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Monitoring and Promoting ICT-based Energy Efficiency in Spain through the Telefonica E2-ICT Cluster

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Abstract: The goal of this work is to present initial results of a joint initiative gathering four Spanish Telefonica-University Chairs (Universitat Politecnica de Catalunya, Universidad de Oviedo, Universitat Politecnica de Valencia, and Universidad de Sevilla) named ICT Cluster for Energy Efficiency (E2-ICT Cluster) to monitor and promote the state of advancement of the different Spanish ICT initiatives to meet the EU "20-20-20" targets for some of the more significant energy efficiency significant sectors.

Keywords: ICT-based Energy Efficiency, Energy Efficiency Social Model, Telefonica- Chair Network

I. INTRODUCTION

In March 2007 [1] the EU endorsed an integrated approach to climate and energy policy known as the "20-20-20" targets to be met by 2020 and consisting on: 1) a reduction in EU greenhouse gas emissions of at least 20% below 1990 levels, b) 20% of EU energy consumption to come from renewable resources, and c) a 20% reduction in primary energy use compared with projected levels, to be achieved by improving energy efficiency. The EU leaders also proposed to increase the EU reduction to 30% (December 2008) provided that other major emitting countries would commit to it.

Furthermore EU determined that Information and Communication Technologies (ICT) sector had to play a central role into this initiative [1]. More specifically it proposed a) to commit, by 2010, to a measurable and verifiable reduction in energy intensity and carbon emissions of all processes involved in the production, transport and sales of ICT equipment and components defining, by 2011, energy efficiency targets, and b) to identify, in close cooperation with the energy efficiency significant economic sectors, specific ICT solutions to improve the environmental and energy performance of new and existing relevant policies, infrastructures and equipments.

The goal of this work is to present initial results of a joint initiative gathering four Telefonica-University Chairs (Universitat Politecnica de Catalunya, Universidad de Oviedo, Universitat Politecnica de Valencia, and Universidad de Sevilla) named ICT Cluster for Energy Efficiency (E2-ICT Cluster) to monitor and

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promote the state of advancement of the different Spanish ICT initiatives to meet the EU "20-20-20" targets for some of the more significant energy efficiency significant sectors.

II. MONITORING AND PROMOTIONAL E2-ICT CLUSTER ROADMAP

The E2-ICT Cluster composed by the four Telefonica-University chairs have created a think tank cluster formed by academic and professional specialists covering the different ICT technologies relevant to the key areas through a set of initiatives to:

- Identify at Spanish level the critical sectors where the ICT may play a significant role and contextualize (consumption, renewability, etc) them at international level.
- Study the more appropriate ICT solutions from the energetic, economic and environmental point of view.
- Promote a sustainable ICT-supported energy efficiency social model and to particularize it to the different geographic (city, region, state) and social needs (education, health, mobility, etc)
- Particularize its application to large-scale and small-scale companies and social groups. Telefonica proposes to reduce by 2015 a 30% of its 4.8TWh/year.
- Create an Observatory to monitor the different ICT-based energy efficiency initiatives among the different geographic and socio-economic sectors.
- Develop educational programs at pre-university and university levels and promote the academic studies on ICT greening initiatives through students and faculty.
- Analyze the social presence of the ICT greening related concepts and projects into the different media and specifically into the social networks.

Some initial activities are now described.

A. Spanish Initial Indicators and Key Areas

As a first approach the main macroeconomic parameters have been studied [2] and the Spanish initial parameters have been contextualized at international level. Fig. 1 shows the comparison of energy consumption per capita and Fig. 2 the percentage of this consumption produced by renewable energies (hydroelectric, geothermal, solar, wind, ethanol). It may be seen that Spain presents a 34MWh annual consumption slightly below European (38MWh) or OECD (51MWh) figures, twice the world average value (19 MWh/year) and clearly below the USA peak level (83MWh/year). In terms of renewable consumption Spain presents a relatively high value (7.5%) two percentage points above European average. During the last 10-year period from 2000 to 2009 Spain, according with the international tendency, has decreased its consumption per capita in a 9% (basically during the last two years) and increased one point (from 6.4% to 7.5%).

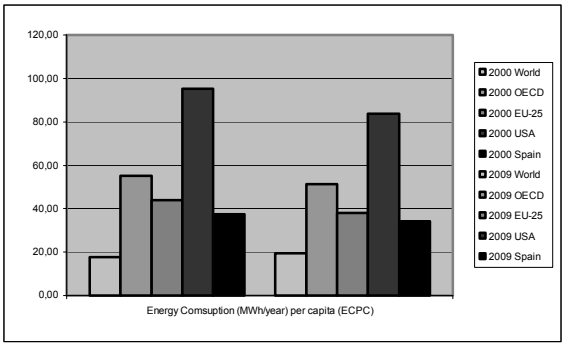

Fig. 1 Comparison of Energy Consumptions

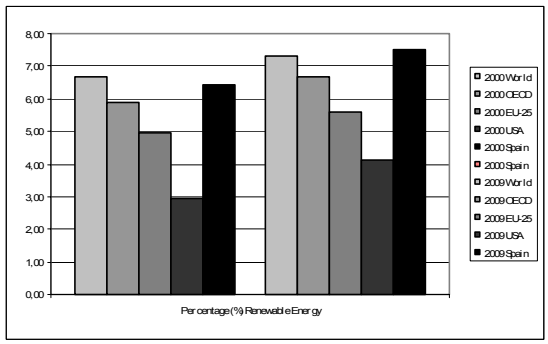

Fig.2 Renewable Energy Percentage

As a second step some of the key areas [3] where ICT has significant potentialities have been studied and contextualized at Spanish level: Smart Sustainable Cities (among them different Spanish cities as Zaragoza, Malaga, Murcia, etc), Smart Metering (starting in 2010 Malaga, Seville

and Barcelona), Smart Buildings (11% potential reduction in total energy consumption by 2020), Transport logistics (from journey savings and route optimization to vehicle improvements), Full electric vehicle (from trip planning to optimizing the charging process), Smart grids (infrastructural active and intelligent bi-modal and bi-directional networks) and New Energy Services and Business Models (from virtual power plants to smart micro-grids).

B. The Appropriate ICT Solutions

ICT has played a significant role in the last decades for improving economic productivity. It gives us the opportunity to make further significant productivity improvements, helping to transform the world towards a more sustainable, lower carbon dependent and more resource-efficient future. Studies such as the recent GeSI (Global e-Sustainability Initiative) SMART 2020 [4] clearly show that a more effective use of ICT can deliver tremendous CO_2e (carbon dioxide equivalent) savings. It is reported in [5] that "*The ICT industry is responsible for approximately 2% of global CO_2 emissions. ICT solutions have the potential to be an enabler to reduce a significant part of the remaining 98% of total CO_2 emitted by non-ICT industries*".

In 2009, the World Bank Group (WBG) issued the World Development Report 2010: Development and Climate Change (WDR10) [6], in which the world was challenged to "act now, act together, and act differently" to confront climate change impacts. It argued that high-income countries would need to lead and to take aggressive action to reduce their own emissions. That would free some "pollution space" for developing countries, but more importantly, it would stimulate innovation and the demand for new technologies so they can be rapidly scaled up.

Finding the most suitable ICT solutions requires a multidisciplinary task, which should be carried out by professional from different socio-economic sectors such as: manufacturing, environmental, building, energy distribution, etc. These professionals can cooperatively work developing efficient and sustainable solutions using ICT as support technology.

On the other hand, the ICT Cluster for Energy Efficiency (E2-ICT Cluster) initiative, which comprises four Telefonica University Chairs and the own company, has the objective to study, monitor, develop and promote adequate ICT solutions in different sectors. Each Telefonica chair exhibits an area of expertise and then focuses its activities on the development of ICT solutions to the actual social aspects. The Telefonica Chairs network works as a reference think tank for the study of the impact of the ICT technologies in the society. Alternatively, each Telefonica Chair can naturally interact with other University Company Chairs related to different socio-economic sectors.

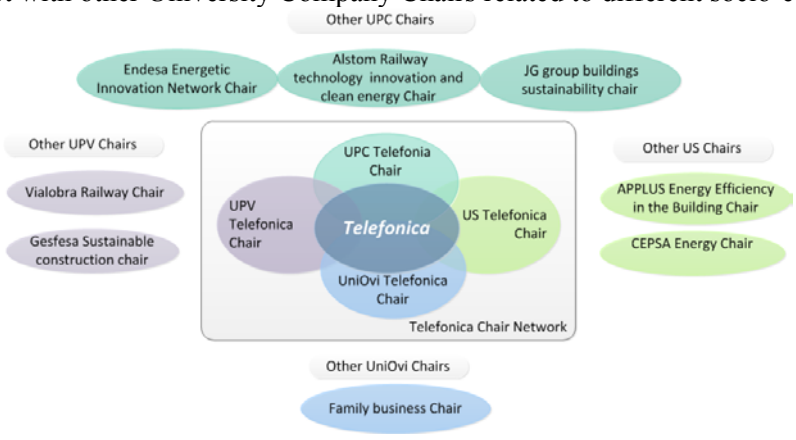

Figure 3. Cooperative structure of the E2-ICT Cluster.

Therefore, the Telefonica Chairs Network reaches easily and naturally researchers, companies and institutions of different sectors and then can discuss with them the use of ICT technologies for energy efficiency. Figure 3 illustrates the interactions between the Telefonica Chairs Network E2-

ICT Cluster and other company Chairs within the same Universities, some of the company Chairs of the Universities related to energy efficiency are also shown.

C. Promote and particularize a sustainable ICT-supported energy efficiency social model

In order to benefit from the technical solutions to the economic and energetic models the social concern and the applicability of solutions to it must be addressed.

Some studies [7]-**¡Error! No se encuentra el origen de la referencia.** indicates that ICT solutions applied to the way people develop their day-a-day activities, may reduce global emissions due to human actions in at least a 15% by year 2020 which implies economic savings of above 500,000 million Euros as a result in increasing energetic efficiency.

Experts recognize three types of solutions that may contribute to create a new social model in which the global energetic demand would be decreased: a) *improvement technologies*, like transport solutions or smart building management (mechanisms such as smart navigation may reduce the fuel consumption in 20% - 30% and those emissions associated, smart houses may reduce fuel needs up to 17.5% within the UE); b) *enabling technologies* like virtualization or dematerialization and c) other solutions such as *e-work* that would mean a 2.3% emission reduction if 1 of every 10 workers would use it.

According to [12], an "efficient" scenario (in which ICT use were promoted within the social an economic models) could reach about a 35% of consumption reduction in housing buildings, compared to a 1.7% reduction in a "BAU" scenario (business as usual). That is the reason of the necessity to promote initiatives that help to generate a social model based on efficient energy use supported on ICT. That model should be built having as basis some actual actions which are already being taken at different geographic level (personal, councils or counties, national, European,..). Within this model, Table I summarizes some initiatives in Spain that are susceptible to be monitored by the E2-ICT Cluster.

Table I. Some initiatives for promoting social models for sustainable ICT supported energy efficiency

		Geographic domain		
		Personal	Local/Regional	National
Social needs	Education	-e-learning	-Public transport -ICT at class -e-learning	-ICT at class -e-learning
	Health	-End-user e-health device	-e-health [16],	-e-health
	Mobility–transportation	-Real time localization and traffic info devices	-Electric car- Battery charging stations -Smart traffic and parking management [17]	-Intelligent transport systems [17] -Electric car [18] -e-toll
	Mobility–communica-tions	-Smart phones, wireless and LAN devices	-Wi-Fi areas -Public domain for base stations wireless services	-Surveillance of competence quality of service of telecom operators
	Energy	-Energy saving habits -Sustainability concern -Smart electric appliances -e-invoicing -Heating/cooling/lighting	-Smart buildings [14]	-Efficient energy production and smart grids
	Security	-Home disaster monitoring	-Monitoring networks for security and polluting agents (air, water, radiation, …)	-Intelligent fire surveillance systems -Natural and industrial disaster monitoring
	Administration	-use of e-Government	e-Government [15],[16]	e-Government

Dematerialization is actually one of the most successful measures introduced in society because of its energetic savings and simplification of logistic and managing procedures. Dematerialization typically involves ICT: e-banking, e-commerce, e-invoicing, e-Government (Government -to-Citizen or Government-to-Consumer) and some others like e-health where a lot of research and implementation effort is being carried out in last years in Europe. According to [7] dematerialization could contribute to a 460 Mt CO2 reduction by year 2020.

There are still factors that prevent people to get involved in the use of ICT-based initiatives which leads to an efficient energy consumption. To avoid this, national and European level R+D+I plans have been developed to promote ICT and new technologies introduction [13]. Furthermore, with the purpose of making people aware and spread new concepts and projects based on energy efficiency and the way ICT greening initiatives may help to achieve it, private organizations and civil and government groups are using social networks to promote new habits or to report on how to adapt to the new social model. It is worth mentioning Telefonica groups [19] and NGO or regional government related groups. In this frame the E2-ICT Cluster aims to evaluate the actual and potential impact of initiatives as those of Table I, through the study of the presence and influence of the topic in social networks. Some methodologies and results of the study of social networks will be presented at the conference.

D. Particularizing to Companies and Social Groups

Following the World Energy Outlook 2010 executive summary [23], the electricity power demand will continue increasing more that any other final use energy. It is expected that it will show a 2.2% annual increment between 2008 and 2035. Buildings are one of the largest end users of energy; in OECD (Organisation for Economic Co-operation and Development) countries, the building sector accounts for 25-40% of the final energy demand. Globally, carbon could be reduced by 715 million tons through simply improving the energy efficiency in buildings and appliances [24].

One of the basic requirements for energy efficiency of buildings, which arises in the recently approved Spain's Building Technical Code (CTE - Código Técnico de la Edificación) [25], is the energy efficiency of the lighting facilities. The lighting facilities of buildings will be appropriate to meet the lighting requirements of users and energy-efficient at the same time. To this end, they will have a control system that will optimize the use of natural light and adapt their use depending on the occupancy of the area.

Environmental responsibility cuts across all levels, increasing the impact of actions to the extent that increases the size of the organization. As an example of large-scale institution, the “Universitat Politècnica de València” (UPV) has more than 40,000 people including students and workers, who develop their activities each day in the 70 buildings that make up its main campus. This fact justifies that the reduction if its high energy consumption is a priority within the environmental management system of the institution.

Since 2006, structural measures are being taken on facilities and equipment not directly depending on changing the habits of the UPV university community. The DERD system (demand and distribution management system of energy resources), which is supported by the use of ICT, provides tools and techniques to improve the management of the University energy resources. It allows the measurement of the power consumption of the various facilities, also stores and processes data, monitoring that the consumption does not exceed certain values. It offers the ability to manage different consumption schedules depending on the price of the energy, and facilitate the generation of reports. DERD system has achieved annual energy savings of 8%, taking also into account the growth experienced in energy consumption. Another implemented measure at UPV is

the remote shutdown of computers. This system allows users to switch off (and on) from home (or anywhere).

As an alternative to institutional initiatives on this issue, researchers from the Telefonica Chair at UPV have developed a system of monitoring environmental and energy parameters in buildings based on wireless sensor networks [27]. The ability to remotely monitor these parameters at several areas of the building allows developing strategies for energy savings. This system has been deployed in City of Justice of Valencia, where the main energy consumption problems were due to the air conditioning system.

On the other hand, Telefonica company has set a goal to reduce up to 30% its global energy consumption during the period 2007-2015, as it is reported in the Corporate Responsibility Report for 2008 [28]. The energy savings on the Telefonica network operation will be supplemented by a decrement up to 10% on the power consumption of their facilities. It is expected that the E2-ICT Cluster initiatives can also contribute to achieve this objective.

III. SOME FIRST INITIATIVES

The "Telefónica Chair" at the University of Seville and its collaboration research groups are directly involved in various research projects and initiatives focusing on different aspects of energy efficiency. Two specific examples are:

- The Project SIMCENER research focused on energy efficiency in the industrial field.
- The Project SMARTCITY focused on the field of Electrical Distribution so-called smart grids

A. The SIMCENER Project

The main objective of this project is to design and develop of a prototype of an integrated system for continuous improvement of energy efficiency of industrial facilities, reducing energy costs and CO2.emissions.

The research focuses on the methodology for the energy characterization of plants, to carry out of a set of procedures for qualitative and quantitative analysis for the determination of energy efficiency indicators (EEI) and the identification of key influencing variables (VICS) . To this end, significant energy systems models of the plant are developed, correlating the IEE for the VICS data mining techniques. This method allows quantification of the impact of VICS on energy efficiency and optimization of modes of operation (operational VICS) using parametric modelling techniques, helping the decision-making to achieve energy efficiency targets.

As a practical and business approach of these studies, modular based software is designed for creating business intelligence dashboard IEE specialist. The project involves numerous advantages for the industries: a) A decrease in energy costs, b) The reduction of CO2 emissions, c) The maintenance of energy savings, d) An Increase of competitiveness, and e) An Improvement of the company image

B. The SMART CITY project

Spanish electricity consumption in 2010 amounted to 275,252 GWh [26], representing a per capita consumption of almost 6 MWh. It is obvious that the electricity sector is therefore one of the critical areas where policies apply appropriate objectives "20-20-20". Some of these objectives are met through appropriate policies for the generation / transport sector. In 2010 the coverage of demand by renewable energies (hydro, wind, solar and other) amounted to 35% of global demand Spanish but we cannot forget that these sources of variability present: in the case of hydropower

depending annual rainfall (2010 was abnormally wet) and in the case of wind power by its very nature. This leads to extreme situations, while 9 November at 3.35 hours the wind energy production covered 54% of demand, on 26 June at 10.32 covered just 1%. These reasons, in addition to purely economic, limit the implementation of these technologies.

Another approach to achieving these objectives is focused on the distribution and final consumption: we speak of so-called "Smart Grids"(SG). The concept of a Smart Grid is inseparable from the ICT. We could say that SG is precisely the widespread application of ICT in the electricity distribution networks to improve energy efficiency, with integration of distributed energy resources (DER). Worldwide there are numerous research projects and demonstrators of the various technologies associated with the concept of SG. [27] [28]. Within the same appears the project "Smart City" to develop in Malaga in the period 2009-2012 [29]. Energy efficiency is one of the main objectives in the Smart City project. This objective, as its name suggests, seeks to obtain a better use of available energy resources, trying to reduce as far as possible the losses of the various systems that make up the network. These losses are typically associated with:

- Losses associated with transport processes and distribution of energy: All electric energy transport system is associated with a range of energy losses in the cable, control systems, etc ... This project is proposed as target minimizes the possible losses. One solution to this is to bring the points of generation to areas of demand (Distributed Energy Resources DER), thereby reducing the lengths of the lines of transportation and distribution. This translates into a reduction of losses associated with this process.
- Difference between the amounts of power demanded and generated: This is normally associated with renewable sources whose level of production, depends exclusively on natural factors. This means that under normal conditions, if the demand is less than the maximum level of production, the difference is converted into untapped energy or loss. The solution to this problem is to incorporate the system of storage elements (eg, batteries, electric vehicle), which could exploit such overproduction, restoring power to said network, when it will be necessary.
- Irresponsible consumption behaviors: This is a problem directly related to the social consciousness to the environment. Although this awareness is increasing, this project aims to further promote this type of behavior. He advocates various initiatives or systems that will control the consumption in terms the needs of each user and network availability.

The development of energy efficiency in the scope of the project "Smart City", therefore, focuses on the following aspects: a) Efficiency in Distribution Network, b) Decreased demand on header, c) Improving the peak to-average daily demand curve, d) Reduction of technical losses, e) Efficiency in Consumption (Improving Habits), f) Decreased domestic consumption, g) Reduced consumption or street lighting, and h) Reduced consumption or large customers.

Other key objectives of the Project and related are:

- The integration of renewable energy sources both medium voltage (Mini generation) and Low Voltage (Micro generation).
- The integration and management (V2G) of electric vehicles. (PEV or PHEV).

IV. CONCLUSIONS

Spain, with a strong ICT related sector and good initial consumption and renewable energy parameters, constitutes a well behaved scenario to study and promote ICT-based greening initiatives according to the environmental and economic needs. Its last 10-year period tendencies show that strong monitoring and social and economic promotion needs to be kept and increased in order to improve this tendency and to fulfill the “20-20-20” European targets.

V. ACKNOWLEDGMENTS

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