

2. Wood energy systems

The energy systems based on plant fuels, especially wood and its derivatives, present important unique features that distinguish them from the others and justify their discussion before initiating a detailed analysis of biofuel production and transformation conditions. This way, among the several energetic chains defined on the basis of the primary resource adopted (biomass, petroleum, natural gas, etc), the bioenergy is the one that presents the most diversity and complexity with a wide range of applications that goes from the use of firewood in household stoves to prepare food to the black liquor combustion in high pressure and high capacity boilers, always involving a great number of traders and presenting multiple interrelationships within society and environment.

In this chapter we try to show the wood energy systems as an interrelated organic set of traders that work to take the vegetable energy to the most diverse human needs with great possibilities of improvement and expansion. In its presentation the main elements for the planning and implementation of improved or optimized wood energy systems are discussed based, mainly, on the work of Trossero (1993).

2.1. Wood energy system structure

Since the harvest or the cutting down of a tree or any other lignocellulosic plant until the transformation into final forms of useful energy in the conditions required by the user, such as heat (thermal energy of high or low temperature) and movement (kinetic mechanical energy), the biofuels must go through a long sequence of stages comprising transport and storage operation and several physical and chemical processes.

Figure 2.1 presents the summary of such unitary operations or the physical chemical processes in three major groups, observing that each group is associated with a series of activities that are evolved in completely different geographic places. For instance, while the production, harvest and preparation of the firewood are processed in rural areas, the consumption of such fuels, many times, takes place in urban or industrial areas. None-the-less, in other occasions there is a coincidence of places where the biofuel is produced and consumed. This situation makes data evaluation and collection very difficult.

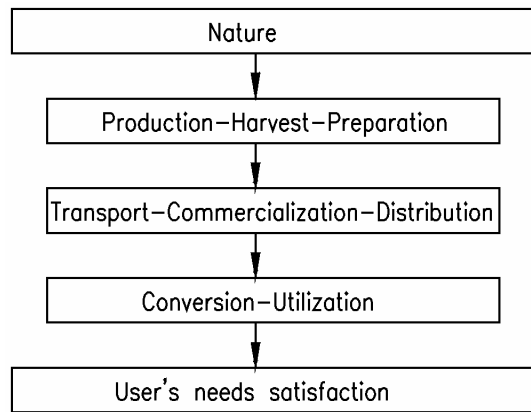


Figure 2.1 – Wood energy operations and activities.

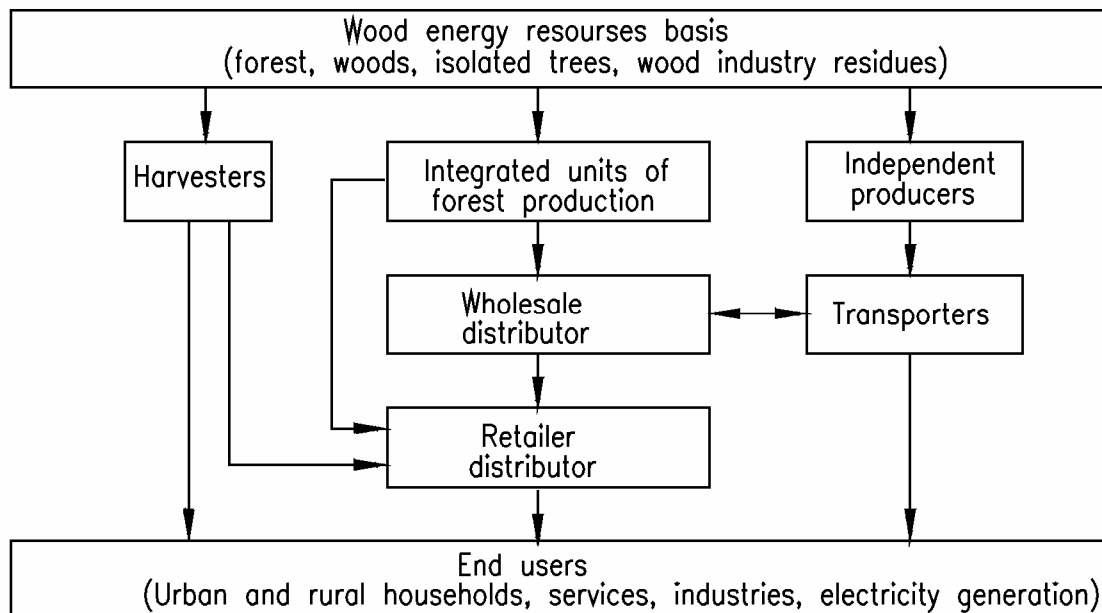


Figure 2.2 – Wood energy systems for firewood (direct use)

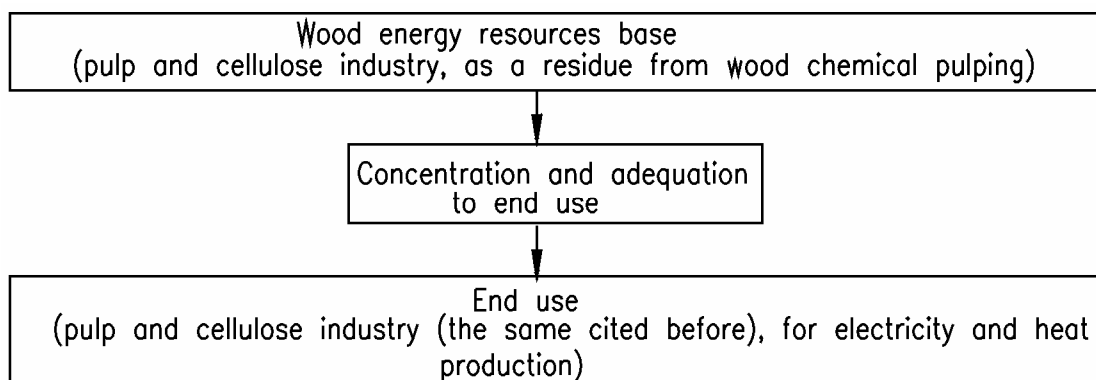


Figure 2.3 – Wood energy systems for black liquor.

As more specific examples of a wood energy system structure, Figures 2.2 and 2.3 offer a view of these systems for wood (direct use) and black liquor, respectively. In the first case it can be observed a diversity of ways connecting the resources to the users' needs. The case of charcoal can be very similar to firewood without considering the direct harvest.

Traditional wood energy systems, as presented in the former chapter, have existed since time immemorial and their general goal is the energy supply for household needs and for small rural industries. Due to the availability of resources and the promotion of an adjustment between demand and offer, their flows are modified without any intervention of the people who are responsible for the forest sectors. These systems have sub-existed for centuries and they still exist in some countries until today where they represent the main energetic basis.

However, the traditional wood energy systems may be considered to be quite rudimentary with a series of inefficiencies that really reduces its sustainability and expansion possibilities. Although the wood from dead trees, pruning and residues can be typically used for fuel production, there is almost no preparation of this products in order to adequate them for the end use. Their combustion is carried out in a very inefficient way, therefore causing considerably elevated losses. In addition, because smoke exhaust systems do not generally exist, conditions are created that are harmful for the user's health.

Facing this scenario it is important to notice that it is possible to propose, project, implement and operate wood energy systems that are more efficient, economically profitable and adequate to the environment contributing towards its conservation and, in some cases, towards the improvement of natural conditions. These systems are supposed to require an appropriate planning and a correct use, integrating the consumers and the entities that are responsible for their promotion and development. These types of wood energy systems are usually called "optimized" and they always present a structure and operation limits determined according to the local conditions. (TROSSERO, 1993). In this sense, each case is a distinct case with its specific problems and imposing its own particular solutions. The considerations about wood energy systems desired evolution are shown in the next topic.

2.2. Optimized wood energy system implementation

There is a wide scope of complementary, not excluding, alternatives for wood energy adequate development. They are presented and grouped in offer and demand actions as follows:

Enhancement and rationalization of the wood energy resource offer:

1. protection and suitable handling of the natural forest formations;
2. creation of new firewood resources in the properties near the users;
3. stimulus to the agro-forest systems that have a multiple, not exclusive, tree vision;
4. valorization of firewood resources through the organization of the markets and the distribution of the profits of their utilization;
5. valorization of biomass by-products and residues that are not used.

Efficiency increase in the end use of wood energy resources:

1. introduction of suitable methods for operation and maintenance of the existing equipment;
2. adoption of improved technologies for final conversion or transformation;
3. adoption of fuel preparation techniques.

An essential preliminary stage for optimized wood energy systems is the realization of basic studies in order to obtain the necessary data about the wood fuels current and possible (sustainable) flows, so as to characterize their origin and main features, for example, the moisture typical values, size composition and density). Such data associated with the demand determining factors (type of required energy, maximum and medium power, etc), allow the configuration of unitary processes that are involved and the real and ideal efficiency degree. A careful institutional analysis regarding eventual policies, legal and normative aspects that affect these systems direct or indirectly must be added to this procedure that is carried out as a wood energy diagnosis to allow the attainment of a complete scenario of the present and future situation. In short, it is about being aware of where and how much wood energy resources there are (and may potentially be), who needs this energy and how much wood energy is needed, and finally who can make the process of the wood energy systems improvement easy of difficult.

Once the current situation is known through the elaboration of a consistent database and the desirable configuration of the future wood energy system is defined, the next step, which is the effective implementation of the optimized wood energy system must be developed by processing, analyzing and projecting such data. It is vital for this stage the existence of decision, execution and supervision mechanisms, not necessarily joined within the same institutional unit, but clearly identified and suitably capacitated to exercise its function. Institutional traders' responsibilities are not very clear, and in some cases their debility is the most difficult obstacle to overcome in order to improve the energy systems based on forest resources.

For all the situations where the introduction of optimized wood energy systems can be proposed, it is important to recognize the determining role of human resources in their conception and operation. The more the people directly involved in the wood energy resources production, transportation and final use are valorized, the more possibilities of success there are. In the same way, regarding the previously mentioned institutions, the actions towards the human resources reinforcement and capacitation must be considered to be pertinent, so that they can be competent enough to understand the complexity of the wood energy systems and recognize their specifications.

Without the pretense of formulating propositions for general rules, but in order to help the implementation of reasonable and lasting wood energy systems, Table 2.1 displays a set of factors according to a management approach of this theme (modified from VIMAL and BHATT, 1989).

Table 2.1. Factors to be considered for the implementation of optimized wood energy systems (modified from VIMAL and BHATT, 1989)

Factors	Description
Technological	Detailed characterization of places, in terms of Physical and biological parameters Suitable selection of forest species to be adopted Proposition of a set of procedures to increase forest productivity Critical selection of efficient processes for final conversion Diffusion of more efficient and productive methods and processes
Environmental	Biomass residues valorization Evaluation of emissions and residue final disposals of wood energy exploitation Evaluation of the impacts on production (erosion, hydro resources)
Social	Evaluation of the consumer energy profile Accomplishment of economic and social diagnosis regarding the social groups that are involved
Economic	Evaluation of the wood energy resource price and cost formation
Fiscal and tax	Forecast of suitable incentives so as to enhance the availability of wood energy resources and improve the efficiency of their use Promotion of a local production of efficient systems for the final conversion Evaluation of the tax systems for marginal land with forest potential
Organizational	Reinforcement of the institutional basis associated with the wood energy Stimulus and coordination of research and development activities Human resources formation and capacitation towards wood energy themes

An evaluation of the Projects and Programs of Forest Action, which are somehow linked to the improvement of the existing wood energy systems in Latin America and the Caribbean, points out, in a very unmistakable way, the presence of four basic factors for its success. (TORRES, 1993):

- A. The Government's well known will and clear commitment that were manifested by its political wish to give support and sustainable financing lines for the adoption of the necessary legal frames and the reinforcement of institutional organisms.
- B. The rural population participation in the protection, organization or establishment of forest resources with energetic purposes collaborating with official organisms.
- C. The effective support of a forest organism that is able and equipped to organize the public woods and support private efforts for the development of silviculture with energetic purposes.

- D. A solid basis of technical solutions that are proved and well adapted to the economic, environmental and social situations of the surroundings.

References

- TORRES, J.E., “La inserción de la Dendroenergía en los Programas de Acción Forestal de America Latina y el Caribe”, **Seminario Regional sobre Sistemas Dendroenergéticos Optimizados para el desarrollo rural y protección ambiental**, FAO y Universidad Nacional de Honduras, Tegucigalpa, 1993.
- TROSSERO, M.A., “Sistemas Dendroenergéticos Optimizados”, **Seminario Regional sobre Sistemas Dendroenergéticos Optimizados para el desarrollo rural y protección ambiental**, FAO y Universidad Nacional de Honduras, Tegucigalpa, 1993.
- VIMAL, O.P., BHATT, M.S., **Wood Energy Systems**, K. L. Publications, Delhi, 1989.