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SUPPORTING EUROPEAN ENERGY CONSUMERS THROUGH GAMIFICATION AND COMPETENCE-BASED LEARNING

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Abstract. The European energy market liberalization strategy aims to assign a new role to consumers and end-users' communities so that they can become active participants on the energy market. In this paper we present the project SOCIALENERGY, EU-funded under the H2020 program. This project aims to promote the EU energy market transformation policy and to deliver supporting instruments. By developing innovative ICT-based tools, the project consortium will empower the EU energy consumers to become more energy efficient and competent. Apart from presenting the advanced features of SOCIALENERGY multi-modular platform, we will highlight the importance of the novel competence-based education (CBE) framework to support educational activities and to promote creation of social communities in the energy efficiency domain.

ACM Computing Classification System (1998): J.1, K.3.1, K.4.3, K.5.2.

Key words: energy efficiency, energy market liberalization, competence-based training and education.

1. Introduction. The liberalization of the EU energy market is a long-term and extensive process initiated in the 1990s and taking place on different levels: first, under EU Electricity Market Directives and second, development and improvement of cross-border trading rules (see [2]). Currently, the core of the EU energy policy is the efficient energy use and reduction of energy consumption outlined in the Energy Efficiency Directive (2012/27/EU and 2013/12/EU—EED) and the 2030 framework for climate and energy policies. EED sets out a number of measures, which cover all the stages of the energy chain—from production to final consumption, for EU to reach its 20% energy efficiency target by 2020. The EU has committed to cut CO_2 emissions by at least 40% by 2030 and meanwhile to modernize its economy by delivering jobs and growth for all European citizens. Furthermore, the amendments of EED from 30 November 2016 as part of *Clean Energy for All Europeans* stated that EU has to lead the clean energy transition and not only to adapt to it [5, 21]. The Commission set three main goals: to put energy efficiency first, to achieve global leadership in the renewable energy sector and most importantly, to provide a fair deal for consumers. The central role in shaping the energy markets of the future is reserved for consumers across EU, by improving their options to choose energy suppliers, to produce and sell their own electricity, and to access reliable tools for comparing energy prices. Moreover, consumers and civil society shall become more directly involved in the energy system. By increasing transparency and providing better regulations on the energy markets the EU will empower consumers to actively engage in energy efficiency actions and to better respond to the price signals. Hence, it is important that consumers and all EU energy policy stakeholders become more competent to effectively and efficiently take part in the new energy market.

This paper aims to outline the main challenges and changed expectations for consumers becoming active market players. Furthermore, the approach of the SOCIALENERGY project will be presented, including innovative tools and ICT instruments for successfully influencing change in consumers' behavior. The main research goal is to design an innovative and adequate solution for educating users on how to become experienced and efficient energy consumers in the new EU energy market.

The paper is structured as follows. The first part will explore the main concepts behind the new policy framework for the liberalization of the EU energy market, and several EU-funded research projects in the field will be outlined. The main accent in the paper will be put on the SOCIALENERGY project, identifying its aims and objectives to use social ICT, gamification and community's tools to motivate behavior change and to empower energy stakeholders and consumers. The competence-based learning approach and its advantages will be further explored. Finally, the conceptualization of the SOCIALENERGY competency framework will be presented, becoming the backbone of the SOCIALENERGY LCMS and its main elements.

2. Related work. The transformation of the energy sector, promoting clean and renewable energy and energy efficiency, are strategic drivers for future economic growth, attracting investments, innovations and research opportunities especially in the realms of new ubiquitous technologies. This is evident from the *Clean Energy for all Europeans* policy framework (2016), which covers a wide range of aspects such as energy efficiency, renewables and bioenergy sustainability, electricity market design and regulations, security of electricity supply, governance rules for the Energy Union, energy efficiency of buildings, eco-design, connected and automated mobility, energy costs, prices and funding.

The goals of the EU energy policy are to reinforce three important aspects of the EU energy market in which EU lags behind the US.

The first aspect is the creation of Demand Response (DR) Energy Programs (EP). DR is the adaptability of the demand for electricity to the availability of supply, aiming to smoothen the energy consumption loads during peak hours, hence reducing carbon emissions. DR EPs (contracts between energy providers and energy consumers) in Europe are more viable in comparison to the situation in 2013, but still variable among EU member states. On one hand, there are countries such as Belgium, France, Ireland and the UK, which have enabled DR. On the other hand, there are 11 EU member states which have not yet become engaged seriously with Demand Response reforms [1].

The second aspect is the development of energy efficiency-related market products and services, which allows energy efficiency and savings. The use of information and communication technologies (ICT) is crucial for the transition to and the development of a sustainable energy system.

The third aspect covers education of EU energy market stakeholders, as new EPs and energy-saving products and services are complex and they need further support in order to take advantage of the liberalized market. Utilities and new energy market participants are adapting their approach towards both the liberalized energy market and consumers-centric role. In that context the need for education of consumers on the new liberalized energy retail market, is of highest priority.

The successful technology advances in the energy efficiency domain on the US energy market succeeded both to reduce pollution and to decrease consumers' financial burden by creating resilient communities [6; 7, 1]. Most importantly, end-users' energy communities are actively involved in energy efficiency programs, using both social and behavioral aspects to affect the end-users patterns of energy demand. Thus there are a steadily increasing number of utility customers in cities, who take part in energy efficiency community programs and successfully reduce their energy waste.

Some of the current EU-funded research and innovation projects, addressing in general energy market transformation, are briefly described below:

SiNGULAR: Smart and Sustainable Insular Electricity Grids under Large-scale renewable integration [8] investigates the effects of large-scale integration of renewables and demand-side management on the planning and operation of insular electricity grids, proposing efficient measures, solutions and tools towards the development of a sustainable and smart grid.

Project ENTROPY (Smart IoT ecosystem in buildings, motivating end-users behavioral changes) [9], which deals with design and deployment of an innovative IT ecosystem targeting at improving energy efficiency through consumers understanding, engagement and behavioral changes with focus on the collection of energy-related information from heterogeneous data sources, proper analysis of the available data and provision of interactive services,

applications and serious games to end users for stimulating their interest for energy efficient activities.

Project Inlife: Incubate a new learning and inspiration framework for Education [10], which provides an innovative gamification framework targeting both typical as well as special education and social inclusion activities based on Serious Games. INLIFE's core concept leverages on the potential of the Internet-of-Things (IoT) paradigm to directly link actions, decisions and events happening in real-life with in-game educational progress and modern gaming technologies.

All these projects cover different specifics of the energy market change such as development of sustainable smart grid, deployment of IT energy efficiency in buildings, motivating end-users' behavioral changes and provision of innovative gamification frameworks. However, none of them take into consideration the social aspects of energy efficiency and the role of social communities for raising Energy efficiency competences, for inducing social and behavioral changes, combining educational, gaming and social features.

3. SocialEnergy project's approach. The SOCIALENERGY project aims to promote the EU energy market transformation and to further empower EU energy consumers, by exploiting innovative approaches based on ICT, like gaming and technology-enhanced learning solutions. This will make it possible to enhance communication and interaction between all energy stakeholders (consumers and utilities, energy efficiency companies, etc.), supporting end-users to take full advantage of the liberalized energy markets. Thus SOCIALENERGY aims to explore the potential of the gaming technologies in education and in social inclusion in the liberalized energy market in the EU following the global trends and taking into account behavioral economics.

The main purpose of the SOCIALENERGY project is to improve the communication models between energy sector stakeholders and residential energy consumers, allowing them to discover each other's needs, to educate and reach a better understanding of the main difficulties and challenges and finally to interact on the energy market and to trade especially in the scope of demand-response (DR) energy programs [4, 245]. All these will lead to a more

energy efficient, free from energy dependencies and environmentally friendly society.

The SOCIALENERGY project's objectives can be summarized as follows:

To apply and evolve recent incentive technologies (localized social externalities) towards effective use of behavioral economics in DR and energy efficiency sector.

1. To develop "SOCIALENERGY virtual world" by transferring gaming technologies into the energy efficiency sector, so as to educate and incentivize utility customers organized in ECs towards understanding and adopting modern DR programs.
2. To develop "SOCIALENERGY real world" by engaging the users via advanced gamification techniques towards self-organization and management of ECs and efficient interaction with SOCIALENERGY's commercial activities.
3. To provide a single point of hosting and advertisement services to energy consumers, energy communities, utilities and companies related to energy efficiency products and services via the development of context-aware recommendation algorithms.
4. To perform small scale and diverse experiments that involve real users, utilities (energy developers) and distributors (companies active in energy efficiency products and services delivery) in order to validate the concept of SOCIALENERGY, evolve its technologies and trigger its adoption from all energy market stakeholders.
5. To offer Energy Information Distribution as a Service (EIDaaS) to multiple stakeholders and to commercialize information related to energy efficiency.

The SOCIALENERGY (SE) will exploit gaming and gamification technologies that will be utilized in the energy sector via the development of the "SOCIALENERGY's virtual world". SE virtual world is a serious game, aiming to motivate and engage energy consumers and energy distributor

companies to deeply interact and educate themselves. There are three main gaming/gamification-related objectives, which are:

- Education and social inclusion towards energy efficiency, DR and environmental awareness.
- Stakeholder interaction and communication via social networks.
- User engagement and profiling.

The SOCIALENERGY consortium consists of members, which possess strong competences and ability to motivate and involve relevant communities, experts from the ICT, energy efficiency, gaming and education sectors with significant background and technology experience. The project leader, ICCS (Greece) will transfer the ICT technologies from its research portfolio by developing and testing already existing functionalities such as clustering, advanced searching and recommendation algorithms as well as experience in social network platforms development. ICCS leads the development of SOCIALENERGY's real world implementations exploiting its know-how from its participation in EU research projects in the converged ICT/energy sector. INTELEN (Cyprus) has developed and implemented its commercial DiG platform (one of the most recognizable energy efficiency, user engagement and gamification platforms in Europe) and its extended know-how in the energy efficiency business sector towards incorporation of social networking features and embedding of gaming technologies. INTELEN will exploit its commercial portfolio of utilities having tight commercial relationships with the energy efficiency market.

Nurogames (Germany) is one of the most successful game developers in the EU area and will transfer its expertise from gaming technologies to the non-leisure context of energy efficiency sector. It will lead the development of SOCIALENERGY's virtual world, exploiting its gaming/gamification portfolio of tools and its participation in EU RAGE project [11].

Finally, the University of Sofia (Bulgaria) will exploit its expertise in developing ICT solutions for the educational sector. It will lead the development of short modular learning units, which will educate all types of SOCIALENERGY's users and energy market stakeholders. It will also lead learning methodology and design, ensuring that all multi-disciplinary aspects

(e. g., ICT, gaming, energy, social, education, security, ethics, etc.) are taken into consideration and exploiting its know-how from its participation in the EU RAGE project.

4. Brief presentation of the SOCIALENERGY platform, tools and services. At the core of SOCIALENERGY stays the development of an energy efficiency social network, referred as Green Social Response Network (GSRN), exploring the combination of gamification and social interaction.

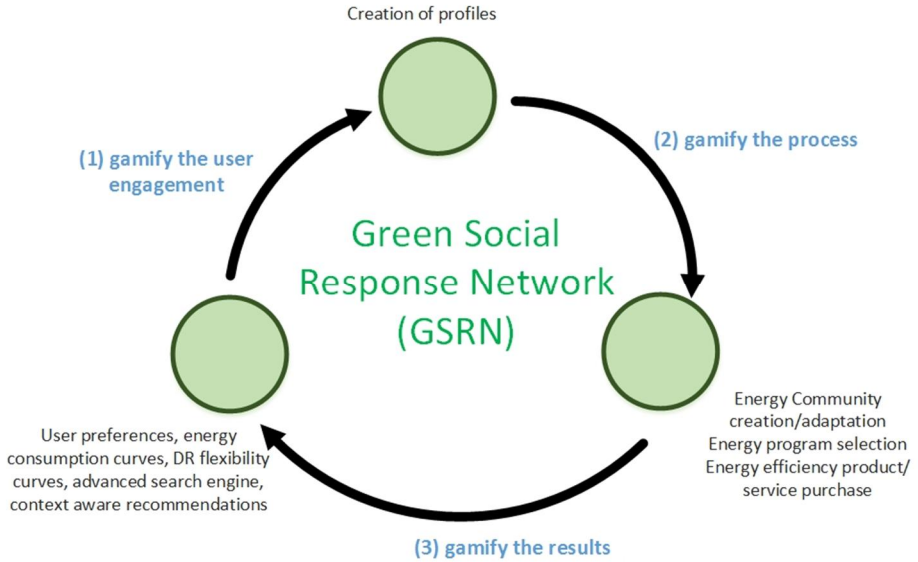

Fig. 1. General model of GSRN

Fig. 1 presents the general model of the GSRN and its three main gamification steps: 1) gamify the user engagement in DR and energy efficiency programs, 2) gamify the process (i. e., EC management), 3) gamify the results and feed them back to step (1).

The functional architecture of SOCIALENERGY platform is presented on figure 2, summarizing the modules and interaction models between the two "worlds": 1) the SOCIALENERGY's "real world", and 2) SOCIALENERGY's "virtual world". All types of users are playing modular, multi-user and self-evolving games in the virtual world. There, they will explore and learn more

about the good practices for DR actions, considering decisions to be made for the use of proposed GSRN platform in the real world. Results from the virtual world are provided as feedback and recommendations to the real world.

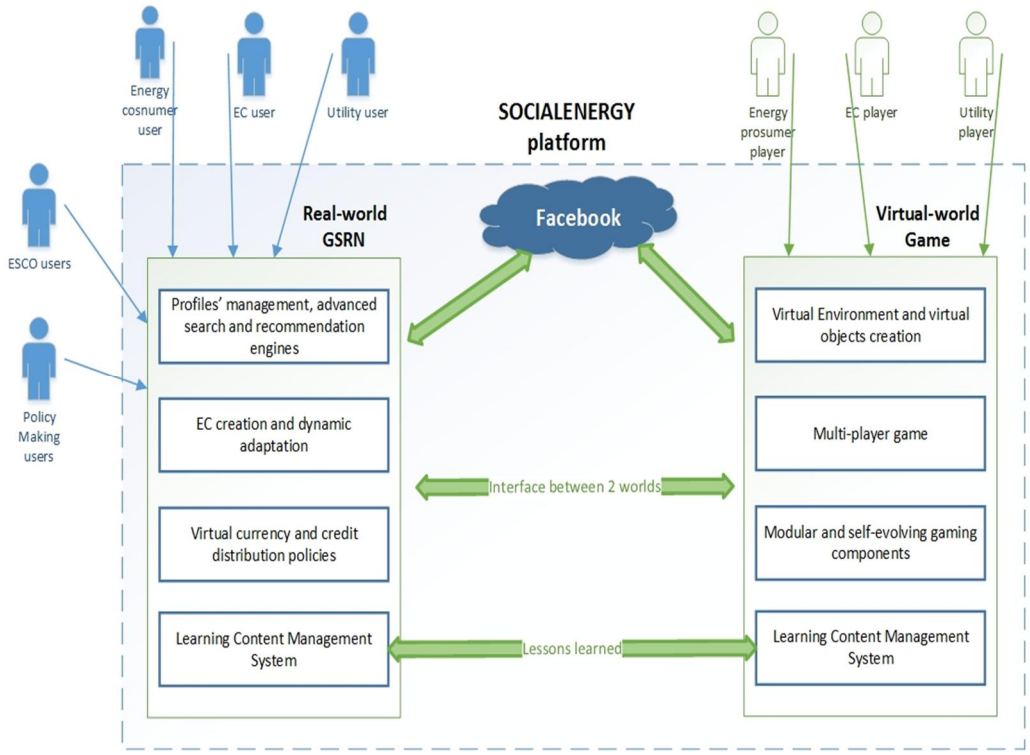

Fig. 2. High-level SOCIALENERGY platform architecture

In the real world, energy consumers are monitored and self-organized to Energy Communities (ECs). The profiles for the end users and Energy communities are created and dynamically adapted according to context-aware recommendations generated by GSRN. Additionally, GSRN facilitates interaction among energy consumers via other channels such as Facebook, ECs' interaction with utilities/ESCOs and other related energy efficiency companies. SOCIALENERGY also exploits gamification components such as the adoption of virtual currency and credit distribution policies. It creates an environment where ECs select dynamically and online EPs from utilities and energy efficiency and DR products and services that optimally fulfill their

needs. As a result of this complex process SOCIALENERGY platform develops well educated ECs and evolved energy efficiency stakeholders, which goes far beyond marketing of EPs and energy efficiency products and services.

The SOCIALENERGY system consists of four main subsystems or software components:

- Green Social Response Network (GSRN) web platform will be the core software platform of SOCIALENERGY, in which all the other subsystems will be integrated. Its concept is based on an existing commercial product (DiG), developed by INTELEN portfolio and used (at the time being) by existing electric utilities/retailers, whose aim is to offer advanced energy services to their customers (i. e., energy consumers).
- SOCIALENERGY GAME is a virtual world (or else virtual home), where the user (i. e., energy consumer) is educated on best practices regarding energy efficiency and the operation of liberalized electricity markets. The goal is the end-user to learn how to apply the knowledge experienced from the virtual world to the real world, which is actually done through the use of the GSRN platform. The GAME is mainly developed by Nurogames.
- Research Algorithms' Toolkit (RAT) provides data analytics services mostly to the GSRN, but also the game by integrating the sophisticated mathematical modeling in the GAME scenarios and score calculations. ICCS elaborates on the implementation of the existing VIMSEN Decision Support System (DSS) toolkit3 by exploiting the existing algorithms and by incorporating new algorithms for innovative Energy Programs (dynamic pricing) and virtual energy communities' creation and adaptation [3].
- Learning Content Management System (LCMS) has an important role as this is the subsystem in which the user/player educates himself/herself offline to receive new knowledge about good practices on energy efficiency. In particular, it provides the user the opportunity to better comprehend the new concepts in the liberalized smart grid markets and inter-relate the "lessons learned" from the GAME with the real-life

conditions (cf. GSRN) in order to be able to efficiently interact with his/her electric utility/retailer.) LCMS is developed by Sofia University (SU-NIS).

The above-mentioned subsystems are complemented by two additional software components. The first component is the Meter Data Management System (MDMS), which serves as SOCIALENERGY's database, where all energy-related datasets and models are available. The second is the innovative Energy Information Distribution as a Service (EIDaaS) API, which aims to provide "data monetization" services to bridge the gap between energy consumers and companies as well as among multiple other stakeholders related to the energy efficiency sector.

All systems will share common data regarding end users of the system, including personal profiles, learning goals and achievements, etc.

5. Competence taxonomy for the energy efficiency domain. Recently, a paradigm shift toward competence-based education is observed where the outcomes of the educational pathway are assessed via competence-based system (CBS). Competence-based education (CBE), also known as Outcome-based education, Competence-based learning or Skills-based learning, refers to the systems of assessment and grading focusing on the attainment of specific level of understanding and proficiency in certain subject-related skills. Even if CBE is not a new concept, the interest towards it is increasing with the emergence of the new e-learning models and blended learning alternatives, as well as on-line training projects such as MOOCs e-learning systems and skills-focused training programs. This way, via CBS the trainers or automated recommendation system can design in advance the best learning path and learning activities for the end-users according to the specific competences that they need to acquire, to excel and to improve. Even more, CBE better fits to specific learning contexts such as adult learning, learner-oriented training, specific industry or technology oriented training programs and others. Furthermore, attainment of a certain level of competency should be possible to be measured and assessed based on demonstrated abilities to apply and use the competency in different situations and circumstances.

The following working definition of the competence will be used for the SOCIALENERGY project activities:

"Competence means the proven ability to use knowledge, skills and personal, social and/or methodological abilities, in work or study situations and in professional and personal development" (European Parliament and Council, 2008).

The competency frameworks represent a hierarchical list of Competencies (usually defined by a standards body or central authority). Thus the competence taxonomy framework aims to identify the structure of the competences that will be then directly addressed by the learning objects. Furthermore, they will help to assess the end-user's competences and the level of proficiency after completion of any specific e-learning activity.

In order to adopt the competence-based learning approach, the SOCIALENERGY should apply a relevant competence taxonomy framework that will best respond to the learning profile of the target groups. The SU-NIS team identified several competence frameworks in the field of Energy efficiency, energy management, energy savings and energy efficiency behavioral change. However, most of these competence frameworks are designed mainly for employees and staff working in the field of energy management and energy efficiency. Therefore a new competence taxonomy framework was implemented, responding more closely to the needs of the SOCIALENERGY project target groups, the subject domain and the specifics of the project activities.

Due to the success of behavior change programs to reduce energy consumption in homes and businesses, the social elements and communities interactions will play a substantial role in the SOCIALENERGY competence taxonomy framework. The behavior change programs are based on social science research and typically combine multiple behavioral science-based strategies (e.g., public commitment, goal setting, and comparison to others' behaviors). Research [7] shows that the main taxonomies in the field of behavioral change range generally from 2 to 10 categories.

Thus, the SOCIALENERGY competence framework aims:

- to allow competency-based learning and assessment, based on taxonomy of competencies;

- to allow the use of rich set of learning resources and activities, supporting achievement of the identified competences;
- to support various modes of assessment of the learner's knowledge and competences and relevant grading according to achieved results, that will be implemented in the learning module;
- to allow learning based on individual learning plans, related to competences.

In the case of SOCIALENERGY, the SU-NIS team has developed a new competency framework, which fully responds on the subject domain, target user needs and specifics of the project activities.

Its current version consists of 28 competencies grouped in three main categories (see Fig. 3) as follows:

1. Energy-related end users knowledge.
2. Competencies to use the SOCIALENERGY platform.
3. Energy-related end users skills.

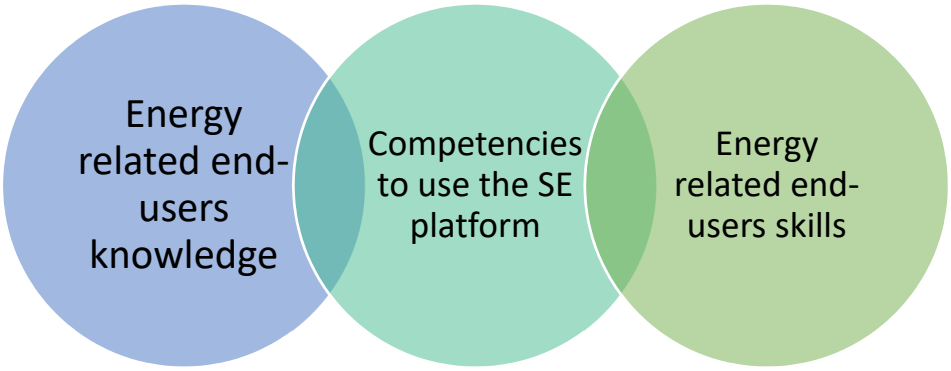

Fig. 3. Main categories of competencies

All competences should be addressed by specific learning activities. This way learning activities or learning resources can be linked and mapped to specific competency and end-users can be evaluated for possessing competencies related to specific learning domain.

6. Competency-based learning activities provided in the SocialEnergy platform via LCMS. The SU-NIS team designed a novel competence-based education (CBE) framework to support SOCIALENERGY educational activities. By employing the concept of CBE, SU-NIS also developed an Energy Efficiency Domain Knowledge Model (EED-KM). The EED-KM is represented by the competence framework described briefly above.

Based on EED-KM/competence framework, four (4) user profile models were developed up to now, namely:

- Basic user profile—traditional individual energy consumer, who shall acquire general knowledge and new skills in the energy efficiency domain; End-user—One family/household end-user; this user profile assumes no preliminary competences.
- Advanced user profile—Experienced user, competent on the liberalized electricity market, knows and participates in DR and advanced energy programs, forms and manages Energy Communities and shares knowledge and skills.
- Proficient user profile—Proficient and active end-user with specific interests in innovative Energy Programs savings and energy efficiency.
- Electric utility user profile—utilities' segment of the SOCIALENERGY's business model.

The developed competence-based learning concept will be realized through the LCMS Moodle, exploiting its advanced competence-based functionalities. These functionalities include the opportunity to design, develop and utilize competence frameworks, individual competences, Learning Plan Templates and Individual Learning Plans (ILPs) and various competence-based modules/courses, individual learning resources and activities. Created competence framework, individual competence, learning plans and developed learning modules/courses will lead to the acquisition by users of particular SOCIALENERGY competences and realization of individual learning plans based on courses/modules taken by these users in LCMS.

LCMS will receive from other SOCIALENERGY components (i. e., GSRN, GAME and RAT) information on identified gaps in competences and

training needs of SOCIALENERGY users. On its side, LCMS will prepare an individual learning plan for the user and will offer set of learning courses and materials. After that it will periodically report to GSRN the results from the training. This communication with GSRN is realized by specifically developed API. The interaction with the LCMS Web Service API will take place through number of services.

In Figure 4, the Learning Content Management System (LCMS) architecture is depicted together with all its S/W modules and the main information exchanges/flows among them. Furthermore, each S/W module's operation and main functionalities are then described.

Authorisation and registration module. Users will use a single ID and password to gain access to each subsystem without using different usernames or passwords. This module is related to identifying uniquely each learner and making use of such unique information across several other SOCIALENERGY subsystems. LCMS will support user authentication using various open mechanisms like LDAP, the Shibboleth protocol, CAS or FirstClass. User enrolment can be supported also on the base of external LDAP server or through suitable IMS standards (like LTI).

Module for storing personal information. In this S/W module, LCMS user personal information is stored about the learner's competences, grades, results, assessments, courses and learning resources used, etc. This information will be visualised to the respective user through her/his LCMS Learner Dashboard. The collected information will be also used by the GSRN platform and appropriate parts of it will be visualised through the GSRN Central User DashBoard.

Individual Learning planning module. This module will receive the created Individual Learning Plan (ILP) from GSRN for each individual user. The ILP is based on the SOCIALENERGY competences' framework, realised, fully supported, and served by the LCMS. On the base of the ILP, this S/W module will create a set of learning objects (courses or learning resources/activities), covering the required competences in the learner's ILP, which later on the system will offer to the learner.

Learning assessment module. This is a S/W module for supporting various modes of assessment of learner's knowledge and competences like quizzes, tests, tasks, etc., with clear and transparent rules for grading. Competency-based assessment will be supported by grading related to activities, where students demonstrate the relevant competencies. As a result, learners will receive a list of outcome competencies, achieved as a result of performing specific learning objects (set of activities and/or courses). Each course (learning object) will have its own Gradebook. Some activities, such as Assignment and Quiz will automatically send grades to the Gradebook. The system will enter and arrange grades into the Gradebook. Grades calculation formula can be set up to the Gradebook for grading each competence. The obtained assessment results (including competences) will be presented in the LCMS Learner Dashboard and submitted to the GSRN for presenting them to the Central User Dashboard and making available to the other GSRN subsystems (e. g., RAT).

On the base of the set of achieved competences, the user will receive respective awards in the form of badges, and eventually (upon ILP completion)—printable PDF certificates.

Learning module. This module provides sets of rich learning objects (activities and/or resources) for each individual learner, based on the required competences in his/her individual learning plan. The activities and resources are related to one or more required competences, and can include, for example, lessons, video lectures, reading materials, demonstrations, simulations, explanations, discussions, feedback, surveys, etc. Progress tracking allows all finished learning activities, visited learning resources, etc. to be guided by individual learning plans for each learner. Learners can follow their success through the course by viewing the respective progress bar. The system can indicate for each course item how it will be registered as complete. Learners may either mark this learning activity complete manually, or the course item will automatically be marked as complete, when learner meets the specified criteria. These criteria will indicatively include: viewing a resource, submitting an assignment, performing an activity, posting in a forum or other relevant output. In addition, badges can be awarded by the system using activity completion settings in a course. Learners may be awarded badges at different

stages of the course for different levels of progress. Also, PDF certificates/diplomas can be issued automatically and awarded to learners in a course, after the successful completion.

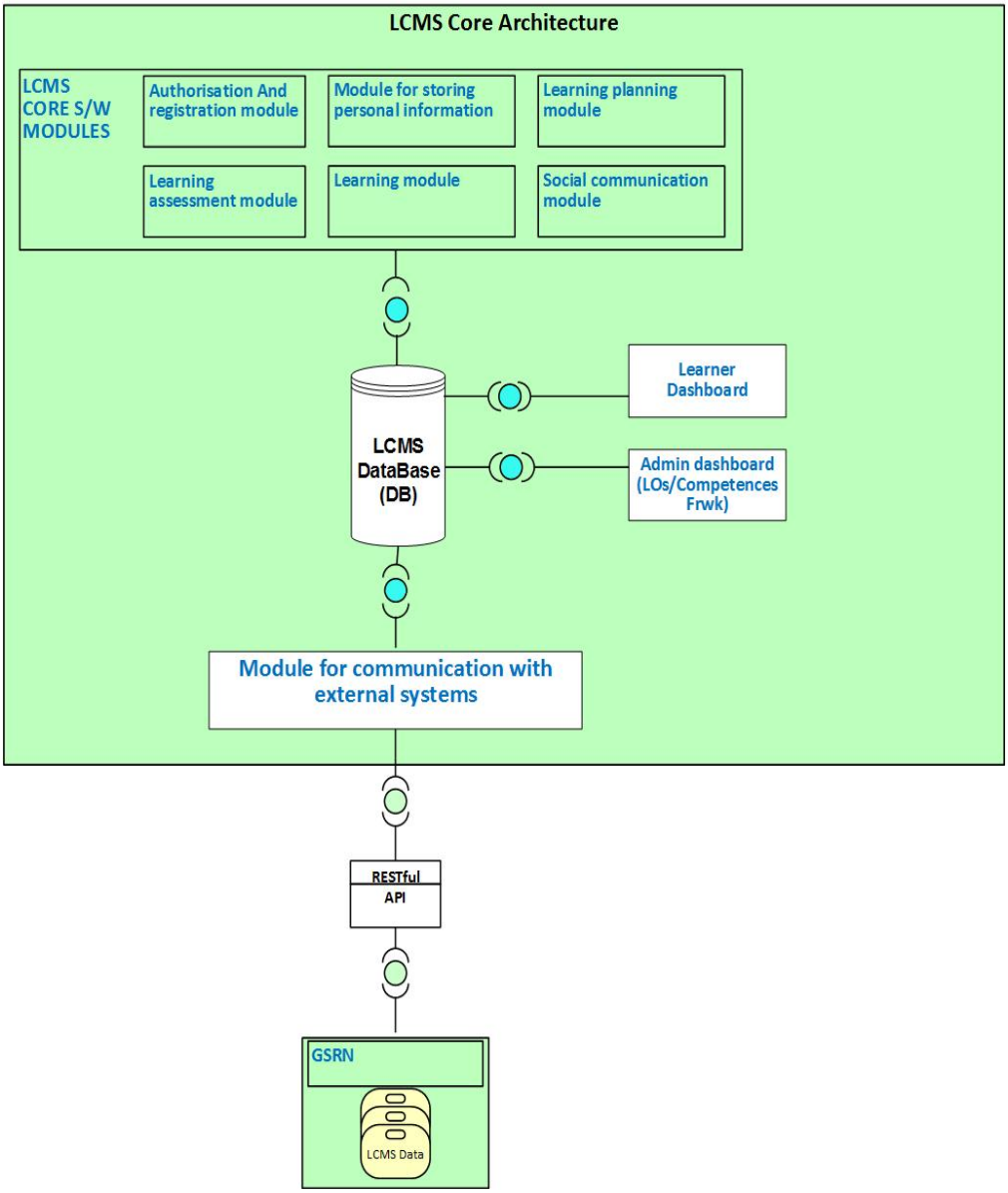

Fig. 4. Learning Content Management System Architecture

Module for communication with external systems. LCMS should be able to communicate with all other SOCIALENERGY modules and subsystems. In order to achieve this, the LCMS should support APIs and standards for integration with other systems, like the LTI (Learning Tool Interoperability), in order to consume learning resources and other relevant information from external systems, as well as to publish (or offer) similar information to external systems, in well agreed (in advance) format. The LCMS should be able to import and export any achievement results, such as badges, following and supporting standards like Mozilla's Open Badges.

LCMS will support the import of Reusable Learning Objects, packaged according to the SCORM/AICC/IMS Content Packaging standards, or according to the IMS Common Cartridge import and export specifications. The use of XML for content import/export will also be supported.

Since the LCMS core API and the modules will communicate on the base of events, this type of communication will allow population of LCMS actions and data of interest to external systems through their public APIs (e. g., new course created, new LO added, LO deleted, new competence added, etc.).

Social communication module. This module will enable learners to be grouped by their interests or using other relevant features, like competence levels, etc. They can communicate in their groups using many different forms using various tools like a chat, forum, dialogue, messages, wikis, tags, ranking, etc. The LCMS will use the GSRN functionality for connection with social platforms (Facebook and Twitter). The users will be able to post to the social networks actions and news from the LCMS about their achievements (e. g., achieved competences, awarded badges, obtained certificates, etc.).

Data models

The model of learning, organized in the set of Learning Objects. Each learning object will provide set of learning resources, activities and/or learning assessments, related to achieving some predefined learning goals in terms of achieving some particular competencies. Each learning object can be represented internally as an organizational unit, for example a course. There will be well-defined sets of available learning resources, activities and

assessments. The set of learning resources will include: lecture note, video lecture, hand-out, blog, message, rank, book, external site (URL), literature, etc.

The set of learning activities will include: forum, glossary, wiki, assignment, quiz, choice (poll), SCORM player, database, simulation, group (of learning activities), learning path, workshop, checklist, news, calendar, programmed lesson etc.

The list of assessments will include: quiz, test, assignment, gradebook, peer evaluation, portfolio, etc. The model of learning will be implemented in the learning module.

Grading (assessment) model. This model should allow simple and flexible possibilities for giving individual grades for each individual learning activity, or for a set of such learning activities organised as a learning object (or course). This could be done automatically dependent on pre-set rules in advance. This model will be implemented in the module for grading and assessment.

Competencies model. The LCMS will support competency frameworks, based on the taxonomy for defining the three structures of the competency names and their dependencies, and competency scales for defining the competency levels existing for each individual competency.

The LCMS will support the export and import of competency frameworks by using some well-defined internal format.

Competency rules will be used for automatically marked competencies as complete at some scale depending on other competencies' completion. Linking competencies to course activities through competency rules will also enable automatic setting of these competences, when the learner will successfully complete these course activities.

Learner profile model. This model will allow storing information related to competencies, which a learner possesses (to be imported from GSRN, or via API), and learning plans assigned to learners (again from GSRN). Other relevant information may be stored as well.

When an action takes place concerning a KPI update, the LCMS will notify the GSRN system through the RESTful APIs (e. g., badge awarded,

competence achieved, or learning plan completion). Moreover, the LCMS can provide KPI information by request from GSRN.

All modules of LCMS support the provision of Learning Objects, which are linked to competences (see Fig. 5). After all other software components (GSRN, GAME, RAT) identify the user's gaps in competences and training needs, an individual learning plan (ILP) will be prepared. The ILP will offer set of learning courses and materials (see Fig. 6).

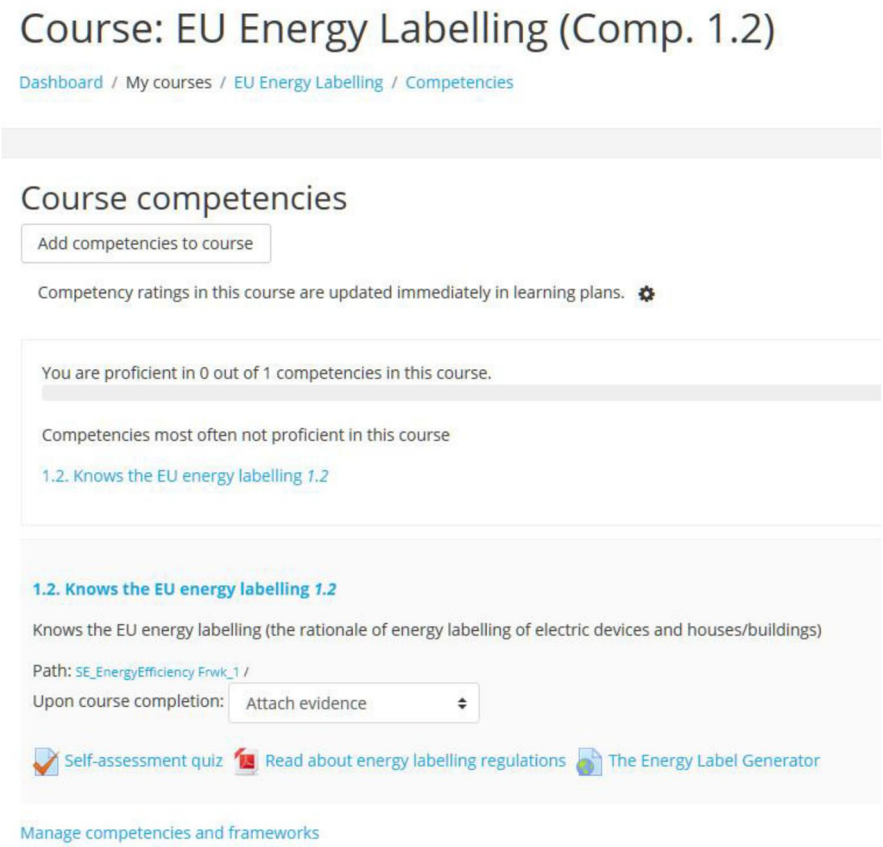

Fig. 5. Linking the course "EU Energy Labeling" to Competence 1.2 (example)

After the user accomplishes an activity, LCSM will periodically report to GSRN the results from the training: which courses were recommended to the user, which ones the user started to visit, which ones s/he finished and was graded, and what certificates and badges for good results s/he obtained.

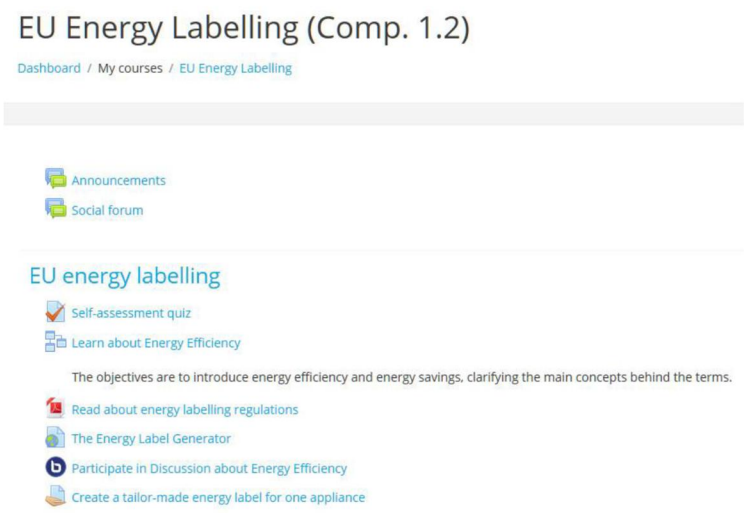

Fig. 6. Indicative course "EU Energy Labeling", which covers Competence 1.2

7. Conclusions. The European Energy market transformation and liberalization imposes new challenges to the stakeholders. In order to transform the EU energy sector to become more sustainable clean, renewable and energy efficient, it needs the adoption of new competencies and changed roles of the end-users.

Based on the identified needs the SOCIALENERGY project proposed implementation of novel competence-based educational methods. It demonstrated that ICT-based tools can play a crucial role for the improvement of EU citizens' knowledge and skills. CBE learning proved to be an effective instrument for adult training and specific sector-related topics. Thus it is an essential driver of flagship initiatives, such as the clean energy transition.

The current SE educational sub-system was tested in two courses at the Faculty of Mathematics and Informatics at the St. Kliment Ohridski University of Sofia. The preliminary results show great potential for its use and will be analyzed to identify potential directions for improvements and enlargements of the system.

The SE framework will be tested in real settings and will allow all stakeholders in the energy efficiency domain to express their own opinion and suggestions for the final exploitation of the system in practice.

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