Chapter XIV
Data Mining in Decision Support for Bioenergy Production

Nasser Ayoub
Tokyo Institute of Technology, Japan
Helwan University, Egypt

Yuji Naka
Tokyo Institute of Technology, Japan

ABSTRACT

This chapter presents Data Mining, DM, as a planning and decision support tool for biomass resources management to produce bioenergy. Furthermore, the decision making problem for bioenergy production is defined. A Decision Support System, DSS that utilizes a DM technique, e.g. clustering, integrated with other group of techniques and tools, such as Genetic Algorithms, GA, Life Cycle Assessment, Geographical Information System, GIS, etc, is presented. A case study that shows how to tackle the decision making problem is also shown.

INTRODUCTION

Vast quantities of data and information are captured and stored through the available information technologies. Moreover, the data available are changing rapidly that force the planners, in governmental and private sectors to think differently in order to face market challenges and predict future trends. The DM is one of the important tools that can master this data explosion and provide usable knowledge from them. The use of data mining in developing DSS is popular in medical science, information technology, (Chae, Ho, Cho, Lee, & Ji, 2001; Wang, 1997) and recently in environmental applications, (Gibert, Sanchez-Marre, & Rodriguez-Roda, 2006). However, in the field of biomass planning and utilization the work presented here is pioneer. To the best knowledge of the authors, no similar work is conducted in the field. Here DM is used to help in deciding

the economical bioenergy production resources and the hot spots of energy production facilities by applying clustering methods to the available biomass resources data. Then Life Cycle Inventory, LCI, analysis is used to estimate the CO2 emission from bioenergy production. As biomass materials distribution is diverse, from one location to another, GIS is used to allocate biomass resources to its real location. The GA is used, as a powerful combinatorial algorithm, to solve the optimization problem in the local level of gBEDS. However, LCI and GA works are not explained here as they are beyond the topic of this chapter. However, for interested reader, a detailed explanation can be found in (Ayoub, 2007).

In this chapter, the multilevel decision problem for bioenergy production has been considered to help local and national planners in deciding about the economical bioenergy resources quantities, energy production methods, facilities locations, annual investments, environmental and social impacts. The solution methods and strategies for such complicated problem including the use of DM as the main part in solving the problem are also discussed in this work. Furthermore a DSS called general Bioenergy Decision System, gBEDS that is used in realizing the solution methods has been explained with a case study.

DECISION MAKING PROBLEMS

Planning and decision-making processes are in most, if not all, cases take a multidisciplinary course of actions; as the decisions have to address many involved stakeholders. Consequently, decisions are seen from multiple perspectives that mostly have tradeoff nature. In addition, the methods of applying the decisions are of prime importance to the overall project efficiency (Basson & Petrie, 2007; Hoskinson, Rope, & Fink, 2007; Marquez & Blanchar, 2006). This means that the success of the decisions made lies, primarily, on their follow up and evaluation rather than their appropriateness only. The decisions assessments, always, provide an aid in judging their suitability for specific actions and, mostly, help in stimulating better results by changing or modifying their drawbacks at early stages of bringing them into reality. The data being analyzed are often historical in nature: daily, weekly and yearly results (Chau, Cao, Anson, & Zhang, 2003) that is a fertile land for DM to be applied.

Although it is a sound solution, environmentally, for energy production, bioenergy is still less attractive, from economical point of view. Therefore, most of the bioenergy production projects are completely or, at least, partly funded by the government in all levels. That makes the communication between different governmental levels, i.e., national, regional, local, and operative; through electronic media (DSS) is a typical example of the E-Government problems where decision making and follow up need to be flexible and quick. All communications between different planners can be performed through automated plans (files with different formats) that can be discussed simultaneously using any communication media, such as video conferencing. That may clarify many misunderstanding between planners in each level. The misinterpretation exist because national level plans are strategic for the whole country and considered as a challenge for the following levels planners to understand strategic decisions and adjust them to the local factors. Some of these factors are regulation / deregulation, the competition in different energy and emissions markets or the competition between different energy carriers in satisfying the local energy demand (Catrinu, 2006; Rozakis, Soldatos, Kallivroussis, & Nicolaou, 2001).

Furthermore, bioenergy local systems planning should operate with measures and designs similar to those applied nationally in order to harmonize the local and national strategies. Although vertical linkages among planning levels are very important, there is rarity of integrated economic and environmental plans at the different