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journal homepage: [www.elsevier.com/locate/rser](http://www.elsevier.com/locate/rser)

## The impact of sustainable construction and knowledge management on sustainability goals. A review of the Venezuelan renewable energy sector



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### ARTICLE INFO

#### Article history:

Received 3 December 2012

Received in revised form

22 March 2013

Accepted 21 July 2013

Available online 8 August 2013

#### Keywords:

Sustainability

Construction

Knowledge management

Renewable energy

Venezuela

### ABSTRACT

The recognition of the relevance of energy, especially of the renewable energies generated by the sun, water, wind, tides, modern biomass or thermal is growing significantly in the global society based on the possibility it has to improve societies' quality of life, to support poverty reduction and sustainable development. Renewable energy, and mainly the energy generated by large hydropower generation projects that supply most of the renewable energy consumed by developing countries, requires many technical, legal, financial and social complex processes sustained by innovations and valuable knowledge. Besides these efforts, renewable energy requires a solid infrastructure to generate and distribute the energy resources needed to solve the basic needs of society. This demands a proper construction performance to deliver the energy projects planned according to specifications and respecting environmental and social concerns, which implies the observance of sustainable construction guidelines. But construction projects are complex and demanding and frequently face time and cost overruns that may cause negative impacts on the initial planning and thus on society. The renewable energy issue and the large renewable energy power generation and distribution projects are particularly significant for developing countries and for Latin America in particular, as this region concentrates an important hydropower potential and installed capacity. Using as references the performance of Venezuelan large hydropower generation projects and the Guri dam construction, this research evaluates the tight relationship existing between sustainable construction and knowledge management and their impact to achieve sustainability goals. The knowledge management processes are proposed as a basic strategy to allow learning from successes and failures obtained in previous projects and transform the enhancement opportunities into actions to improve the performance of the renewable energy power generation and distribution projects.

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## 1. Introduction

The global society faces many issues related to poverty, political tensions, knowledge and innovation, management, ethics, economics, energy and growing environmental challenges.

The consciousness about the severe impact of fossil energies on the environment and the necessity to improve current energy patterns is rising the interest in renewable energy. Renewable energy, that comprises the use of energy free from CO<sub>2</sub> emissions with overall unlimited potential and that can be naturally generated by the sun, water, wind, tides and modern biomass and thermal [1,2] is acknowledged as a fundamental requirement for poverty reduction and sustainable development.

From all renewable energy sources the main benefits are acknowledged to hydropower because of its abundance and availability, and also for being supported by reliable and mature technologies and infrastructures being able to supply about 19% of the planet's electricity needs [3]. Additional advantages arise from the long life cycle of infrastructures that support its generation and its relative low maintenance costs. Such advantages compensate the huge initial investments and time required for facilities construction and make hydropower to be acknowledged as essential mainly in developing countries that concentrate about two thirds of the global hydropower potential [4].

The relevance of hydropower generation is particularly sensitive for Latin American countries since they depend mostly on this energy source for about 72% of their regional needs. Brazil, Mexico, Argentina and Venezuela, among other Latin American countries depend on hydropower generation for most of their energy needs [5]. In fact, for Latin American countries hydro energy is more important than for OECD countries [6] which shows the strategic role that this type of energy has for competitiveness and regional development. This sustains the particular attention directed to ensure the improvement of this sector [7].

Additionally to the complex technical, financial and legal efforts needed, hydropower requires the support of the infrastructure necessary to generate and distribute it. Important efforts are demanded from the energy and construction sectors for this goal.

The construction and maintenance of renewable energy facilities is not easy especially for power generation units. The complex knowledge required, the unpredictable technological constraints that may arise, the huge investments needed, the conflicting economic and political interests that may appear and the social and environmental concerns show the intricate conditions that make any new project an important challenge for every country. This drives the attention to sustainable construction as a process that may integrate all such efforts to obtain long term sustainable solutions.

But attaining the goal of sustainable construction is a demanding task. Because of their complexities, the renewable energy power generation and distribution infrastructure projects are influenced by several construction problems. The main consequences of such problems are project re-programming, losses of resources and knowledge, costs overruns and delays that affect the start-up, operations and final costs of the renewable energy facilities and the services that they supply. This means that construction performance becomes another important issue to consider when planning the construction or refurbishment of large power generation facilities.

The aim of this research is to present some references about the positive relationship existing among knowledge management, sustainable construction and the global sustainability goals along with the constraints that may limit its achievement. Based on the relevance of renewable energy power generation and distribution projects for Latin America's energy supply, the Venezuelan case is presented as a reference of such connection and the possible

consequences of inadequate construction performance. On the other hand, the Guri dam construction is offered as an example of sustainable construction, being considered the most emblematic large renewable energy hydropower generation project built in Venezuela. Finally, knowledge management processes are proposed as a means to take advantage from the construction lessons learned and to support the achievement of sustainability goals.

The authors of this review emphasize the importance of improving the construction performance, conscious of the global impact that it may have in areas as critical as renewable energy supply and sustainability. To be able to follow the sustainable construction path the authors propose timely knowledge management processes as the means to create and disseminate new knowledge and learn from knowledge accumulated from other projects, extracting from them the positive and negative wisdom that may support future decisions. This could make it possible to improve the renewable energy supply in order to cooperate with sustainable development. In this research authors used the wide concept of renewable energy that includes solar, wind, geothermal, biomass and hydropower sources [1,2].

## 2. Renewable energy and sustainability

Sustainability has been an important issue since ancient times. Historians and philosophers in different cultures studied the consequences of soil erosion, food, water shortages or air quality and important knowledge was transmitted from their learning to current times [8]. Today sustainability concepts refer in general to the conscious production and use of the resources required for residential, industrial, transportation, commercial or recreational processes related to mankind, all supported on a long term vision and on ethical, environmental and global fundamentals which consider individuals as beneficiaries of such efforts, in order to improve their quality of life [9,10].

Even though sustainability concerns are expanding with formal efforts from different countries, there are still millions of people suffering the consequences of poverty under conditions which are in total contradiction with sustainable criteria [11,12]. This constraint is particularly evident in Latin America, a region that in spite of its huge energy resources still suffers from energy supply shortages and inefficiencies [7].

Due to its capacity to offer solutions to fight poverty, the full access to energy has become an essential input for sustainable development with rising interest in the performance of this sector [6,11,13] and this stresses the strong relationship between energy and sustainability.

Because of the fundamental importance of these resources the international demand for energy has been growing progressively. This demand, which is expected to increase by about 30% for 2040 as compared to 2010, has been driven by the demographic and economic growth, mainly related to emerging economies, especially in Asia [2,14,15].

Even if experts estimate an unchanged pre-eminence of fossil energy consumption for at least until 2035 [6,16] society in general invests important efforts to develop alternative clean energies as a fundamental element for sustainability. Besides the acknowledged traditional benefits of abundance in nature, being clean and with lower impact on global ecosystems, renewable energy today is considered also because of its potential to meet an important part of the world energy demand while offering long term sustainable solutions, since it creates wealth, employment and new business opportunities [2,4].

Despite the general acknowledgement of the importance of renewable energy, experts advise that its current use is still modest since its share is around 15% of global energy demand

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