CHAPTER III

THE RURAL COMMUNITY DEVELOPMENT MODEL

Introduction to the Energy Planning Model

Since the early 1970's the world has experienced a change from cheap and plentiful energy to expensive and uncertain energy supplies. This transition has been especially difficult for oil-importing developing countries, not only because of the accompanying large losses in foreign exchange, but also because of the relative costs and benefits of different industries and technologies have been altered, leaving governments uncertain about the strategies they should adopt towards energy supply and demand in the future. Although this situation has eased in early 1986 with unexpected decreases in oil prices, the situation is still uncertain for the medium and long term.

Until recently sources of energy such as electricity, coal, and petroleum, were viewed separately, with little examination of the linkages between forms of energy and the overall economy. Today, because of the effects of energy price increases and fluctuates on economic activity, the importance of the integrated nature of a country's total energy system is recognized. National energy policies currently entail analysis of all energy supplies (including renewable technologies such as bimass) and energy demand factors so that all possible tradeoffs, substitutions and relevant strategies are explored.

Various modeling methods have been developed by both academics and policy makers to further national integrated energy planning. A number of the models used in the Third World forecast demand over the next 20 to 30 years and evaluate alternative supply sources (in terms of financial cost, domestic production, etc.) that best meet forecasted demand. The well-known models include Brookhaven's Energy Economic Assessment Model (BEEAM), Argonne's Energy Model (AEM) and the Wise Models developed by the University of Wisconsin and IIASA. A discussion of the structural differences between models, the level of details (including time, demand and supply) and the different handling of costs and projects can be found (Daniere, 1983). Ultimately, such a comparison can be used to develop more effective and useful models contributing to greater understanding of energy systems in the developing world. BEEAM has been applied to a number of countries including Peru, Portugal and Korea (Mubayi & Meier, 1981).

In Thailand, the Energy Master Plan Model (EMP) was commissioned in 1980 under the sponsorship of the Asian Development Bank (ADB) and the United Nations Development Program. The major objective was to equip the National Energy Administration (NEA) with tools to do macro-energy planning and prepare a long-range, sector-wide energy plan for Thailand " with a view to reduce the growing dependence of energy supply on the import of petroleum products and devising and implementing effective, appropriate measures for improved management of energy demand". The five basic components (or tools) of the Energy Master Plan Model are listed below (Nathan Associates, Fichtner Consulting Engineers, Columbus Consulting Engineers, Gold GmbH & Co., Thalang & Co.,1983) :

1. An Energy Reference System (ERS), description of the Thai energy sector, including all major supply alternatives, conversion processes, and major components of the energy-consuming subsystems of the economy ;

2. An associated energy sector data base ;

3. An Energy sector simulation and optimization software designed to operate on the basis of the ERS and associated data bases ;

4. A set of linkage relations used in forecasting demands for the energy sector simulation and optimization models, which are designed to accept as inputs and outputs of either the NESDB macroeconomic forecasting model or an adaptation of that model ;

5. A macroeconomic forecasting model adapted from one in use at the NESDB in conjunction with the formulation and revision of macroeconomic development plans.

Historical Background of the Rural Community Development Model

A prime objective of Thailand's last national development plan, the fifth five years plan (1982-1986), was to fulfill Thailand first national objective i.e. to accelerate rural development, to improve rural life, and to boost rural economy for better income distribution. Higher economic growth requires more energy consumptions. Energy strategy should be planned in order to achieve higher income growth in the rural sector. Although energy resources are abundant in rural areas, most of such resources are in forms that are not convenient or ready to use. Investment are required for resource development before the resource can be fully utilized. Vast rural areas and scattered energy resources make rural development rather costly. Therefore, all capital has to be carefully invested to obtain the highest benefit for the country in order to achieve the national objective.

The Village Energy Model or Household Energy Model (HEM) had originally been designed and used for measurements of demands for upriced energy in various forms for a single snapshot year. This was done without taking into account integrated energy supplies/demands or important rural community activities and rural community development programs. Inclusion of such factors made the model a subset of an appropriate model for a community.

A model is developped to simulate a decision process for the development of rural communities with emphasis on rural energy development, taking into account the income, economic conditions, and occupations of people in typical Thai rural communities as well as resources (e.g. natural resources, human labour) in the communities. The income of the community is maximized in such a way that resources, labour, and technologies are used in an appropriate manner. The model mentioned is called Rural Community Development Model (RCDM) which is applied from concepts utilized in EMP and expansion or modification of HEM to include time scale for required planning intervals. The model took into account alternative energy resources, energy conversion or distribution processes so that it could be used to evaluate community scale energy projects.

The Conceptual Model

The diagram shown in Figure 3.1 represents a simplified system of RCDM. The system is divided into components : end products/services goal, intermediate

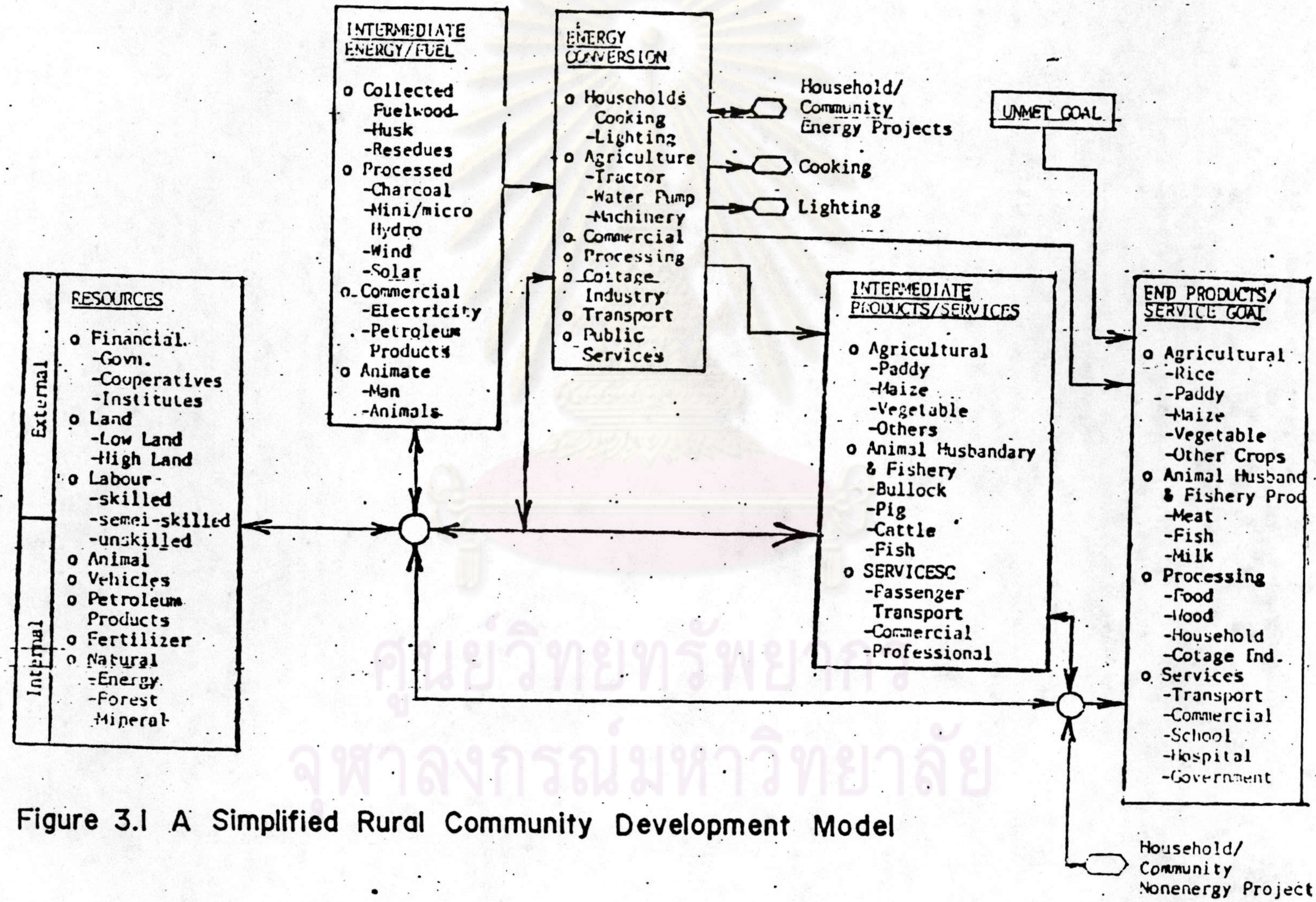

Figure 3.1 A Simplified Rural Community Development Model

products/services, energy conversion, rural intermediate energy, internal and external resources.

1. End Products/Services Goal

End products/services demand goal is a set of levels of products to be produced and services to be rendered by a community. In each community, one could project a products/services goal at intervals, e.g. each year, every five years, etc.

The goal is divided into: agricultural products, animal and fishery products, industrial products, and services. The agricultural products include selected economic or major crops of the community such as paddy, maize, vegetables, cash crops (e.g. cotton, jute, tobacco, fruits), etc. Animal husbandary and fishery products include meat (e.g. pork, beef), fish, milk, egg, etc. Industrial products include food products (e.g. rice, the milled grains, cassava, red sugar, dried fish), wood products (e.g. timber, charcoal), household products, and others. Services include transportation, commercial activities, school, etc.

2. Intermediate Products/Services

The intermediate products/services are those raw material to be converted to end products/services through processes (if necessary). For example paddy may either become rice if it is milled or still be paddy if it is sold to markets outside the community.

The intermediate products/services include agricultural products (e.g. paddy, cassava, sugar cane, vegetable, grass, eucalyptus, maize), animal and fishery products, passenger transport, commercial activities, and others.

3. Energy Conversion

The energy conversion component allows the conversion of the end-use energy demands to demand in intermediate energy forms. The intermediate energy could be supplied from either external sources or from sources within the community.

4. Rural Intermediate Energy

Rural intermediate energy is energy in intermediate forms required by energy conversion components to produce products, to render services for households and public use. This includes collected fuels (e.g. fuelwood, field residues, crop processing residues, dung), process energy (e.g. charcoal, biogas, biomass, solar, wind), commercial energy (e.g. petroleum products, electricity), and animal energy (e.g. human labour, draft animal).

Energy from external sources include petroleum products (e.g. LPG, diesel, gasoline), transmitted electricity, lignite, etc. Energy to be supplied from sources within the community include fuelwood, biogas, biomass, mini-hydro, wind, solar, etc.

5. Resources

Resources could be either internal or external resources. Most resources are limited and are the constraints of the linear programming problem of this study, such as the limitation of land, water, man-power, animal, etc.

Internal resources are the resources available in the community such as land. External resources are the resources required from sources outside the community such as petroleum products, government budget, electricity, etc. Some external resources, such as Government budget, are limited.

FINERG-A Linear Programming Model

A FINERG software, used in EMP, will be used in RCDM. The model will provide systematic formulation equipped with a conversion table to convert parameters from one dimension to another. This would allow changing of economic parameters used in the model when the model is used for different communities having variations of value parameters.

The model is developed to maximize community income for given end products/service goals and resource constraints.

To be consistant with other national planning procedures,the procedure in determining the community income follows the one employed in determining national income by the National Economic and Social Development Board (NESDB).

For a set of end products/services goal, resources will be drawn through links of the model network. Some process links would generate income to the community such as conversion of paddy to rice through milling process, small industry in the community, introduction of new energy technology (e.g. biogas, biomass). All these processes increase values of resources available in the community and also become income to the community.

The model structure and its main components are shown in Figure 3.2 and are composed of :

1. <u>Energy Flow Network</u> ;

The Reference Energy System (RES) integrates a set of estimated energy demands, energy conversion technologies, fuel allocations, and energy resources into an overall energy supply/demand balance (Mubayi et.al, 1981).

RES is represented by a network through which the energy flows from the supply nodes, through the network links, to the demand nodes. The nodes of this network represent an energy form or a mix of energy forms, while the links represent energy supplies, conversion or consumption process. Figure 3.3 shows a simplified example of such a network. The boundary nodes (for supply or demand energy forms) of the system are represented as ⬡, the nodes for intermediate energy forms and the ancillary nodes are represented as ◯ and ☐, respectively.

A network link represents an industrial process converting an energy form (or a mix) into another energy form (or mix of forms). Therefore, the links are undirectional. The yearly amount of energy leaving the process is called the link's flow. The various technological and financial data characterizing a process are associated with the network link representing that process.

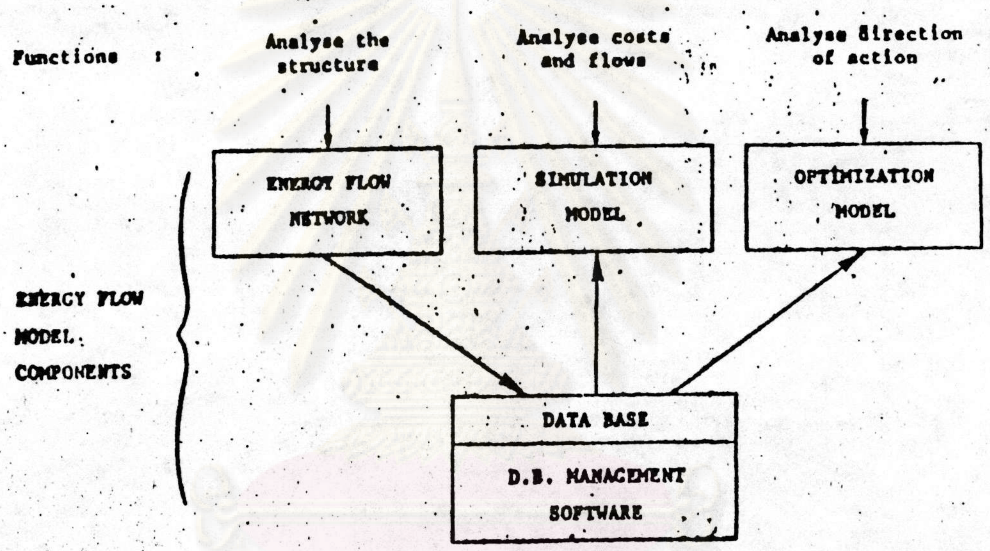

Figure 3.2 - FINERG Basic Function and Corresponding Model Components

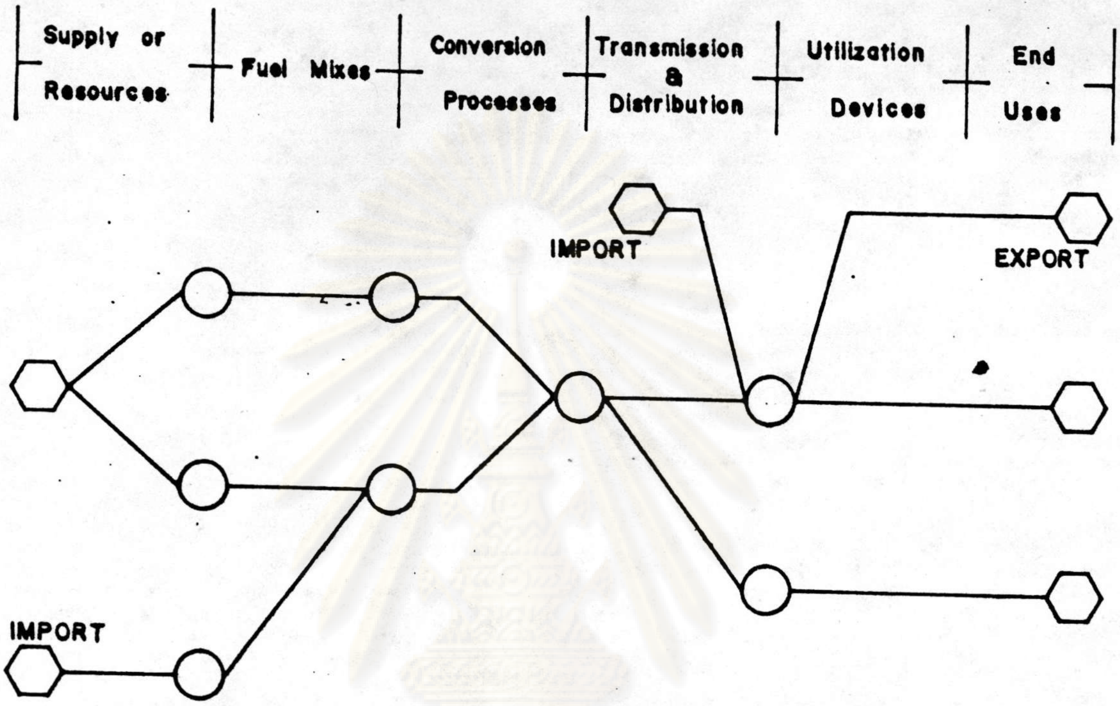

Figure 3.3 A Simplified Network Diagram of Reference Energy System

2. The Energy Sector Data Base

The energy data base contains a massive amount of both historical and projected data relating to subsystems and the specific activities represented within them. The parameters defined in the Energy Data Base can be classified in four categories :

2.1 Technological data

These determine the energy flow pattern through the network and consist of :

- The process efficiency
- The ancillary and by-product coefficients defined per unit of process outflow
- The market allocation coefficients defining the usual contribution of a given fuel in a mix of competing fuel forms or the specific consumption of a fuel in a process.
- The product allocation coefficients defining the repartition in a mix of products concurrently generated by a process.
- The flow levels for past years and pertinent forecasting for future years (according to scenario definition).

Upper and lower bounds can be specified for flow level, market and product allocations.

2.2 Cost data

These describe the process' financial data and comprise :

- The variable cost per unit of process outflow (excluding energy costs).

- The fixed cost per unit of capacity (excluding depreciation and financial charges).

- The investment cost per unit of capacity.

2.3 Equipment Data

These describe the capacity and the performance of the process equipment which include :

- The installed capacity at the initial year of the study.

- The residual capacity : this is the capacity which would be available if, starting from the initial year of study, no new capacity was invested. The residual capacity decreases in time to reflect equipment dismantling.

- The technical lifetime of equipment.

- The availability factor of equipment which considers only the maintenance and forced outage rates.

- The utilization factor of equipment which considers the effective utilization rate.

Upper and lower bounds can be specified for the capacity levels of future years.

2.4 Environmental and social data

These describe the process' impact on the ecological and social environment which allow the accounting of :

- water pollution

- air pollution
- direct employment

A short description of the various parameters is shown in the Appendix A.

The energy data base's associated management software for storing and retrieving the energy data is DAMOCLES which requires 406 K bytes of core and CPU-time of 1 minute on IBM 370/158 for program execution. The DOCUMENTA is the associated program for documentation updating.

3. The Simulation Model

Simulation enables the use of the model and data base as a large calculating machine. It permits calculations of the "if...then" variety, but is entirely dependent on input data determining the choise among fuels, processes, or utilization alternatives represented in the model. It can be used to calculate energy flows, balances, and costs resulting from such predetermined decisions, but provides no real insights as to the value of the trade-offs which might be involved or as to the "most desirable" among the large number of possible future development alternatives open for the Thai energy sector.

Starting with a given structure, a set of final demands as extensive variables and per unit coefficients as intensive variables, SIMUL computes the energy and material flows through the network, from the final demands up to the primary resources. Subsequently, it calculates the associated cost flows (running and investment costs) from the primary resources down to the final demand.

In SIMUL, flow allocation is performed on the basis of the inflow mix coefficients assigned to the nodes ; these coefficients are exogenous to the model and stored also in the data base. These inflow mix coefficients are either specific consumptions or market allocations. In the former case, their relative shares are fixed for technological reasons. In the later case, they represent the share of concurrent flows which are competing resources. Those market allocations are used in policy assessment. Each simulation covers one time period ; one computer run may consist of several independent simulations.

SIMUL computes also the amount of ancillaries required and the amount of by-products yielded by each process and sums up homologous ancillaries and by-products. It compares the amount of ancillaries required with the initial flow value of corresponding ancillary demands and, if significantly different, starts a new iteration of flow calculation, based on this new demand for ancillaries.

For each by-product, the total amount of by-products available is compared with the amount required according to the input allocation coefficients. If the supply is higher than the requirements, the efficiency of the supply process is reduced accordingly so that unusable by-products are accounted for as losses. If the supply is lower than the requirements, input allocation coefficients are adjusted so that the balance is supplied by other resources provided that this is possible, i.e. that competing flows are fed together with by-products.

SIMUL yields several types of reports such as

3.1 The flow pattern, i.e. the flow level on each link of the network.

3.2 The cost map which gives the average and marginal fuel cost at each node.

3.3 The yearly cost of the energy system, by process.

3.4 The equipment capacities needed by the process.

3.5 The investment needed due to capacity creation.

4. The Optimization Model

Optimization modelling is designed to evaluate systematically each of the possible alternatives and find the 'most desirable" one according to the criterion selected for optimization, given a full set of data describing the various options open for the development of the energy sector, and their costs, yields, and efficiencies, as well as any external constraints affecting their development.

The optimization model generates estimates of the "value" of each alternative in contributing to the achievement of the desired objective, in the form of estimates of the degree to which marginal deviations from the optimal solution would affect the increments to the present value of energy supply cost over the planned period for each supply alternative. This information provides important insights about the magnitude of the trade-offs involved in selecting alternative development paths.

The optimization model also provides valuable information on the way in which the configuration of the "most desirable" development path will change in response to important changes in the planning data or assumptions. Thus, various scenarios can be constructed to reflect changes in assumed values for such key parameters as reserves, import prices, investment costs, and demand growth, thereby enabling estimation of the impact of such changes on various components of the energy development plan. The stability of the most likely scenarios, the base cases, can be checked, and key sensitvities identitied.

The variables in the optimization model are the flows on the links in the network and the capacities of the processes represented on this network.

Based on cost minimization (operating, fixed and capital costs) of energy supply, conversion and use, it takes into account the technological, economical, political and environmental constraints, as well as the whole set of possible fuel substitutions and capacity developments.

The optimization model contains 3 programs :

4.1 <u>ORESTE</u> - Linear programming input matrix generator
4.2 <u>MPSX</u> - Standard linear programming software
4.3 <u>ORACLE</u> - Report generator

ORESTE is the software generatating the linear program models. It has been designed to allow for multinational and time-phased studies. For the system selected from the data base, a linear programming matrix is generated as an MPSX computable input stream and the solving software is actually the IBM MPSX 370. The mathematical formulation of the linear programming model includes for a large part network topological constraints. Moreover, the linear programming following the energy system as represented in the data base, redundant equations and unknowns, may happen in the initial formulation increasing unnecessarily the system size. To cope with this situation, the matrix generator ORESTE includes a matrix modifier which reduces the linear programming by eliminating the topological unknowns which do not bear on the linear programming solution, or reducing the redundant variables and constraints. ORESTE executes in batch mode which requires 450 Kbytes of core and approximately 1 minute of CPU time for one country and one year.

The output phase is made of the report generator ORACLE used to retrieve the results from the MPSX file and present them in a format comparable with the simulation program output.

Model Equations (Jadot, Fuchsova, Vankelecom, 1979)

1. Flow Balance Equations

With each node k, an annual flow balance equations yields :

$$\sum_{i \in JI_k} X_{it} = \sum_{j \in JO_k} \frac{X_{jt}}{\eta_{jt}}$$

This equation vanishes at nodes where JI_k is empty, i.e., at resource nodes.

2. Ancillary Demand

ANCILLARY allows the FINERG software to connect flows in processes to the point where the flow has to be produced. The energetic self-consumption of the energy sector, so-called ancillary demand, is endogeneously computed as follows :

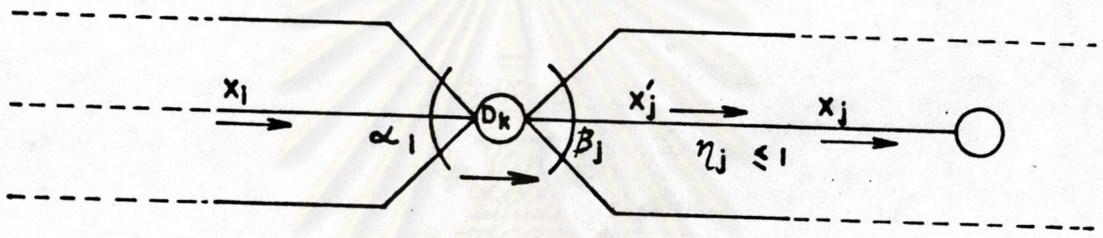

Figure 3.4 A Node-link Diagram

$$D_{ft} = \sum_{i=1}^{N} ANC_{f,it} X_{it}$$

Where f is the ancillary demand node associated with fuel form f.

3. <u>By-Product Supply</u>

By-PRODUCT allows the FINERG software to connect the generated by-products to the processes where they are used. The model computes the supply of by-products and verifies that the use of by-products at year t cannot override the supply.

$$\sum_{i=1}^{N} BYP_{f,it} X_{it} \geq \sum_{j \in JO_k} \frac{X_{jt}}{\eta_{jt}}$$

where k represents the supply node for by-product f.

4. <u>Market Allocation Constraints</u>

These equations apply at node k for which the ratio of inflows is fixed for technological reasons :

$$X_{it} = \alpha_{it} \sum_{j \in JO_k} \frac{X_{jt}}{\eta_{jt}} \qquad i = 1,\ldots,JI_k$$

or must be within a certain range

$$X_{it} \leq \bar{\alpha}_{it\,max} \sum_{j \in JO_k} \frac{X_{jt}}{\eta_{jt}} \qquad i = 1,\ldots,JI_k$$

$$X_{it} \geq \underline{\alpha}_{it\,min} \sum_{j \in JO_k} \frac{X_{jt}}{\eta_{jt}} \qquad i = 1,\ldots,JI_k$$

The above constraints are generally used for production processes in the utilization system. In these cases, the market allocation coefficients are usually dimensional, or the inflows must be expressed in terms of total outflow of node k.

5. Product Allocation Constraints

These equations apply at node k for which the ratio of outflows is fixed for technological reasons.

$$\frac{X_{jt}}{\eta_{jt}} = \beta_{jt} \sum_{i \in JI_k} X_{it} \qquad j = 1, \ldots, JO_k$$

or must be within a certain range

$$\frac{X_{jt}}{\eta_{jt}} \leq \bar{\beta}_{jt\,max} \sum_{i \in JI_k} X_{it} \qquad j = 1, \ldots, JO_k$$

$$\frac{X_{jt}}{\eta_{jt}} \geq \underline{\beta}_{jt\,min} \sum_{i \in JI_k} X_{it} \qquad j = 1, \ldots, JO_k$$

As the product allocations coefficients could also be dimensionned, the outflow must be expressed in terms of total inflow into node k.

6. Flow Capacity Constraints

When the equipment is explicitly considered for a process, the flow through the process is related to the capacity by :

$$X_{it} \leq AVF_{it} \left(RCAP_{it} + \sum_{k=t-DV_{it}}^{t} Z_{ik} \right)$$

7. Flow Boundaries

Energy or material flows may be bounded for several reasons such as policy constraints, or physical constaints. They will be noted :

$$FIOMIN_{it} \leqslant X_{it} \leqslant FIOMAX_{it}$$

8. Capacity Bounds

As for the flows, bounds can be defined for the equipment variables in terms of minimal and/or maximal capacity existing at year t.

$$CAPMIN_{it} \leqslant RCAP_{it} + \sum_{k=t-DV_{it}}^{t} Z_{ik} \leqslant CAPMAX_{it}$$

where the sum represents the equipment not dismantled in year t.

The Objective Function of the Model

Two objective functions are developed : (Jadot et al. 1979).

1. It uses a direct evaluation of investments and neglects the residual value of equipment at the end of the study period.

The objective of the dynamic optimization model is to determine the most economic investment and operating plan to satisfy the energy demand during the study period T_o, T.

The total cost, discounted at the starting year is composed of variable cost (proportional to the flow), fixed cost (proportional to the capacity) and capital cost (proportional to the new capacity). The annual costs for all processes are summed up and discounted at the starting year of the study. The sum over the years applies on all of the years between T_o + 1 and T.

$$\sum_{t=T_o+1}^{T} \frac{1}{(1+a)^{t-T_o}} \sum_{i=1}^{N} [\, C_{it} X_{it} + F_{it} Z_{it} + I_{it} Z_{it}] \quad (1)$$

In order to reduce the problem size, the whole period (T_o-T) is divided into P subperiods : T_o-T_1, T_1-T_2,...T_{p-1}-T_p,....T_{P-1}-T_P. The objective function now becomes :

$$\sum_{p=1}^{P} \frac{1}{(1+a)^{T_p-T_o}} \sum_{i=1}^{N} [\, C^*_{ip} X_{ip} + F^*_{ip} Z_{ip} + I^*_{ip} Z_{ip}] \quad (2)$$

Computations of modified coefficients C^*_{ip}, F^*_{ip}, I^*_{ip} are made equivalent the corresponding terms of (1) and (2) for each period. One assumes that the flow and the capacity of the equipment vary linearly during each period.

$$C^*_{ip} = \sum_{t=T_{p-1}+1}^{T_p} (1+a)^{T_p-t} \, C_{it} \frac{t-T_{p-1}}{N_p}$$

$$F^*_{ip} = \sum_{t=T_{p-1}+1}^{T_p} (1+a)^{T_p-t} \left[\sum_{k=1}^{DV} \frac{1}{(1+a)^k} \right] \gamma(t,DV) \frac{F_{it}}{N_p}$$

With $\gamma(t,DV) = \text{integer}\left[\frac{t-T_{p-1}+1}{DV} + 1 \right]$

$$I^*_{ip} = \sum_{t=T_{p-1}+1}^{T_p} (1+a)^{T_o-t} \gamma(t,DV) \frac{I_{it}}{N_p}$$

This objective function,

$$\sum_{p=1}^{P} (1+a)^{T_o-T_p} \sum_{i=1}^{N} [\, C^*_{ip} X_{ip} + (I^*_{ip} + F^*_{ip}) Z_{ip}] \ ,$$

gives the total discounted cost of energy supply during period T_o, T_P except for two constant terms :

1.1 Variable cost of the first period expressed in terms of flow at the starting years.

1.2 Fixed capacity cost related to the residual capacity,

and it is valid if the residual value of the equipment is negligible.

2. For medium term studies, the basic assumption of negligible residual value is no longer valid.

The capital cost will therefore be evaluated annually by a leasing formula based on per unit investment cost, technical life time and interest rate, r.

The annuity to be charged for the new capacity is given by :

$$A_{it} = I_{it} \frac{r}{1-(1+r)^{-DV}}$$

This annuity reflects exactly the investment as far as the interest rate equals the discounting rate, a. In fact :

$$\sum_{k=1}^{DV} \frac{A_{it}}{(1+a)^k} = I_{it} \frac{(1+r)^{DV}.r}{(1+r)^{DV}-1} \sum_{k=1}^{DV} \frac{1}{(1+a)^k}$$

$$= I_{it} \frac{(1+r)^{DV}.r}{(1+r)^{DV}-1} \frac{(1+a)^{DV}-1}{(1+a)^{DV}.a}$$

$$= I_{it} \quad if \quad r = a$$

The objective function now becomes

$$\sum_{p=1}^{P} (1+a)^{T_o-T_p} \sum_{i=1}^{N} \left[C^*_{ip} X_{ip} + K^*_{ip} Z_{ip} \right]$$

where
$$K^*_{ip} = \sum_{t=T_{p-1}+1}^{T_p} (1+a)^{T_o-t} \frac{\gamma(t,DV)}{N_p} \left[\sum_{k=1}^{T_K} \frac{A_{it}}{(1+a)^k} + \frac{1}{(1+a)^k} F_{it} \right]$$

$$T_K = Min(t+DV, T_p)$$

when $T_p < t+DV$

$$\sum_{k=T_p+1}^{t+DV} \frac{A_{it}}{(1+a)^k}$$ represents exactly the residual value of equipment :

$$\sum_{k=1}^{T_K} \frac{A_{it}}{(1+a)^k} = I_{it} - \sum_{k=T_p+1}^{t+DV} \frac{A_{it}}{(1+a)^k}$$

Therefore, this objective function considers automatically the residual value of the equipment.

The Program Capabilities and Limitations

The present program limits are :

1. Initial problem dimensions :

- maximum number of countries	8
- maximum number of subsystems	20
- maximum number of parameters	120
- maximum number of years	8
- maximum number of ancillary parameters	25
- maximum number of by-product parameters	25
- maximum number of storage parameters	25
- maximum number of nodes	4000
- maximum number of unit conversion factors	500
- maximum number of units	250
- maximum number of links in one country	1000
- maximum number of processes in one country	1000
- maximum number of parameters in a link	120
- maximum number of boundary nodes for one subsystem	100

2. Linear programming matrix dimensions

- maximum number of rows	6000
- maximum number of positive elements in a row	6000
- maximum number of negative elements in a row	6000
- maximum number of columns	7000
- maximum number of additional constraints	2000

Subsystem Development

Rural community activities are classified into subsystems and grouped as follows :

1. Basic Rural Community Group
   - Land
   - Household (or Rural community labour)
   - Agriculture
   - Animal
2. Energy Subsystem Group
   - Energy supply and demand
   - Biogas/Fertilizer
3. Small Industry Subsystem Group
   - Rice processing (or Rice mill)
   - Animal processing (or Slaughter house)
   - Spindling/Weaving
   - Mat weaving
   - Pottery
   - Handicraft
   - Tobacco curing
   - Rubber processing
4. Community Development Subsystem Group
   - Irrigation/Water resource
   - Fast-growing tree
   - Village fishery
   - Upland rice growing
   - Mulbery plantation & Silk worm farming
   - Second cropping
5. Services
   - Transportation
   - Commercial services
   - Government services

Some details in FINERG such as the identification of node types, the identification of processes (links), hypothesis attribute, and the matrix generator notations are shown in appendix B. Others can be found in the User's Mannual of Data Collection, Program DAMOCLES and Program ORESTE (Jadot et al., 1979).