INTELLIGENT POWER DISTRIBUTION SYSTEM

PATENTED TECHNOLOGY

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ABSTRACT

The research group of computer engineering and networks of computers of the University of Alicante has developed an innovative system that enables the distribution and management of the electricity in a more efficient and rational way.

The system uses artificial intelligence techniques to predict energy demand and taking optimal decisions about sources of supply to be used and prioritizing those preferential consumption centers. These decisions are based on rational criteria, such as the characteristics of the consumption centers, the expectations of supply, demand characteristics and previous experiences.

This technology allows to reduce consumption and optimize the operation of the electric system. It means greater energy efficiency and a considerable reduction in costs. It is also suitable for environments where power fluctuates or is scarce.

INTRODUCTION

Sustainable energy is one of the main challenges facing society today. Although there are different sources of energy, this is precious and limited, and must be rationally managed.

Electrical distribution networks co-exist with generation systems to give service to companies and households. There are systems power generation like solar power plants, generators farms, plants for combustion of biomass, etc. that are discontinuous in time depending on the characteristics of each one and its power source.

On the other hand, there are many centres of consumption and demanding devices of this energy. These elements have a discontinuous demand of energy depending on its activity and the needs of users. Likewise these centres may have a higher or lower priority with respect to others, and its operation can be complementary or critical for the functioning of the whole.

Distribution systems can also include energy storage that accumulates excess energy, and in times of shortage act as energy suppliers.

Take into account all of these components involves high complexity which so far is not considered in the electrical distribution networks. A smart, planned and automated management can greatly improve the performance and energy efficiency of the system.

So far, there is not a system to get an intelligent control of supply and demand for energy and that allow to optimize its distribution and consumption. The technology developed by the University, consists of a control system of distribution based on techniques of artificial intelligence, scalable and distributed, allowing you to take decisions related to the selection of the most appropriate energy sources and establish which centres of consumption spend them at any time.

TECHNICAL DESCRIPTION

The distribution and energy management system is structured in three subsystems listed below:

1. **Decision-making unit.** Processing algorithms and strategies to optimize energy management.
2. **Power unit.** It regulates the power supplied. t is composed by the inputs and outputs of the network.
3. **Control Unit.** Manages the behavior of consumption centres so that they conform to available energy supply.

Each of these units, physically, is implemented through two different types of devices called modules and agents. The modules must be installed grouped with at least one decision-making module, while the agents are autonomous and can be deployed at any point in the installation.

These devices are connected to the different elements of the system (power generators, consumption centers and storage devices) following an elaborate design established by the research group.

The decision making units are capable of communicating among themselves and with the different agents in order to distribute the available power between the centres of consumption through distributed and scalable negotiation protocols.

The actions to be performed by each of the modules and agents agreed between them using smart negotiation protocols.

The data to make these decisions comes from the criteria of optimization, power data available in the centers of production and the energy requirements of the centres of consumption.

The system is able to operate automatically, and depending on the circumstances, define sources of energy more cost-effective, optimal, use temporary storage of energy and prioritize, centers as well as enable or disable power consumption devices.

Also the system can learn from the corrective measures introduced by the users, and information from external sources, such as the Internet (weather forecast, singular dates) to implement even more refined management strategies.

ADVANTAGES AND INNOVATIVE ASPECTS

MAIN ADVANTAGES OF THE TECHNOLOGY

• Optimizes the distribution of electrical energy in an environment using intelligent management of each of the elements of the system.

• Lets customize the system and adapt to the energy needs of the users or complex patterns.

• Can learn and receive information from external resources to make preventive decisions and optimize its performance.

• It guarantees the energy supply to consumption centres that are vital or have priority and allows to reduce energy consumption through selective shutdown of equipment and systems.

• Reduces costs to prioritize domestic energy sources and reducing the demands to the public distribution network. You can also set other savings mechanisms as the demand for energy when the electric rate is reduced.

INNOVATIVE ASPECTS

• Use distributed artificial intelligence techniques to streamline the supply.

• Allows to set profiles of distribution according to the characteristics and temporal needs of users.

• Can use external information to anticipate demand and establish preventive actions. It could use for example, information about the upcoming weather forecasts and establish the possible energy contributions from sources of generation based on renewable energies.

• The behavior is dynamic and progressive, since it is capable of learning from the corrective actions that the user can set.

• The system takes into account the storing of energy or batteries available, taking advantage of the surplus to minimize the events of power shortages.

• Controls the behavior of devices that require power, optimizing its consumption and prioritizing those most needed according to the requirements of the users.

• The system is scalable and distributed, which can be later expanded and in case of any failure, the rest of the system would still be operating.

CURRENT STATE OF DEVELOPMENT

All software support, which includes the programming of the system of artificial intelligence, has been fully developed and carried out simulations to validate the proper functioning of the system.

Some simulations already made are as follows:

- Evaluation of a detached house. Valdivieso-Sarabia, R., Ferrandez-Pastor, F. and Garcia-Chamizo, J. (2012) Distributed Optimization of Finite Resource Planning for Asynchronous and Non-linear Systems: Application to Power Management Advances on Practical Applications of Agents and Multi-Agent Systems. Springer Berlin / Heidelberg.
- Management of a home equipped with four energy sources. www.metaltic.org
- Air conditioning system underfloor powered by renewable energy. Valdivieso-Sarabia, R. J., García-Chamizo, J. M., Ferrández-Pastor, F. J. and Flórez-Revuelta, F. (2010) Sistema de climatización por suelo radiante coalimentado por energías renovables. VIII Jornadas de aplicaciones y transferencia tecnológica de la inteligencia artificial, TTIA 2010 (AEPIA). Valencia, Print House.
- A laptop computer powered by photovoltaic plate management. Valdivieso-Sarabia, R. J. and Garcia-Chamizo, J. M. (2012) Power Management Strategies based on Multi-Agent Systems for Portable Devices Equipped with Renewable Power Sources: Laptop Case Study. Sustainable ICTs and Management Systems for Green Computing. IGI Global.

Currently system is being subjected to various tests of validation using generic computing devices and we are already getting quantitative information of the advantages and the energy savings that provides. This information allow us to tackle with sufficient guarantees the next phase, the fabrication of distributed computing devices that can be installed alone or integrated in other systems.

The validation tests we are doing in real-world scenarios are:

- Evaluation of a detached house.
- Management of a home equipped with four energy sources.
- Management of a building in the University of Alicante.

MARKET APPLICATIONS

The described technology can be used in all types of electrical facilities, any size:

- Networks of very high power, as well as those of high and medium power for transport and supply large areas, industrial areas, municipalities and urban areas.
- Installations of medium size, such as malls, industries, hospitals, University campuses, housing developments, sports and recreation, transport stations.
- Corporate and institutional buildings, industrial buildings and homes.
- Machinery, vehicles, robots.

The target entities of this system can be both firms belonging to the industry of the generation and distribution electric, as any company or group that have several sources of energy I consumer devices, and want to optimize its performance.

COLLABORATION SOUGHT

Companies interested in acquiring the technology are wanted. Several ways to transfer technology are possible (agreement of the patent license, assignment of rights of use, manufacture or marketing to third parties, etc.).

INTELLECTUAL PROPERTY RIGHTS

The **patent** in the Spanish Patent and Trademark Office has requested:

- *Title of the patent: "Sistema y método para la distribución y gestión de energía eléctrica"*
- *Application number: P201101361*
- *Date of application: 26122011*

MARKET APPLICATION (4)

Construction and Architecture
Pollution and Environmental Impact
Computer Science, Language and Communication
Engineering, Robotics and Automation