consortium organized several workshops, special sessions, meetings and panel discussions concerned with the low energy consumption and energy efficient methods and technologies for computer networks. The target audience consisted of stakeholders from government and businesses, technical experts, researchers, network operator organizations (e.g., GeSI, etc.) and industrial forums (e.g., HGI, etc.).

The following events were organized or co-organized by the ECONET consortium during 2013

- CNIT (R. Bolla and F. Davoli) were strongly directly involved in the organization of the **22nd ITC Specialist Seminar** on **Energy Efficient and Green Networking (SSEEGN 2013)**.

- The same objective was in charge for the **2013 Tyrrhenian Workshop on Digital Communications (TIWDC 2013)**, which was organized by F. Davoli and R. Bolla on Green ICT and the telecommunication network energy efficiency themes. The objective here was to have a session dedicated to the ECONET project results.

- The **ETSI Workshop on Environmental Impact Assessment and Energy Efficiency** was co-organized with ETSI by GRNET and ECONET with the work of A. Zafeiropoulos and Prof. Bolla in in 2013 in Athens.

- The **Green and Energy-efficient Networking Workshop**, realized by ECONET jointly with the GreenTouch initiative and the TREND project at the Future Networks 12th FP7 Concertation meeting, the 22th October 2013.

### 2.8.2 Attended workshops and exhibitions

The partners have already organized and participated in workshops shown in Table 6.

**Table 6. Attended workshops.**

| Workshop | Date | Location |
|----------|------|----------|
| **3rd Int. Workshop on Green Communications** <br> *Presentation* <br> *An Analytical Model for Designing and Controlling New-Generation Green Devices* <br> R. Bolla, R. Bruschi, A. Carrega, F. Davoli (CNIT) <br> Note: <br> **Winner of the Best Paper Award** | 10 December 2010 | Miami, FL, USA |
| **4th Future Internet Cluster Workshop on ICT and Sustainability** <br> *Presentation* <br> *ECOnet: Low Energy Consumption Networks* <br> R. Bolla (CNIT) | May 2011 | Budapest, Hungary |

| Workshop | Date | Location |
|---|---|---|
| **GTTI 2011**<br>***Presentation***<br>*A Flexible Router for On-fly Dynamic Packet Management in NetFPGA Platform*<br>A. Lombardo, C. Panarello, D. Reforgiato, E. Santagati, G. Schembra (LGT) | June, 2011 | Messina, Italy |
| **IEEE NZ Wireless Workshop**<br>***Presentation***<br>*Green Networking in Wired and Wireless Networks – Bridging the Gap*<br>F. Davoli (CNIT) | 26 August, 2011 | Christchurch, New Zealand |
| **ITU Green Standards Week**<br>**ITU Green Standards Week – Workshop on "Moving to a green Economy through ICT standards"**<br>***Invited speech***<br>*ECONET: low Energy Consumption NETworks*<br>R. Bolla (CNIT)<br>Notes:<br>ITU event hosted by Telecom Italia.<br>The main purpose of the event was to raise awareness of the importance and opportunities of using ICT standards to build a green economy.<br>The body of the talks comprised three workshops:<br>• *Methodologies for Environmental Impact Assessment of ICT*, jointly organized with the European Commission and hosted by TELIT,<br>• Moving to a Green Economy through ICT Standards, jointly organized with Telecom Italia,<br>• Submarine Cables for Ocean/Climate Monitoring and Disaster Warning: Science, Engineering, Business and Law was organized with WMO and UNESCO.<br>A general presentation of the ECONET project was provided.<br>The program of the event, including presentations and record of the webcast can be found at the following link:<br>http://www.itu.int/ITU-T/climatechange/gsw/201102/index.html | 5-9 September, 2011 | Rome, Italy |
| **Joint Workshop of EU projects: EARTH, C2POWER and TREND** | October, 2011 | Italy |

| Workshop | Date | Location |
|---|---|---|
| **GN3 Green networking: advances in environmental policy and practice**<br>***Presentation***<br>*Towards energy efficient Internet Service Providers –ECOnet perspective*<br>C. Vassilakis (GRNET)<br>***Presentation***<br>*Baseline studies of an NREN and the whole GÉANT network*<br>A. Zafeiropoulos (GRNET) | 5-6 March 2012 | Utrecht, The Netherlands |
| **1st ETSI workshop on Energy Efficiency**<br>***Presentation***<br>*Energy Consumption NETworks (ECONET): Smart power management for fixed network devices*<br>M. Enrico (TEI)<br>***Session chaired***<br>*EE Research Projects*<br>R. Bolla (CNIT)<br>Notes:<br>Workshop supported by ECONET (including technical committee participation, session chairing and final panel participation). | 21-22 June, 2012 | Genoa, Italy |
| **GTTI 2012**<br>***Panel***<br>*Modeling temperature and dissipation behaviour of an open multi-frequency green router*<br>G. Schembra (LGT) | June, 2012 | Villasimius, Sardinia, Italy |
| **e-FISCAL Summer Workshop co-located with the Samos Summit on Open Data and Interoperability**<br>***Presentation***<br>*GRNET Cloud Center economics and Green IT case studies*<br>A. Zafeiropoulos (GRNET) | 3 July 2012 | Samos, Greece |
| **Future Internet & Mobile Summit**<br><br>**Workshop 10a: "Future wired and Wireless Networks: Green, Heterogeneous and Cloud-Powered"**<br>***Presentation***<br>*Energy Efficiency in Next-Generation Datacenter Networks*<br>F. Davoli (CNIT) | 4 July, 2013 | Lisbon, Portugal |

| Workshop | Date | Location |
|---|---|---|
| **24th Tyrrhenian International Workshop on Digital Communications (TIWDC)– Green ICT** <br> *Scientific and Logistic organization of the Workshop* <br> *Workshop leadership and organization of an ECONET session* <br> F.Davoli (University of Genoa, Italy), Phuoc Tran-Gia (University of Wuerzburg, Germany), R. Bolla (University of Genoa, Italy), Trinh Anh Tuan (Budapest University of Technology and Economics) | 23-25 September, 2013 | Genoa, Italy |
| **ETSI Workshop on Environmental Impact Assessment and Energy Efficiency** <br><br> Local Organizer: A. Zafeiropoulos <br> Supporters and Program Committee Members: <br> R. Bolla (CNIT), A. Zafeiropoulos (GRNET) <br><br> *Selected speech* <br> *ETSI/EE-0030 - Green Abstraction Layer (GAL)* <br> R. Bolla (CNIT) | 7-10 November, 2013 | Athens, Greece |

The results of the ECONET project have already been presented on exhibitions co-located with conferences and workshops (see Table 7).

**Table 7. Attended exhibitions.**

| Exhibition | Date | Location |
|---|---|---|
| **Presentation of UE projects co-located with the Polish National Telecommunication Symposium (KSTiT)** <br> ***Presentation*** <br> *ECONET project* <br> M. Kamola, P. Arabas and M. Mincer (NASK) <br> Notes: <br> The focus was on the results of WP5 workpackage. <br> The exhibition stand of the ECONET project is presented in Figure 7. | 12-14 September, 2012 | Miedzeszyn, Poland |

| Exhibition | Date | Location |
|---|---|---|
| **The 6<sup>th</sup> International Warsaw Invention Show (IWIS 2012)**<br>***Presentation***<br>*ECONET project*<br>E. Niewiadomska-Szynkiewicz *et al.* (WUT) | 16-19 October, 2012 | Warsaw, Poland |
| **Presentation of UE projects co-located with the Polish National Telecommunication Symposium (KSTiT)**<br>***Exhibition & poster***<br>*ECONET project*<br>M. Karpowicz and E. Niewiadomska-Szynkiewicz (WUT), M. Kamola and P. Arabas (NASK)<br>Notes:<br>The focus was on the results of WP5 work package.<br>The exhibition stand of the ECONET. | 4-6 September, 2013 | Gdańsk, Poland |
| **Exhibition co-located with the SECURE 2013 Conference**<br>***Exhibition & poster***<br>M. Karpowicz, P. Arabas (NASK)<br>Notes:<br>The focus was on energy-aware multi-level control system for a network of Linux software routers. | 9-11 October, 2013 | Warsaw, Poland |



**Figure 8 – ECONET exhibition stand.**

Moreover, the "ECONET Green Reference Router" developed for the NetFPGA community was published by LGT. The project is distributed as an open source project and the source code is available online at: https://github.com/lightcomm/Econet-Green-Reference-Router/wiki.

## 2.9  *Seminars and presentations*

In order to enable regular information about the ECONET project results, the partners of the consortium have already organized several academic and technical seminars for researchers, students and industry experts in the field. Moreover, the partners have already participated and plan to participate in various meetings, round table discussions and other dissemination events concerned with the activity in green networking. Particular attention has been and will be paid to create awareness on the low energy consumption and energy efficient methods and technologies developed in the project for wider audience.

### 2.9.1  Attended seminars and dissemination events

The ECONET project was presented at the meetings and dissemination events collected in Table 8.

**Table 8. Attended dissemination events and meetings.**

| Meeting or Dissemination event | Date | Location |
|---|---|---|
| **Xilinx Research Day** <br> ***Poster and flyers*** <br> *ECONET activities* <br> M. Collier (DCU) | January 2011 | Dublin, Ireland |
| **Green Networking and correlated activities** <br> ***Presentation*** <br> *ECONET cross presentations and possible cooperation with COST804* <br> R. Bolla, F. Davoli (CNIT) | 26 January 2011 | University of Würzburg, Germany |
| **Economic Forum: Telecommunications, Internet, Media, Electronics** <br> ***Presentation*** <br> *ECONET project* <br> M. Kamola (NASK) <br> Notes: <br> Organized by the Polish Chamber of Commerce for Electronics and Telecommunications | 16 May 2011 | Rzeszów, Poland |

| Meeting or Dissemination event | Date | Location |
|---|---|---|
| **Future Networks 8th FP7 Concentration meeting**<br><br>**Green Networks Cross Cluster meeting**<br>*Presentation*<br>*Energy Consumption in Fixed Telco's Networks: Status, Trends, Needs and Opportunities*<br>Zafeiropoulos (GRNET)<br>*Presentation*<br>*A Pragmatic Approach in Developing New Generation Sustainable Networks*<br>M. Enrico (TEI)<br>*Panel*<br>R. Bolla (CNIT) | 6-7 October 2011 | Brussels, Belgium |
| **STRONGEST Project meeting**<br>*Presentation*<br>*Presentation of the ECONET Project*<br>R. Bruschi (CNIT) | October 2011 | Pisa, Italy |
| **The Rince Institute Research Day**<br><br>*Presentation*<br><br>*ECONET project*<br>M. Collier (DCU)<br>Notes:<br>Presentation to DCU researchers of the ECONET project. | October 2011 | Dublin, Ireland |
| **Home Gateway Initiative (HGI) meeting**<br>*Presentation*<br>*HGI Energy Phase 2 and ECONET Project. Possible Synergies*<br>L. Giacomello (TELIT), O. Wachendorf (LQDE)<br>Notes:<br>Dissemination of ECONET objectives and state of the art (with specific reference to NT and home gateway activities). | 11 November 2011 | Dubrovnik, Croatia |
| **Green Touch meeting**<br>*Presentation*<br>*ECONET project*<br>F. Davoli (CNIT)<br>Notes:<br>Online presentation of the ECONET project to the Core Optical Network and Transmission (CONT) Working Group of the Green Touch Consortium | November 2011 | Seattle, WA, USA (online) |

| Meeting or Dissemination event | Date | Location |
|---|---|---|
| **Green ICT in Italy: Networks, Cloud and Power Grid** <br> *Presentation* <br> *Presentation of the ECONET project* <br> F. Davoli (CNIT) | December 2011 | Milan, Italy |
| **Meeting of the COST Action IC0804** <br> **(Energy Efficiency in Large Scale Distributed Systems)** <br><br> **Round table discussion on** <br> **"Metrics for End-to-End Energy Efficiency"** <br> *Presentation* <br> *Connection-wise Energy Efficiency: Measuring Power Consumption of TCP and of Nodes along the Path* <br> F. Davoli (CNIT) | 8 May 2012 | Madrid, Spain |
| **Industry Forum of the IEEE International Conference on Communications (ICC'12)** <br> *Panel* <br> *Future Home Gateway Services for Next Generation Home Network* <br> L. Di Gregorio (LQDE) | 12 June 2012 | Ottawa, Canada |
| **Home Gateway Initiative (HGI) meeting** <br> *Presentation* <br> *Requirements for Network Connections Proxy Functionalities in the HG* <br> L. Giacomello, M. Quacchia (TELIT), <br> O. Wachendorf (LQDE), M. Giribaldi (INFO) <br> Notes: <br> Dissemination of ECONET architectural model and requirements on connectivity proxy. | 12 June 2012 | Paris, France |
| **ETNO (European Telecommunications Network Operators) meeting** <br> *Invited speech* <br> *Research Activities at the TNT LAB: the Project ECONET* <br> R. Bolla (CNIT) | 18 June 2012 | Genoa, Italy |

| Meeting or Dissemination event | Date | Location |
|---|---|---|
| **Home Gateway Initiative (HGI) meeting**<br>***Presentation***<br>*HN Device Energy Management Architecture<br>and Data Model Proposal*<br>L. Giacomello, M. Quacchia (TELIT)<br>Notes:<br>Dissemination of ECONET architectural model and requirements on connectivity proxy, integrated with other HGI contributions.<br>In cooperation with the ECONHOME consortium and Orange. | 13 September 2012 | Heidelberg, Germany |
| **IEEE International Conference on Communications 2013 (ICC 2013)**<br><br>**Industry & Business Panel P9 – "Collaborative Programs in Green Communications: Successful Cases and Key Remaining Research Challenges"**<br>***Invited Panel Presentation***<br>*Energy Efficient Networking: The ECONET Project*<br>F. Davoli (CNIT) | 12 June, 2013 | Budapest, Hungary |
| **International Teletraffic Congress 2013 (ITC 25)**<br>***Panel Discussion***<br>*Energy efficiency, network performance and users' Quality of Experience in a scalable Future Internet*<br>Moderator: F. Davoli (CNIT) | 12 September, 2013 | Shanghai, China |
| **Home Gateway Initiative (HGI) meeting**<br>***Demonstration***<br>*Live demonstration of the NCP prototype*<br>Speaker (s):R. Bolla (CNIT), M. Giribaldi (INFO), R. Khan, M. Repetto | March, 2013 | Turin, Italy |

The ECONET project was presented to different DCU and CNIT visitors and contacts including:

- CNIT: Mr. Olivier Lauvray: President & Managing Director of NetLogic Microsystems Europe;

- CNIT: Mr Shugong Xu, Pricipal Scientist and Vice –Director of Comm. Lab, Senior researcher Mr. Zhu Bin, from HUAWEI TECHNOLOGIES Co.;

- DCU: Mr.Zhaotian Zhang: Deputy Director General of the National Natural Science Foundation of China, in charge of the ICT division (very important figure for research funding in China);1

- DCU: Prof. Yinghai Zhang: Vice President of BUPT (Beijing University of Posts and Telecommunications), and a number of research active professors from BUPT including Prof. Wenbo Wang (Director for postgraduate studies in BUPT);

- DCU: Mr. Jichun Feng (former director general of the High-Technology Research & Development Centre in The Ministry of Science & Technology, China);

- Other DCU visitors including from Wuhan University, Beijing Institute of Technology, Xian Jiaotong University, ETM: European Telecommunications Management Ltd, and Indian Institute of Science Bangalore.

Prof. Suresh Singh and his PhD student Ms Candy Yiu visited the TNT Lab at the University of Genoa, Italy, in November 2011 within the framework of the external participation of Portland State University (PSU), OR, USA, in ECONET activities (see table 8). Within the same framework, Mr Alessandro Carrega, PhD student at the University of Genoa, strongly involved in ECONET activities, spent 6 months at PSU, between October 2011 and April 2012.

Prof. Franco Davoli was appointed Visiting Erskine Fellow at the University of Canterbury, Christchurch, New Zealand, where he spent two months in the period July-September 2011, teaching a course in "Green Networking" and giving a few talks and seminars on the same subject (see Table 9 below).

Some contacts have been created by Telecom Italia with the project ECONHOME that has been finalized in a common remote meeting realized in April 2012, where possible common contributions to the standardization forum in the area of the NCP have been discussed.

The partners of the ECONET consortium have organized seminars on green networking and ECONET project goals and ideas. The titles of talks given by the partners of the consortium are listed in Table 9.

**Table 9.  Organized seminars and talks.**

| Seminar or Talk | Date | Location |
|---|---|---|
| ***Seminar***<br>*ECONET: low Energy Consumption NETwork – project presentation*<br>E. Niewiadomska-Szynkiewicz (WUT) | November 17, 2010 | Warsaw University of Technology, Poland |
| ***Seminar***<br>*ECONET the 7th FP project – project objectives*<br>M. Kamola (NASK) | November 24, 2010 | NASK, Poland |
| ***Seminar***<br>*Energy efficiency in the future Internet: current status and trends*<br>R. Bolla, R. Bruschi (CNIT) | March, 2011 | Scuola Superiore Sant'Anna, Pisa, Italy |

| Seminar or Talk | Date | Location |
|---|---|---|
| **Invited speech**<br>*Green Networking Technologies for a sustainable future internet*<br>F. Davoli (CNIT) | August 8, 2011 | University of Canterbury, Christchurch, New Zealand |
| **Seminar**<br>*Green Future Internet and green energy: a profitable liaison*<br>F. Davoli (CNIT) | August 24, 2011 | Auckland University of Technology, Auckland, New Zealand |
| **IEEE NZ ComSoc**<br>**Invited talk**<br>*Green Future Internet and green energy: a profitable liaison*<br>F. Davoli (CNIT) | August 25, 2011 | Christchurch, New Zealand |
| **Seminar**<br>*Merging Traffic to Save Energy in the Enterprise*<br>S. Singh (University of Portland, UPC) | November 11, 2011 | University of Genoa, DIST |
| **Seminar**<br>*Green networking: the frontier of the Internet and telecommunications beyond the crisis*<br>R. Bruschi (CNIT) | May 10, 2012 | University of Catania, Italy |
| **Seminar**<br>*Green Networking*<br>D. Reforgiato | December, 2012 | University of Maryland, USA |
| **Seminar**<br>*Energy-efficient CPU service rate control mechanisms for the Linux kernel*<br>M. Karpowicz (WUT) | January, 23, 2013 | NASK, Poland |
| **Seminar**<br>*Energy Consumption and Power Saving potentiality in ICT: the experience in Telecom Italia*<br>D. Suino (TELIT) | May 10, 2013 | University of Catania, Italy |
| **Seminar at ISTI-CNR**<br>*Energy Efficient Networking*<br>F. Davoli (CNIT) | June 28, 2013 | Pisa, Italy |

| Seminar or Talk | Date | Location |
|---|---|---|
| **Seminar**<br>*ECONET the 7th FP project – WP5 results*<br>M. Karpowicz (WUT), M. Kamola (NASK) | November 13, 2013 | NASK, Poland |

The ECONET working progress was presented by Telecom Italia during the ITU-T Joint Coordination Activity on ICT and climate change (JCA-ICT&CC), which was held in Geneva on the 11th of October 2012. The objectives of the Joint Coordination Activity on ICT and climate change (JCA-ICT&CC) are to co-ordinate activity on ICT & CC across ITU-T Study Groups, in particular SGs (5, 9, 13, 15 and 16), and to coordinate with ITU-R and ITU-D, as well as to provide a visible contact point for ICT and Climate Change activities in ITU-T, to seek co-operation from external bodies working in the field of ICT & CC and enable effective two-way communication with these bodies.

## 2.10 *Academic and training courses and tutorials*

Although in the last years the sustainability and the green approach to technologies became a critical issue in many research fields, the majority of engineers, researchers and students have only scattered information and superficial knowledge about the energy efficiency technologies related to the networking field. We identified training needs among partners. Based on this survey, a training program was elaborated with the required workshops and training courses, making use of either partners' or external resources.

Academic partners have already prepared and deliver lectures on green networking and included ECONET outcomes in their institutional courses and other educational activities. Furthermore, M.Sc. and Ph.D. these and other research works on the subject have been proposed.

The following courses provided in Warsaw University of Technology include materials related to ECONET:

- Modelling and Computer Simulation

- Computer Networks

- Distributed Systems

Moreover, the ECONET partners have already prepared and submitted tutorials about technologies for green networking. Several tutorials have already been held (see Table 10).

**Table 10. Delivered lectures and tutorials.**

| Lecture or Tutorial | Date | Location |
|---|---|---|
| **Course "COSC473: Relational Methods"** <br> *Lectures* <br> *Green Networking* <br> F. Davoli (CNIT) <br> Notes: <br> Eighteen hours of lectures delivered by Prof. Davoli as Visiting Erskine Fellow. | July-Aug. 2011 | University of Canterbury, Christchurch, New Zealand |
| **The 12th IEEE International Conference on High Performance Switching and Routing (HPSR 2011)** <br> *Tutorial* <br> *Green Technologies for Smarter Next-Generation Wire-line Networks* <br> R. Bruschi (CNIT) | July 3, 2011 | Cartagena, Spain |
| **Course "Architectures and Applications for TLC Networks" in the Telecommunications Engineering Curriculum** <br> *Lectures* <br> *Green Networking* <br> F. Davoli, R. Bruschi (CNIT) | May, 2012 | University of Genoa, Italy |
| **ICE ERASMUS MUNDUS PhD Program** <br> *Lectures* <br> *Green Networking* <br> R. Bolla (CNIT) | July 16-20, 2012 | University of Genoa, Italy |
| **2012 International Symposium on Performance Evaluation of Computer and Telecommunication Systems (SPECTS)** <br> *Tutorial* <br> *Green Technologies for Smarter Next-Generation Wire-line Networks* <br> R. Bruschi (CNIT) | July 11, 2012 | Genoa, Italy |
| **The 4th International Conference on Communications and Electronics (ICCE 2012)** <br> *Tutorial* <br> *Green Networking: A Tutorial* <br> F. Davoli (CNIT) | August 2, 2012 | Hue, Vietnam |

## 2.11 *Contacts with potential users*

In the course of their business contacts the ECONET participants are familiarizing their partners with their concepts and emerging technologies. Telecommunication companies and institutions have already been and will be contacted and exposed to the ideas and results of the project.

Some ECONET partners are end-user operators that can be potential users of the project outcomes. Research and Academic Computer Network (NASK) considers the use of the local and network-wide control policies developed by the consortium to energy conservation in its metropolitan network connecting research centres and universities in Warsaw. Another possible and considered application is to use the local control mechanisms developed by WUT in the National Centre for Nuclear Research in Poland.

Another project outcome - the sensor system for telecom infrastructure developed by NETvisor - has been turned into a product, "GreenLane Power Metering System". It is an electric power measurement system designed for telecommunication systems and data centers. The system includes sensors for both DC and AC power, sensor aggregator and a central system for measurement data collection and analysis. NETvisor has already customers for this product.

Moreover, beside the fact that ECONET partners are potential users of the project outcomes, in many of the contexts in which the activities and the results of the project have been presented most of the attendees were potential users of the ECONET results. Examples are the ETNO (European Telecommunications Network Operators) meeting Group ECONET presentation and discussion, the presentations and the stands at the ITU-T Green Weeks (2011 and 2012) and most of the presentations done in the standardization area. In this last respect the ETSI Workshop on Energy Efficiency and the **ETSI Workshop on Environmental Impact Assessment and Energy Efficiency**, both supported by ECONET, were very effective and important cases (we receive feedback and strong expressions of interest and support from many of the participant Telecoms and ISPs).

# 3. Conclusions

A lot of dissemination and standardization activities have been done during the entire life of the ECONET project and some of them are still ongoing or will be done to further exploit the results and bring the development carried out in the project to the research and standardization community and industry.

Many important results have been concretized, one over all **the standardization as ETSI Standard of the Green Abstraction Layer**: by considering that this object has been envisioned, studied, developed by the ECONET project alone for the first time, **we consider this an exceptional result**. Moreover, the vigorous push that this project obtained in the Network Energy Efficiency is clearly evident. Notable are several publications in Journals/Magazines of great relevance together with the large number of publications in high level International Conferences, with also the achievement of some Best Paper Awards. Finally, the strong, effective and complex action realized with respect to the BB-CoC, which is today a world-wide reference for Energy Efficiency in network devices, is another concrete indication of the effective results obtained by the ECONET project.

# References

[1]    GENI, "*Global Environment for Network Innovations*", http://www.geni.net.

[2]    COMBO project, http://www.ict-combo.eu.

[3]    IDEALIST project, "*Industry-Driven Elastic and Adaptive Lambda Infrastructure for Service and Transport Networks*", www.ict-idealist.eu.

[4]    The ECONET project, Deliverable 7.3, "*First ECONET Information Dissemination Plan*", available on line https://www.econet-project.eu.

[5]    The ECONET project, Deliverable 7.5, "*Second ECONET Information Dissemination Plan*", available on line https://www.econet-project.eu.

[6]    The ECONET project, Deliverable 7.6, "*ECONET Standardization*", available on line https://www.econet-project.eu.

[7]    ETSI, "*European Telecommunications Standards Institute*", http://www.etsi.org.

[8]    ETSI TC-EE, "*European Telecommunications Standards Institute–Technical Committee – Environmental Engineering*", http://www.etsi.org/technologies-clusters/technologies/environmental-aspects.

[9]    ITU, "*International Telecommunication Union*", http://www.itu.int.

[10]   ITU-T, "*International Telecommunication Union –Telecommunication Standardization Sector*", http://www.itu.int/en/ITU-T.

[11]   HGI, "*Home Gateway Initiative*", http://www.homegatewayinitiative.org.

[12]   EU-JRC, "*European Commission – Joint Research Centre*", http://ec.europa.eu/dgs/jrc.

[13]   BB-CoC, "*Code of Conduct on Broadband Equipment*", http://iet.jrc.ec.europa.eu/energyefficiency/ict-codes-conduct/energy-consumption-broadband-communication-equipment.

[14]   GeSI, "*Global e-Sustainability Initiative*", http://gesi.org.

[15]   ICT&CC, "*ICT and Climate Change*", http://www.itu.int/en/action/climate/Pages/default.aspx.

[16]   ATIS-NIPP, "*Alliance for Telecommunications Industry Solutions– Network Interface, Power, and Protection*", http://www.atis.org.

[17]   CENELEC, "*European Committee for Electrotechnical Standardization*", http://www.cenelec.eu.

[18]   IEC TC111, "*International Electrotechnical Commission – Environmental standardization for electrical and electronic products and systems*", http://www.iec.ch/dyn/www/f?p=103:7:0::::FSP_ORG_ID:1314.

[19]   BBF, "*BroadBand Forum*", http://www.broadband-forum.org/technical/test_cert_programs.php.

[20]   3GPP,"*Third Generation Partnership Project*", http://www.3gpp.org.

[21]  GSMA,"*GSM Association*", http://www.gsma.com.

[22]  BRAN, "*Broadband Radio Access Networks*", http://www.etsi.org/technologies-clusters/technologies/broadband-wireless-access.

[23]  IETF Energy MANagement (EMAN) Working Group, "Energy Management (EMAN)." https://datatracker.ietf.org/wg/eman/charter.

[24]  EU Research Projects, http://ec.europa.eu/research/index.cfm.

[25]  Final draft ETSI ES 205-200-2-1 (V1.2.0), Access, Terminals, Transmission and Multiplexing (ATTM), Energy Management, Global KPIs; Optional infrastructures; Part 1: General                                                requirements, http://www.etsi.org/deliver/etsi_es/205200_205299/20520001/01.02.00_50/es_20520001v010200m.pdf.

[26]  Final draft ETSI ES 205-200-2-1 (V1.2.0), Access, Terminals, Transmission and Multiplexing (ATTM), Energy Management, Global KPIs; Optional infrastructures; Part 2: Specific requirements; Sub-part 1: Data centres, http://www.etsi.org/deliver/etsi_es/205200_205299/2052000201/01.02.00_50/es_2052000201v010200m.pdf.

[27]  ETSI Workshop on Energy Efficiency, http://www.etsi.org/WebSite/NewsandEvents/Past_Events/2012_EEWORKSHOP.aspx.

[28]  The ECONET project, Deliverable 4.1, "*Definition of energy aware states*", available on line https://www.econet-project.eu.

[29]  The ECONET project, Deliverable 4.3, "*Abstraction layer final definition*", available on line https://www.econet-project.eu.

[30]  The ECONET project, Deliverable 4.4, "*Abstract layer prototypic implementation*", available on line https://www.econet-project.eu.

[31]  B. Claise; J. Parello, "*EMAN: Energy-Management Activities at the IETF*," IEEE Internet Computing, vol. 17, no. 3, pp. 80-82, May-June 2013.

[32]  "*Liaison on monitoring of energy efficiency in telecommunication network infrastructures*", https://datatracker.ietf.org/documents/LIAISON/liaison-2013-09-04-etsi-tc-ee-eman-liaison-on-monitoring-of-energy-efficiency-in-telecommunication-network-infrastructures-attachment-1.pdf.

[33]  Final draft ETSI ES 203 237 V0.7.4, Environmental Engineering (EE),"*Green Abstraction Layer (GAL); Power management capabilities of the future energy telecommunication fixed network                                                nodes*", http://www.etsi.org/deliver/etsi_es/203200_203299/203237/00.07.04_50/es_203237v000704m.pdf.

[34]  ITU-T Green Standard Week, Rome, September 5th − 9th 2011, http://www.itu.int/ITU-T/climatechange/gsw/201102/index.html.

[35]  ITU-T Report on "*Boosting energy efficiency through smart grids*", http://www.itu.int/ITU-T/climatechange/report-smartgrids.html.

[36]  Second ITU-T Green Standard Week, Paris, September 17th − 21st 2012, http://www.itu.int/ITU-T/climatechange/gsw/201209/index.html.

[37]  European Commission - Joint Research Centre - Institute for Energy and Transport-

Renewable Energy Unit Code of Conduct on Energy Consumption of Broadband Equipment Version 4.1 , 20th December 2013
http://iet.jrc.ec.europa.eu/energyefficiency/sites/energyefficiency/files/code_of_conduct_broadband_equipment_v4_1_final.pdf.

[38]   European Commission - Joint Research Centre - Institute for Energy and Transport-Renewable Energy Unit Code of Conduct on Energy Consumption of Broadband Equipment Version 5.0 , 20th December 2013
http://iet.jrc.ec.europa.eu/energyefficiency/sites/energyefficiency/files/files/documents/ICT_CoC/cocv5-broadband_final.pdf