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Energy Efficiency and Renewable Energy Technologies Using Smart Grids: Study Case on NIPE Building at UNICAMP Campus

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Abstract

In its broadest interpretation, the smart grid vision sees the future of power industry transformed by the introduction of intelligent two-way communications, ubiquitous metering and measurement. This enables much finer control of energy flows and the integration and efficient use of renewable forms of energy, energy efficiency methodologies and technologies, as well as many other advanced technologies, techniques and processes that wouldn't have been practicable until present. The smart grid vision also enables the creation of more reliable, more robust and more secure power supply infrastructure, and helps optimize the enormous investments required to build and operate the physical infrastructure required. The smart grid promises to revolutionize the electric power business that has been in place for the past 75 years. This work discusses the efficiency, targeted at the consumer units of electricity, with a view to sustainability and potential for technological innovation. The issue is addressed from two perspectives: the systems for generation and power distribution, and the design of a building "smart energy". Because of the novelty of the subject in our country, the concepts presented and treated throughout this work come from material obtained at events and specialized sites on electric power system in Brazil and worldwide, being accompanied by information and data from NIPE's building at University of Campinas's campus case study in which it exemplifies the applicability of the techniques and recommended technologies.

Keywords

Smart Grids, Energy Efficiency, Renewable Energy, Smart Building, Generation and Distribution System, Decentralized Generation

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1. Introduction

The ongoing structural and technological changes make it possible to expand the renewable energy use, decentralized generation and energy efficiency in order to supply the demand for electricity. In this way, besides the fundamental concepts of operation, transmission and distribution knowledge on electrical systems, it requires to include topics such as information and communications technologies, and signal processing to improve energy used by smart grid (SG).

SG is becoming a reality in many developed countries like United States, Japan and Germany with the implementation of pilot projects countries and improvement actions in their supplying networks [1]. Brazil's Federal Government establishes the guidelines of the Brazilian Program of Smart Grids (PBREI) through the National Electric Energy Agency (ANEEL) [2] and the 482/2012 Resolution paves the way to replace 67 million conventional electricity meters for smart meters. Universities, corporations, NGOs, government and society worldwide had been concerned with energy issues. The energy field involves many aspects of social life including the background on engineering, environment, logistics, sources, and, more recently the use of information technology (IT) "intelligence" to optimize and manage power systems, adjusting supply, demand and efficiency in the use of electricity.

Modern life has made electricity an increasingly vital product. In any segment such as production of goods or services for the public safety, health or simply for the comfort of homes, electricity is an indispensable element. However, its intense use stresses the system and request for more power production. Whereas the world is generating hydro, an equally increasing impact on the environment has been seen. Environmental issues have reached their limit and have the most importance for the mankind survival and that is the reason why to think of solutions that reconcile energy production and environmental preservation. In this context, the point of view of the power distribution system and the future of the consumer unit, covered by SG concept, will be prioritized. Utilities and consumers will converge their interests and make use of new technologies to achieve energy efficiency, reliability on electricity distribution systems, decrease cost and reducing environment and natural resources. This work discusses the efficiency, targeted at the consumer units of electricity, with a view to sustainability and potential for technological innovation. The issue is addressed from two perspectives: the systems for generation and power distribution, and the design of a building "smart energy". Furthermore, this work discusses a case study on NIPE Building at UNICAMP campus, which has good values to the scientific community and contributed new information to the related field. Finally, **Table 1** provides an example project approach for analysis energy efficiency and smart grid for this case study.

2. Renewable Energy and Energy Efficiency on Brazilian Context

In Brazil energy efficiency is clearly less important than the addition of "new energy" to the grid, despite the great potential of reducing energy intensity of the Brazilian GDP and the recent successful experience in increase energy conservation during the blackout in 2000. Making energy efficiency the key topic in the whole society should be priority in the government agenda. The little importance given to the subject in the Ten Year Energy Plan in 2019 [3], neglects the fact that investments in the area are smaller and faster return and therefore should be highlighted in the policy and government plans, especially when the country should observe growth of energy demand of 54 GW over the next ten years.

Renewable energy together with energy efficiency alternatives should be considered because the wide social and environmental benefits that often result to generate electricity. Brazil has several options for generating clean and competitive energy for its expansion: hydropower, biomass, wind and solar power. In less developed countries, there are also ocean energy and geothermal energy. But as important as increasing the supply of renewable energy is to increase the efficiency of energy consumption generated from renewable sources or not in the economic fields. Moreover, the improving of energy efficiency can occur in more narrow term to transition to a more renewable energy sources, which will not happen abruptly, since the dynamics that sustain the current non-renewable energy model cant not be easily reversed for many reasons such as: (i) the high level of material consumption and energy in an emerging country, (ii) the non-renewable energy infrastructure already established, (iii) the growing demand for electricity services by applicants, and (iv) population growth.

3. Smart Grid and Energy Efficiency

SG represents the application of IT in the integrated communication electrical system. This technology involves

Table 1. Phases in a sustainable building retrofit.

Phase 1	Phase 4
Project setup	**I & C**
definescopeofwork	implementation
availableresources	comissioning
prediagnostic	**Phase 5**
Phase 2	**Validation**
Energy auditing	verification M & V
selectindicators	
measures	
finaldiagnostic	**SUSTAINABLE**
Phase 3	**BUILDING**
Retrofitoptions	
energysaving	**energyefficiency**
economicanalysis	**and**
energygenerationon site	**smart grid**

installing sensors on the lines of the electric power grid, embedded with chips that detect data on the operation and performance of the network like voltage and current. The devices analyse those information to determine what is significant. For example, if the voltage is too high or too low. When the sensors detect significant information communication data to a central analytical system where it will analyse them and determine what is wrong and what should be done to improve network performance occurs. In the case of very high voltage, the software will instruct one of the devices already installed in the network to reduce the voltage, thus saving energy.

SG technology has been benefits with fuel efficiency, which means less energy the utility company to provide equal or better quality of service to its customers; increases the reliability of the electric system, reducing costs and carbon emissions. The SG detects when the assets of a network fail or are with declining performance, will identify them to the concessionary can repair them or replace them before there is a real power outage, but also allows you to isolate the impact of a failure to customers, so that fewer customers are affected when there is a power failure. Lastly is the integration of cutting edge , ranging from reading a smart meter system to interact with the client's management at home, solar panels , which require interaction with the network to achieve success [4]. Furthermore, the SG lever distributed generation from renewable sources, in that power generation can be carried out at or near the independent power consumer, technology and energy source. The main advantage of distributed generation systems is the savings in investments, transmission and reduction in losses in these systems, enhancing the stability of electric power service and increases energy efficiency.

With the SG tool it can relax the retrofits. In the energy context, retrofit is used to define changes and upgrades in systems generators and consumers of electricity aimed at their conservation. This type of application occurs in power plants with reform or adding equipment to increase efficiency, production and life. A common case is the retrofit of boilers in power plants. Another important example of retrofit is the object of the case study presented below in the NIPE's building at University of Campinas's campus. Retrofit buildings is normally associated with the change in lighting systems, electrical and plumbing installations through energy efficient communication technologies and advanced quality. In addition to improving energy efficiency, retrofit helps to reduce emissions of greenhouse gases over the life cycle of buildings.

4. Retrofit Buildings: Brief Description of the Case Study Progress in Building NIPE-UNICAMP

Campus at UNICAMP as same micro representatives of society contains buildings with a variety of functions and uses, each with their own characteristics in the consumption of energy, water and waste. As a task to become "good examples" for society in general, universities need to develop "best practices" to make sustainable buildings, both in the rehabilitation of buildings and in new buildings. Sustainable buildings on campus may have educational goals for college students and the academic community, reflected in potential "best practices" for society at large gains.

Energy efficiency and renewable energy in the built environment stand out as one of the main alternatives to minimize problems arising from climate change. The retrofit project of NIPE-UNICAMP will demonstrate concrete gains on rehabilitation of a building live "post-occupation" by proposing actions to saving energy, maximizing the educational impact of these actions and awareness through interaction with students and the university's community, under the supervision of experts. Participatory nature of the project will allow the perception of specific possibilities of a green building among users of the Campus, increasing local knowledge to be adapted to the "perfecting" of the sustainability process extra-campus. The project will share know-how to process a wider spread in the society. Against this background, the NIPE-UNICAMP project deals with the theme "Smart Grid and Sustainable Buildings" with the main objective of the study and evaluation of opportunities for energy efficiency and comfort environmental post-occupancy building for research, considering the surroundings, air conditioning system, lighting type and acoustic quality, based on the evaluation of sustainability of the built environment through possibilities INMETRO nota certification. Therefore, it is a survey of constructive characteristics, architectural and the thermal NIPE-UNICAMP, followed by the determination of energy needs through software simulation, and finally evaluating the results and proposing alternatives for energy optimization and environmental comfort NIPE through the retrofit of the building interventions from the sustainability approach, involving the energy performance, thermal quality , lighting quality and acoustics quality, should integrate the agendas of pilot projects and retrofits that begin to be stimulated and developed by various national and international organizations that study the impacts of the sector building and construction for society and the environment [5].

There are many softwares available for the study and evaluation of opportunities for energy efficiency and environmental comfort, and mention: i) DOE2 (EQUEST), ii) Design Builder, iii) ECOTEC, iv) TRNSYS, v) and vi) Energy Plus and ESP-r, among others [6]. Besides these, there RET Screen software support for decision making opportunities for energy efficiency with a focus on renewable energy to a building. This is free software, provided by the Government of Canada, which helps the decision maker to identify and access potential energy projects that bring reduction in energy intensity of a building, including its technical and economical viability [7]. Regarding the thermal comfort of the environment, their qualification and quantification requires making measurements, for example if the air temperature and the Globe. From measurements of the thermal evaluation can be performed by the Predicted Mean Vote (PMV), while simulations with 2:03 Comfort software method. Regarding the study and analysis of the luminal comfort, it has been alternatively windsurfing and Reluxcad and finally, evaluation of acoustic comfort in the Brazilian case can be according to NBR 10152 [8].

5. Final Considerations

There is a strong correlation between energy consumption, environmental comfort and the life cycle of a building. Indicators of energy intensity throughout the life cycle analysis of a building provide a way to understand the evolution of that correlation. The energy intensity can be reduced in two ways. First, greater energy efficiency can reduce the energy consumed to produce the same level of energy services (for example, a more efficient light bulb produces the same light with less energy consumption). Second, the issues surrounding sustainability, markets and peer pressure, end up imposing changes in energy intensive activities, such as the search for the lowest energy consumption activities, greater comfort and environmental activities and/or less carbon intensive process. Energy efficiency assisted by replacing fossil energy by renewable and sustainability criteria in the lifecycle is the key to driving incremental reduction in energy intensity and can offer solutions as diverse as climate change, energy security, competitiveness, and human being and socio-economic development.

With the intensification of urbanization, the demand for infrastructure for the growing industrialization and economic development, the pressures on natural resources are being added to the vulnerabilities caused by climate change. This development enhances the dynamic impacts on society and the environment, due to the generation of waste and the increase of energy requirements in buildings required to structure human activities. Global and national statistics show similar scenarios. Only the construction sector accounts for up to 40% of the consumption of energy resources and up to 30% of solid waste. Participation in emissions of Greenhouse Gases

(GHG) is 30% [9]. The final energy consumption in Brazil, only for residential household, more public trade, represents 47.1% of the total consumption of energy sources [10]. The evaluation of energy efficiency and environmental comfort in a built environment, post-occupancy, as NIPE-UNICAMP, is requesting a careful study to obtain data that allow integrate simulations and diagnostics to make decisions.

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