‘A survey on the developments in Expert Systems Research and a proposal for the design of an Expert System for the energy management produced from renewable energy sources’

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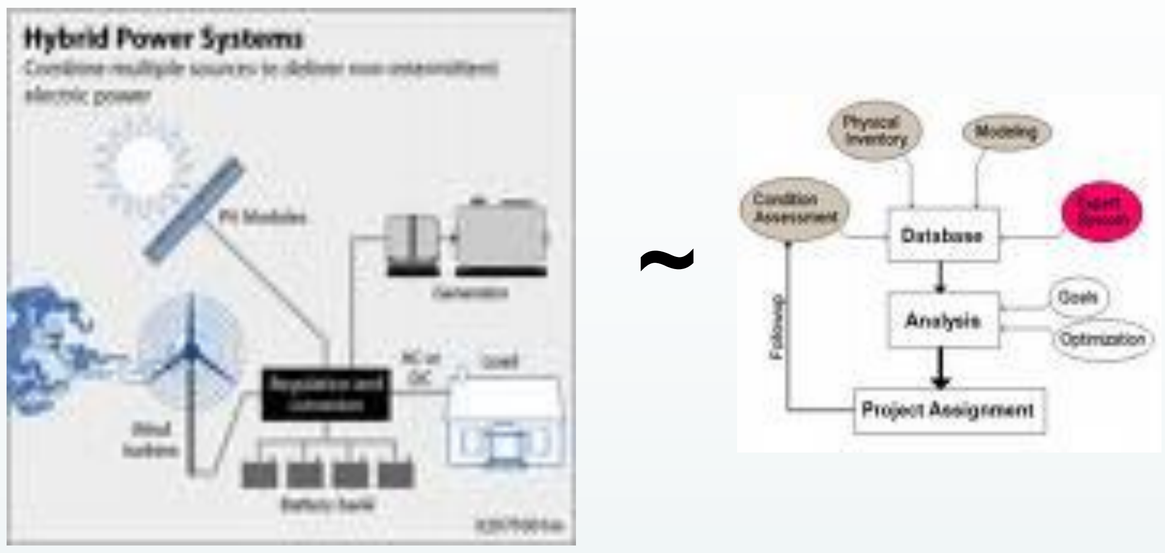

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Description of the project

The scientific field of interest, that this project belongs to, is optimum control for energy management applications. More special, we are interested in Expert Systems that utilize fuzzy logic models in their algorithm in order to efficiently manage the energy produced from renewable energy sources and especially from solar and wind energy. The interest for fuzzy logic model in such systems comes from the fact that such models offer advantages in the handling and processing of data in the form of linguistic statements or other qualitative data, which we usually meet in such concepts. As the title of “Dissertation” project clearly shows, the project is divided in two parts.

The first part of the “Dissertation” project is a survey on the developments in Expert Systems research which is covered by a background overview and a literature review of the scientific field of our interest. In order to keep our research over scientific standards we restrict our enquiry exclusively in approved scientific databases and academic libraries. Another standard we want to meet was is necessity for an updated survey, so we focus mainly in the more recent research works. Our survey includes an overview of the most common models for optimum control in the field of renewables before we resume in the fuzzy models which we inspect more thoroughly before comparing them. Our research focuses on the modelization and the performance of these fuzzy techniques from the scope of forecasting of wind and solar energy production, short-term load forecasting as well as the management.

In the second part of the project it is required to make a proposal for the design of an Expert System for the management of the energy produced from renewable energy sources. Our research will begin with the gathering and processing of data from past research works on fuzzy Expert Systems, for similar applications. We will analyze fuzzy models for solar and wind energy production, short-term load forecasting and management of combined PV-wind stand-alone systems. The observation of their statistical behavior will lead us to the fuzzification model we are going to use. After that we have to decide about the linguistic variables of the system and appropriately divide the universal set of the domain. A lot of membership functions will be tested trying to fuzzificate the qualitative data in a way that a more realistic mathematical model of such a system is approached. The choice of the defuzzification model follows. After modeling the system, we have to integrate it by setting the priorities, constructing the algorithmic rules and the weighting algorithm. After implementing the system in Matlab environment, the simulation procedure will start. Planning this task, we will have to choose among a lot of simulating scenarios, before we finally simulate our model according to them. The evaluation of the results will help us to extract conclusions about our Expert System concerning its performance, reliability against the load, effectiveness in meeting the priorities and energy efficiency capabilities.

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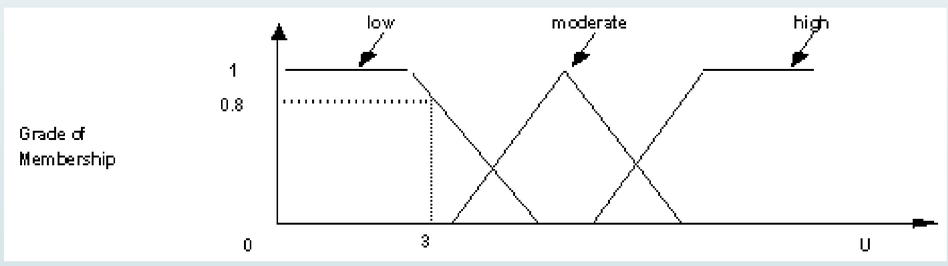
Abstract

Forecasting of the energy produced from wind and solar energy systems as well as short-term load forecasting are critical and necessary procedures for the energy management of renewable energy systems. Expert systems using fuzzy logic techniques can offer great advantages due to their symbolic reasoning and the capability to deal with qualitative data and vague linguistic statements. In this paper a survey is made in Expert Systems research for applications of RES energy management. Several models are indicated for the forecasting of wind and solar energy production. Intelligent models for short-term load forecasting are examined, too. Although our survey is focused on Fuzzy Expert Systems, several other robust models of recent research like artificial neural networks, fuzzy-neural and other hybrid models are overviewed. A proposal for a model of an Expert System for the energy management produced from pv-wind energy system will follow. Fuzzy techniques will be utilized for the modelling of the linguistic data before the decision making algorithm will be integrated by rules. The system is going to be implemented in Matlab environment. Enough scenarios will be simulated and the evaluation of the results will let us make conclusions on its performance, reliability, precision, effectiveness and other capabilities.



Aims and Objectives

Aim of this project is to make an effort to contribute in the research in the field of optimum control techniques and more precisely fuzzy Expert Systems that can be used in applications of energy management of energy produced from renewable energy sources.

The main objectives of the project may be reported as:

- The definition of an appropriate fuzzy model that effectively handles linguistic data in order to be utilized by an algorithm used by an Expert System for the management of RES produced energy.
- The identification of all the scenarios needed to satisfy the load equilibrium and the other objectives that we set for the system
- The implementation of the algorithm in Matlab environment

Project management

Task Name	Duration	Start	Finish
Project "Dissertation"	**143 days**	**Mon 23/2/09**	**Thu 10/9/09**
Critical Analysiss and Research	**34 days**	**Mon 23/2/09**	**Fri 10/4/09**
Portfolio preparation	29 days	Mon 23/2/09	Thu 2/4/09
Hand-in Portfolio	0 days	Fri 3/4/09	Fri 3/4/09
Poster preparation	4 days	Mon 6/4/09	Thu 9/4/09
Poster presentation	0 days	Fri 10/4/09	Fri 10/4/09
Expert System design	**27 days**	**Mon 13/4/09**	**Tue 19/5/09**
Data gathering - processing	10 days	Mon 13/4/09	Fri 24/4/09
Modelization	8 days	Tue 21/4/09	Thu 30/4/09
Algorithm design	12 days	Mon 4/5/09	Tue 19/5/09
Implementation of the system in Matlab environment	**23 days**	**Wed 20/5/09**	**Fri 19/6/09**
Familiarization with Matlab environment	8 days	Wed 20/5/09	Fri 29/5/09
Integration	15 days	Mon 1/6/09	Fri 19/6/09
Simulation	**10 days**	**Mon 22/6/09**	**Fri 3/7/09**
Planning of simulation	5 days	Mon 22/6/09	Fri 26/6/09
Running simulation	5 days	Mon 29/6/09	Fri 3/7/09
Results' evaluation	**10 days**	**Mon 6/7/09**	**Fri 17/7/09**
Evaluation of simulation's results	10 days	Mon 6/7/09	Fri 17/7/09
Writing of thesis	**37 days**	**Mon 13/7/09**	**Tue 1/9/09**
Writing	25 days	Mon 13/7/09	Fri 14/8/09
Feedback from supervisor and corrections	5 days	Mon 17/8/09	Fri 21/8/09
Presentation preparation - Powerpoint	7 days	Mon 24/8/09	Tue 1/9/09
Evaluation of dissertation	**6 days**	**Wed 2/9/09**	**Thu 10/9/09**
Oral presentation	0 days	Wed 2/9/09	Wed 2/9/09
Final corrections	5 days	Thu 3/9/09	Wed 9/9/09
Hand-in Dissertation	0 days	Thu 10/9/09	Thu 10/9/09