

THE DECISION PROBLEM

A regional authority wants to evaluate the harvesting of agricultural and/or forest biomass for energy production using combustion plants in a small-medium territory (less than 1500 Km²), mainly characterized by mountainous territory covered by spontaneous vegetation. The motivation of this decision is to join advantages given by an autonomous energy production, and environmental and social advantages, such as an improvement of the territory control that should be related to a reduction of forest fire risk, a reduction of CO₂ emission for energy production and an improvement of social and work activities in rural areas.

Biomasses are present in the territory in different locations. In this work, $i=1,\dots,N$ parcels of different areas have been considered, each of them being characterized by various predominant biomass typologies ($j=1,\dots,M$). These parcels have also different characteristics, that are, for example, different slope variability and human accessibility. In this territory, $k=1,\dots,K$ locations for plants for energy conversion from biomasses have been identified. These plants may produce both electric and thermal energy.

The main objective of this work is to define a decision support system able to:

- verify that the chosen locations for plants are convenient;
- size the various plants and determine the quantity of thermal and electric energy to produce;
- find the optimal biomass flows to plants and the parcels to be exploited for energy production.

The objective function

The objective function takes into account all costs and benefits in the system. Specifically, collection, transportation, harvesting and plant costs are considered, together with benefits from the selling of thermal and electric energy. The objective function to be minimized is composed by the following five terms:

- **G**: benefits deriving from the selling of energy produced
- **C_P**: plant costs related to installation and maintenance of plants
- **C_T**: transportation costs
- **C_C**: the biomass harvesting costs
- **C_D**: costs due to the distribution of energy

The **overall cost function** to be minimized is given by:

$$\mathbf{C} = -\mathbf{G} + \mathbf{C}_P + \mathbf{C}_T + \mathbf{C}_C + \mathbf{C}_D$$

The formalization of the overall problem can be obtained by introducing a valid **set of constraints**, which have to be taken into account in the minimization of the overall cost function.

Problem structure and software implementation

The overall problem defined in the previous subsections turns out to be a nonlinear mixed problem (i.e., characterized by the presence of continuous and binary variables). A system allowing experts to plan the biomass exploitation in a region according to the previous optimization model has been implemented. To support the decision, the EDSS is based on three modules:

- the GIS based interface for the characterization of the problem and for the computation of the relevant parameters;
- the database;
- the optimization module.

To define the problem from a geographical point of view, the experts can view the territory by a GIS oriented interface. The territory is divided in parcels, each of them being characterized by various kinds of biomass.