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# OptimaGrid

SUDOE Interreg IV B

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## THE NEW WAY TO CONSUME ENERGY

Recently, the incorporation of renewable energy is changing the concept and ways of servicing electricity, with a trend towards decentralization in the generation and distribution. The integration of renewable energy into the system causes changes in the method of production. Conversely, the demand must adapt their requirements to the supply of available energy without sacrificing reliability and service quality. The implementation of this process automatically, looking for a balance in optimizing certain parameters, necessarily involves the control system development, that gives the character of "intelligent" to the grid. Energy generation is one of the biggest causes of CO2 emissions. It seems that the world is serious about reducing the amount of CO2 being pumped into the atmosphere, but no country is willing to reduce its energy demand. Then, the way out is to incorporate a renewable energy generation and a rational strict control in consumption and distribution.

*The solution is the microgrid proposed by Optimagrid for industrialized areas.*

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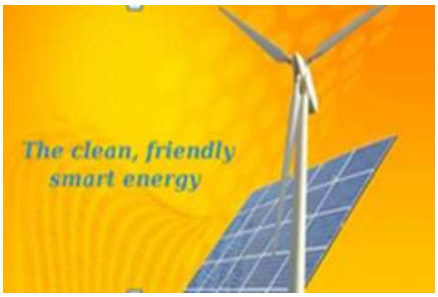


## CIRCE FOUNDATION CONTRIBUTION IN OPTIMAGRID

Founded in 1993, the CIRCE foundation has developed four main areas of investigation and development: evaluation of resources and processes, efficient use of resources, electricity generation and finally transmission and distribution of electricity. CIRCE is contributing to OPTIMAGRID with its know-how in these two final fields.

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## MULTIAGENT SYSTEMS

In a traditional model, servers offer services and clients request them, hence none existent communication appears in between clients. In this kind of architecture, clients always take the initiative and must know all the available services.

On the other hand, in Multiagents model, all agents that compose the system are continuously interacting with the rest of agents and performing tasks.

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## SCADA AND MULTIAGENTS IN MICROGRIDS

When we have an electric grid (or network) integrating components such as generators, clients and storage systems, we need to deploy some control items to manage the service in order to help it to fulfill its objectives, could them be power availability, efficiency, clean generation of electricity, etc.

To this end, there are 2 different approaches in order to build this control system. Of course, both of them present advantages and disadvantages, and knowing them in advance is vital in order to select the best-fitting one for our grid. In this article, we show the main features for each model.

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## RECENT EVENTS

It is as important to have a good idea as to let people know about it, therefore Optimagrid has put its effort into letting others know about our ideas and future planning's. This is just the start of many more forums, congress and other diffusion platforms to which we will actively participate.

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Ha FUNDACIÓN PARA EL DESARROLLO DE LAS NUEVAS TECNOLOGÍAS DEL HIDRÓGENO EN ARAGÓN

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cener centro nacional de energías renovables national renewable energy centre

Circe Centro de Investigación de Recursos y Consumos Energéticos

aicia

# Optimagrid. The new way to consume energy

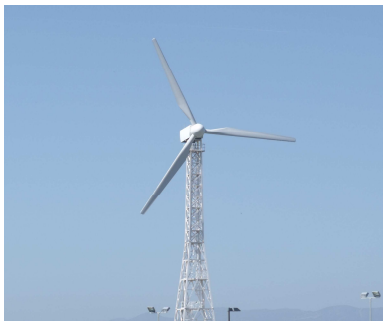
The essential idea OPTIMAGRID project is to define, design, develop and implement intelligent control systems based on distributed computing, to decide in real-time the optimal allocation of renewable energy being produced, taking into account the demand of a particular industrial area. It is entirely an efficiency project that seeks to optimize resources and minimize costs to businesses.

Optimagrid proposes a microgrid with interesting advantages as:

- Optimagrid raises a microgrid necessarily based on renewable energy generation. Moreover, the reduction in gaseous and particulate emissions due to close control of the combustion process may ultimately help combat global warming, since the closeness of customers to microgrid may help to increase the consciousness of consumers towards sensible energy usage.
- The improvement in power quality and reliability will be achieved due to a better match of supply and demand and the decentralization of supply. The reduction of the impact of large-scale transmission over the generation lessens the downtimes and enhancement of the restoration process through black start operations. Microgrid is capable of sensing overloads and rerouting power to prevent or minimize a potential outrage.

**"Establishing new ways for selective power quality management"**

- The cost savings are achieved in Microgrid. As they are locally placed in plug-and-play mode, the distribution costs are drastically reduced or eliminated. There are also other added values that can be obtained by providing ancillary services. An extensive application of modular plug-and-play microgrids may contribute to a reduction in energy price in the power market.
- A good opportunity on creating new opportunities and markets by means of its ability to capitalize on plug and play innovation wherever and whenever appropriate. New entrepreneurial energy markets can emerge, including allowing consumers to sell excess production into the electricity market;
- Microgrid could be capable of meeting increased consumer demand without adding infrastructure. In real-time communication between the consumer and utility so consumers can tailor their energy consumption based on individual preference like price. The information system enables prices and demand decisions flowing back and forth at the direction of the consumer.



- Accommodate energy flows from different sources, as solar, wind or biomass, and integrating energy storage technologies, as hydrogen cells. This small local generation is a good chance for the new types of consumption, for example, the charging stations for electric vehicles.
- Power quality is one of the important aspects. The advanced communication technologies in microgrid, can establish new ways for selective power quality management. Classes of disturbances are the variation of voltage, harmonics, flicker, and unbalance. Other disturbances are rapid voltage changes, dips, swells and interruptions.
- The more autonomous generation will require less high-voltage lines to transport electricity over long distances, avoiding the significant electromagnetic fields (EMF). The possible effect of high-voltage transport on the neighboring population health and on the environment has been the subject of in-depth research since 1996, through the International Electromagnetic Fields Project launched by the World Health Organization (WHO).
- Microgrids are less vulnerable to attack and natural disaster, because of decentralized operation with fewer transmission lines, and alternative sources.

Along the initial stage of Optimagrid project, the research team is carrying out the definition and modeling of micro-networks in almost all SUDOE's industrial areas (south of France, Portugal and Spain). They try to identify problems and opportunities for integration of renewable energy in such areas, establishing continuous contacts with the stakeholders. For each of the case studies identified, there will be a campaign to collect data through surveys to study the degree of awareness of microgrid in industrial areas and obtain data on electricity consumption.

The goal is to reach the optimal configuration in terms of renewable generation mix that allows the highest percentage of renewable generation, while maintaining network stability, and ensuring the provision electricity consumers, with and without energy systems intermediate storage. Suitable software is used to system identify and carry out the various models in order to classify into different possible microgrid patterns. The obtained models are validated with real data taken with existing renewable installations. Also, the development of guidelines and requirements for industrial areas, so they can get an eco-labeling, enables them to acquire a distinguishing feature compared to their competitors. A practical guide is a way of training and reporting on this aspect and the procedure to follow.

**"Reaching the optimal configuration that allows the highest percentage of renewable generation"**

Finally, under these requirements, Optimagrid will build the RECOC (Renewable Energy Consumption Optimization Center). RECOC carries out the static and dynamic control of the microgrid, with a given criteria, switches circuits, estimates a system state prediction, acts on demand, and fits the quality resources.

| 20th century | Optimagrid |
|---|---|
| Analog /electro-mecanic | Computer control |
| Totally centralized | Accommodates decentralized |
| Radial topology | Network topology |
| Manual restoration | Self-healing |
| Average priced | Real-time priced |
| Commodity-based | Service based |
| No consumer choice | Many consumer choices |

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# CIRCE Foundation Contribution in Optimagrid

CIRCE is involved in the characterization of the demand of industrial areas in Spain. Especially interesting will be the geographical distribution of these areas, in order to evaluate the renewable resources which may be interesting to integrate in these distribution grids in order to set up micro-grids.

In a second step, an optimization tool will be developed, in order to find out the best configuration of renewable resources and storage in order to meet the needs of the customers in terms of energy supply quality and costs.

Finally, an operational model will be set up to test different micro-grid control strategies, which will be developed during the project. Although CIRCE is not directly in charge for the development of these control strategies, it will contribute with its know-how from other projects.

# Multiagents Systems

They act as servers and clients at the same time, carrying out a variety of actions such as offering or requesting different services, taking initiative and decisions over different features, solving problems or cooperating with other agents in order to solve more complex problems.

Agents are modular components of the system. Each agent is specialized in solving a particular problem or aspect, and the coordination of these activities ensures that the main objective is achieved. Making modularity is one of the main features that Multiagent Systems offer.

In the implementation methodology, RECOC is being designed using the MaSE methodology, which has been created to perform Multiagent Systems. It provides a set of procedures to guide the developer in the analysis and design phases, to finally implement the system.

MaSE understands agents like objects in programming, but with extensions. MaSe modeling is based on UML, a standard well known by developers, which makes diagrams intuitive, and therefore facilitates the comprehension of the architecture, dataflow and its interactions into the system.

**"Modularity is one of the main features that Multiagent Systems offers"**

Furthermore, MaSE give us agentTool, which is a graphical development environment to help users to analyze, design, and implement Multiagent Systems.

The agent platform can be distributed across machines, using different Operative Systems as it uses FIPA standards. This allows intercommunicating with other systems developed under different technologies.

In the future, several load and generation components will be connected to the system. These components will be allocated in different places, and RECOC will need many devices, computers and sensors to manage all this dataflow. Therefore, in Multiagent Systems data is decentralized, turning them autonomous and heterogeneous, and making them able to handle distributed and open systems.

# SCADA and Multiagents in Microgrids

**Centralized control systems (SCADA)**: **S**upervisory **C**ontrol **A**nd **D**ata **A**cquisition systems were firstly developed for automatic management of industrial processes and devices, although it also offers human-machine interfaces for supervisors, logging and storage of data and the possibility of using feedback. Although they were completely monolithic in their early days (mainframe systems), SCADA evolved to become distributed and networked systems, just following the evolution of computer science – yet they are still considered an example of centralization.

Adapted to our project, the main advantages of using these kind of technology in controlling our network are; firstly we can find many of them in the market, secondly they are usually easy to adapt to our use cases (small and well-defined networks, with a single type of generators each). Furthermore, they have a reasonable cost and offer both automatic management and user-friendly interface with low delays.

On the other hand, once the SCADA is designed and deployed, it is really hard to change it in order to include new features (low scalability). They could prove to be insufficient to manage a wide and complex network (or very expensive to implement in those cases), and also there are quality differences depending on the SCADA you are buying for your system, so you need to know well what you want and choose the one appropriately.

**Decentralized control systems (Multiagents)**: Much more recent than SCADA, multiagents are conceived as an evolution of artificial intelligence in networks. They are based in the use of agents, intelligent units devoted to simple tasks that can work together in a distributed way to achieve a great goal. In this case, systems control.

The main advantage of these systems is that once they are designed they can easily grow to control more elements. They fit well both in small and simple systems and large and complex ones, and can also be adapted to offer human supervision interface with low delays.

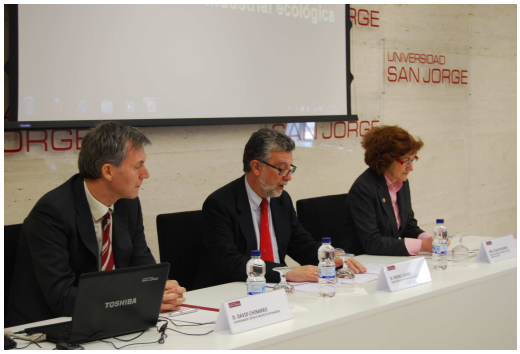
Probably the main disadvantages are that they are usually hard to design and build, there is much less documentation and support than for SCADA systems (they are much older) and if you want to use them you will surely have to develop them by yourself because, by now, there are no companies selling these kind of control systems.

# EVENTS We Have Recently Taken Part In

## February 18, 2011. Launching event. Kick off meeting

San Jorge University presents Optimagrid project to Press. Pilar Molinero, Aragon's Goverment Energy and Mines Director, spoke and said "Aragon produces double the energy it consumes","Optimagrid Project its a good alternative to provide and outlet for this extra energy to Spain and Europe". Also, USJ's research director, Pedro Larraz, was satisfied with "the most important project the university is taking part in its 6 years of existance ."

The project aims to design and implement intelligent energy management systems. This way we will be able to manage in real-time an electric energy microgrid applied to an industrial area with high penetration rate of renewable energy. "We will focus on industrial areas willing to change its pollution associated label for a new concept of ecological industrial areas" explained David Chinarro, Optimalgrid Project coordinator.

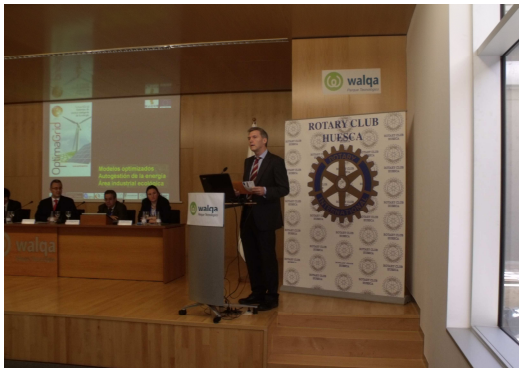



## March 5, 2011. Optimagrid in the Rotary Club of Huesca, to mark the twenty-fifth anniversary of its founding.

The Rotary Club of Huesca, to mark the twenty-fifth anniversary of its foundation, organized a workshop on Innovation and Opportunities for Economic and Social Development of the province of Huesca.

The conference delved into the "Hydrogen as a clean source of energy " and other forms of renewable energy use Huesca Rotary Club, to mark the twenty-fifth anniversay of its foundation, organizes a Day on Innovation and Opportunities for Economic and Social development in the province of Huesca.

Optimalgrid represented by its Project Coordinator David Chinarro gets invited to this event presenting Optimalgrid solutions.




## May 5, 2011. CENER organizes a conference on Microgrids in industrial areas


All those attending the conference had the chance to visit the Microgrid that CENER has recently launched. This microgrid focuses on industrial application and it provides electricity for the Wind Turbine Test Laboratory, situated there, as well as for part of the public lighting of the Rocaforte industrial estate where it is located. It has been co-funded by the Government of Navarra and the European Commission, through the Regional Development Funds.

The conference on Friday, May 6, combined theoric and practical concepts, as, apart from those already mentioned Examples of good practices of this type of installation were also been presented, such as the Walqa project in Aragon, and additional services for the correct management of the grid (modelling), as well as the role played by the microgrids in the European energy strategy.

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