Economia e Energia - e&e - Edição Especial Matriz Energética - Economy and Energy - Special Edition Brazilian Energy Matrix

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Matriz Energética e de Emissões

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Query Language

The text search engine allows queries to be formed from arbitrary Boolean expressions containing the keywords AND, OR, and NOT, and grouped with parentheses. For example:

`information retrieval`
finds documents containing 'information' or 'retrieval'

`information or retrieval`
same as above

`information and retrieval`
finds documents containing both 'information' and 'retrieval'

information not retrieval
finds documents containing 'information' but not 'retrieval'

(information not retrieval) and WAIS
finds documents containing 'WAIS', plus 'information' but not 'retrieval'

web*
finds documents containing words starting with 'web'

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Energy Matrix

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The team has experience in previous runs of the national Energy Matrix for the National Energy Commission and in works coordinated by the Ministry of Mines and Energy – MME.

The proposal for supplying tools for the Energy Matrix was presented to the Secretariat of Energy of the MME. It is ***e&e***'s intention to publish intermediary reports and share these instruments with other contractors that could follow in an active way the discussions and their approval by the National Commission for Energy Policy - CNPE.

The work uses the concept of equivalent energy, already described in this periodical, that makes it possible to project demand by sector in equivalent energy.

A first version of the Matrix will be available in the first semester of 2001 based on the instruments already developed and to be developed.

The first tools – macroeconomic and equivalent energy modules – are already available. In this issue we present a description of these tools and an application of the methodology for demand projection and individual vehicles.

The updated version of the initial works will be available at the address http://ecen.com/matriz.

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Progressos na Matriz Energética e de Emissões de Gases Causadores do Efeito Estufa

Este é o segundo número dedicado a descrever progressos nos estudos da Matriz Energética e de Emissões Geradoras do Efeito Estufa. Apresentamos uma primeira versão do Cenário Econômico de Referência que está proposto para discussão.
Nossa proposta é trabalhar por aproximações sucessivas e estamos apresentando neste número uma Primeira Aproximação do Consumo Global em Energia Equivalente e o de Energia Elétrica.
Apresentamos também uma primeira versão de um dos módulos Físicos de Oferta relativo a Expansão de Termelétricas.

Introdução

Passo seguidos para estudar as futuras emissões de termelétricas

Cenário Econômico de Referência

Cenário usado para o estudo de emissões e atual cenário de referência para a Matriz Energética e de Emissões

Geração Termeleétrica 2000-2020 e Participação dos Combustíveis

Participação das Centrais por Tipo de Combustível na Geração

Capacidade de Geração Térmica Necessária

Avaliação Preliminar para o período 2000-2020

(considerando o Cenário de Referência):

Demanda de Energia Equivalente

Demanda de Energia Elétrica

Esta primeira aproximação faz correlações globais e deverá ser aprimorada com o tratameno setorial

Emissões em Termelétricas

Conclusões e Avaliação de Sensibilidade

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Project
Macroeconomic Module
Equivalent Energy Module
Energy for Transport Sector

CNPE (only in Portuguese)
Decree
Law

e&e links
Guest Book

Economy & Energy
http://ecen.com

Energy Matrix:
http://ecen.com/matriz

PROJECT FOR ELABORATING THE NATIONAL ENERGY MATRIX

1 - Energy Sector Restructuring and the Energy Matrix

The Energy Sector Restructuring is part of a policy under development in the Country aiming at restructuring the participation of the State in the economic activities.

At the start of the nineties, through the Federal and Federation Units governments, the State practically controlled the entire energy generation and transmission and private companies controlled only a small fraction of electricity distribution. The State economical intervention was dominant in the sectors of natural gas and petroleum and its products, even though in a lesser degree. Even in sectors where private initiative was predominant, such as alcohol fuel and mineral coal, the State was present by fixing prices or applying subsidies and compensatory measures.

There is consensus among those conducting the process that in Brazil the State will continue to have a strong presence in the energy sector albeit in a more indirect way, through associations or by granting financing. Strengthening the regulating role of the State is part of this policy.

In the new reality, the different energy sources will compete more freely among themselves; the vanishing of the unique national price policy emphasized the regional aspects of energy use in the country; energy trade among the neighboring countries that was practically absent in the nineties began also to be taken into account; natural gas, which was of limited presence in the national energy matrix, began to be taken into account.

Actually, withdrawal of the State from direct activity in the energy area does not exempt it from its responsibilities concerning the Country's supplying, vulnerabilities vis-à-vis external price variations, such as those occurred during the petroleum crises in 1973 and 1979, or the environmental effects resulting from energy generation or use.

The strategic nature of the energy question makes it object of legal and even constitutional determinations that must be taken into account in the energy planning. In its elaboration it must be also considered the guidelines and plans proposed by the Government and the regional policies established by the President of the Republic coming from Ministries and specific agencies.

The deregulation of the energy sector in a general way created the need of reactivating energy planning in a different concept from that adopted during the petroleum crisis when the policy of governmental intervention in this sector was emphasized.

Due to its long term characteristics the Energy Sector had the most improved planning system at the national level, although made by the State, and it acted together with regional and state enterprises that had their own dynamics The Energy Sector Restructuring aims at preserving this

capacity. The reformulation of the electrical sector began to consider the competitive nature of the market - which will be composed mostly of private companies - and imposed a reformulation of electrical planning.

In the general case, Energy Policy became a responsibility of the National Council of Energy Policy - CNPE in Portuguese - (Law n^0 9,478 of August 6, 1997) which is chaired by the Ministry of Mines and Energy - MME. Its Executive Secretariat is charged to the Energy Secretariat of MME (Decree n^0 2,457 of January 14, 1998). The energy policy established by CNPE supplies the basis for the energy planning in the Country.

The Coordinating Committee for Planning the Expansion of Electrical Systems - CCPE (Administrative Law MME 150 and 485 of 1999), was established for the electrical sector. Among other things, its objective is to guide governmental actions for assuring energy supply, having the quality and quantity levels demanded by society and coherent with the National Energy Policy, as determined by CNPE. It is under study the hypothesis of establishing a planning organ for the Energy Sector with adequate structure for its important functions.

Therefore, the integrated energy planning, whose objective is to establish the energy policy, is under the executive responsibility of MME both because of its main functions in the Mines and Energy realm and its role as Executive Secretariat of the CNPE. The new reality of the sector imposes open and participating planning where competitive aspects among enterprises and energy sources are preserved.

The elaboration of the National Energy Matrix is part of a more global process concerning strategic planning for the Country that involves the Society and, through the constituted powers, the State. Actually, the Matrix is a tool for integrated energy planning in the energy area that in its turn is linked to the Country's strategic planning.

After approval by the Executive Power, the results of the Energy Matrix should have the conditions necessary to be included in the Strategic Planning process and in the Multi-annual Plan.

The National Energy Matrix and Regional Matrices as well as the Sectorial Plans are the main instruments for defining this policy that must be in harmony with the Social and Economical Policy of the Government. The Energy Matrix takes into account the governmental investment plans and guidelines for the Industrial, Transport and Agricultural sectors that, together with the Residential sector, are the main sectors using energy.

In the definition of the energy policy one must also consider the international and regional scenarios and their configuration in the global environment of the Country. It is also necessary to consider the technological aspects that condition the use and production of energy in the present and in the future, in the medium and long terms, besides the environmental impact of its production and use in the short, medium and long runs.

To the complexity of the energy question it should be added the long term character involved in the decisions to be taken and that surpass in general the governmental administration and therefore demand a consensual process where the society should have large intervention capacity. The State's decision to move off from some direct activities in this area where it had (and still has) a

preponderant role stressed this need

In this perspective, the present proposition is related to the creation of a tool for the elaboration and analysis of the National Energy Matrix to be used in the integrated energy planning process of the MME and opportunely its discussion within the CNPE and with society.

The National Energy Matrix will supply for enterprises of the Energy Sector the perspectives of demand by sectors and in the future the electricity demand by region, in its specific uses and in uses competitive with other energy sources. It should be emphasized that in systems where production is predominantly hydraulic and subject to a larger rigidity and dependency on the rain regime, the alternatives of uses between electricity and other energy source are also an important factor to be considered from the point of view of market regulation.

2 - The Proposition

2.1 - Methodology

Since investments in energy - production, conservation and even use - have a maturation period of five years, it is essential for private initiative and government to have a perspective of future demand and offer. All countries that face the future with responsibility consider this input as strategic. Large projects have typical horizons of more than one decade. On the other hand, this is a sector investment-intensive and whose prices have been unstable in the last three decades. Failure in projecting offer can cause serious problems to the development of the Country.

In the past, planners whose high demand forecasts were systematically denied by reality, misused this evidence. Actually much of their errors originated from optimistic economic scenarios, external to energy planning, that did not come true. These scenarios reflected in most cases political want of economical growth.

During some time several economic scenarios were used, with different growth rates that were not practically useful since the resulting diversity did not clearly oriented the investments

There are strong indications that in the case of electricity there is a situation close to the criticism from those who became accustomed to disbelieving the planners' warnings. Furthermore, our analysis shows that the Brazilian economy has been using a utilization factor below the average one and that an available margin of 5 to 6% for growth can be materialized in the short run without large investments in the production capacity. But that could collide with difficulties in what concerns electrical supply.

Another problem found in the energy projections was in sector planning (electricity, petroleum, alcohol, etc.) that could not coherently consider contributions from different sources.

The methodology proposed for evaluating the Energy Matrix has the purpose of eliminating most of the above mentioned problems. It combines the projection methodology of equivalent energy, developed by experts from e&e for the former National Commission for Energy of the Ministry of Mines and Energy, with a model of economic projection that is capable of detecting restrictions to growth by extrapolating

The methodology utilizes:

- An economic model that takes into account the limitations to economic growth.
- The adopted sectorial structure of the economy, basically that of MME's Energy Balance that emphasizes the sectors more relevant to energy consumption.
- The projected sectorial growth considers the historical evolution of the participation of these factors in the economy, global growth and projected annual rate.
- The equivalent energy/product rate for each sector of the economy is used to relate economic activity to energy demand.
- The participation of each energy source is inferred from the historical evolution and from considerations regarding competitivity among the energy sources, and different sub-scenarios can be considered.
- An offer versus demand balance of primary energy sources and its products at the national level is used to revise the relative participation of the energy sources.

2.2 - Steps of the Matrix Elaboration

The Matrix elaboration is shown schematically in Figure 2.1

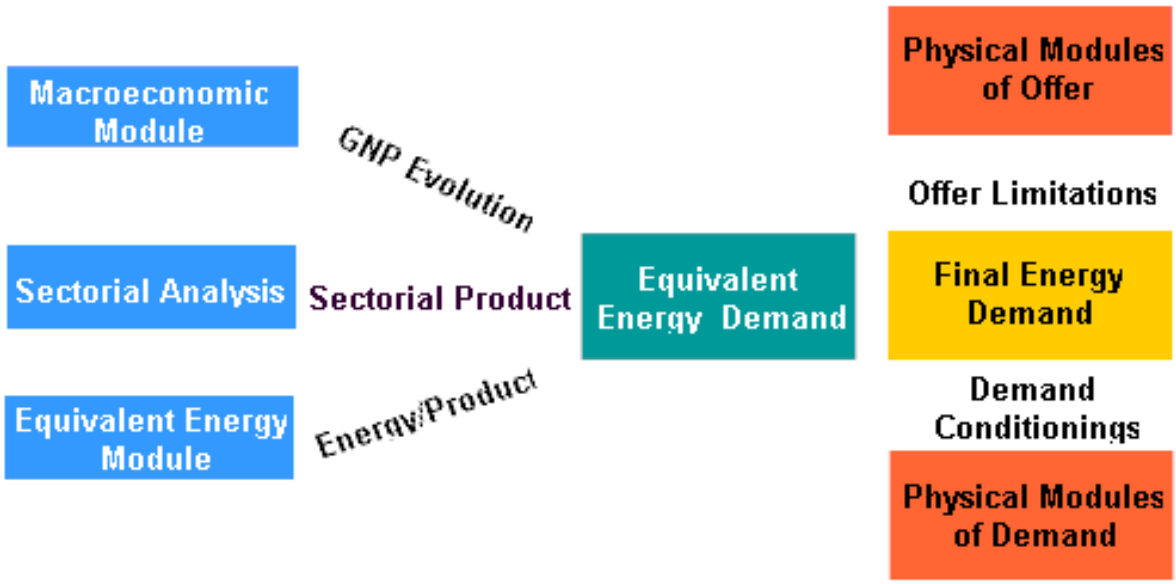


Figure 2.1 : Scheme for obtaining the Energy Matrix

. It includes a macroeconomic module, where economic growth is projected; a module for converting energy data into equivalent energy , that allows treating the energy use by considering the efficiencies of each use relative to a reference fuel; a module that relates energy to economic activity and/or other macro-variables (population, urbanization, etc.). It also foresees specific physical modules for energy offer (petroleum production and refining, electricity, alcohol, mineral coal, etc.) and modules related to the main consuming sectors, that take into account the existing consumption equipment (transport, industrial, residential, etc.). In the future, regional aspects of energy demand will also be considered.

It is proposed the execution of the work in three phases:

- In the first phase, foreseen to last 6 months, a first version of the Energy Matrix will be elaborated and discussed. The demand and offer physical modules role would be supplied considering available information relative to energy sectors and energy users. Demand would be projected in an indicative manner in a 20-year period and offer versus demand analysis would be made for a 5-year period.. External information would be that already available.
- In the second phase the main physical modules will be available and it is expected that some necessary external information will be more elaborated since other concurrently planning activities such as the sectorial energy offer and the regional and state energy balance should be completed. It is expected to have an energy matrix with demand estimated for 20 years and offer versus demand balance for 10 years.
- In the third phase the matrices at the geo-economic and state levels would be incorporated. The national and state information would be consolidated in regional (or state) and national matrices.

The schemes of Figures 2.2 to 2.4 show the three foreseen phases. A description of phase 1 and of the products obtained will be presented in the description of products expected for this phase.

2.3 Economic Projection Model

The methodology was presented in the book **Brasil: O Crescimento Possível** whose coordinator and several authors are part of e&e's staff. The evaluation of economical growth is made from a model developed by the authors that takes into account the inertial behavior of some factors in the last 50 years. The time anchor has been very useful in the recent past (last 4 years), where the model made it possible to detect the restrictions to capital available for investment, the importance of the Brazilian external trade limitations and the relevance of the internal debt.

The time anchor permits also to prevent conjuncture factors from influencing planning excessively, preventing optimistic circumstances - such as those present when the book was published - or pessimistic ones - such as those in the recent past - from creating unrealistic scenarios that would invalidate the projections.

In the economical projections we work with historical experience of about 50 years (national accounts) and 30 years for sectorial composition. In the energy demand data from BEN - of about 30 years - and primary energy data relative to the last 50 years are used.

The economic sectorial structure - of considerable inertia along time - is projected from extrapolation of historical trends and assumptions about future composition that takes into account the present structure of the developed countries but considers some national peculiarities..

The macroeconomic ***Projetar*** is the present electronic version of the model and it has been used in projection works by:: the former Strategic Issues Secretariat (SAE) of the Presidency in projections for 2020; in works for The Ministry of Science and Technology concerning the evaluation of gas emissions; by ELETRONORTE for market projections; and by ELETROBRAS in the evaluation of economic scenarios of the Decennial Plan. Its description is presented in

Appendix 1.

Figure 2.2: **1st Phase (6 months of duration)**

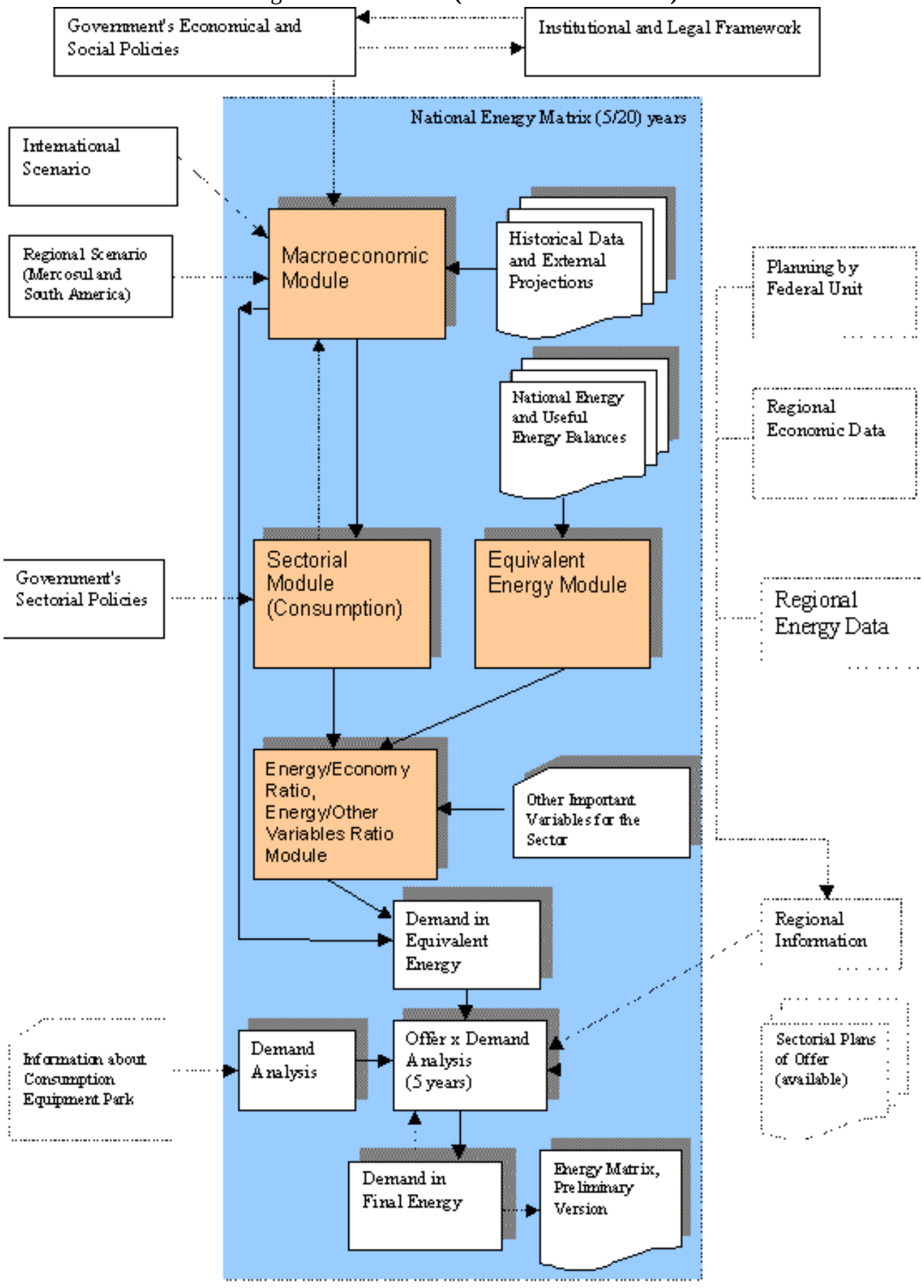


Figure 2.3**: 2nd Phase (12 months)**

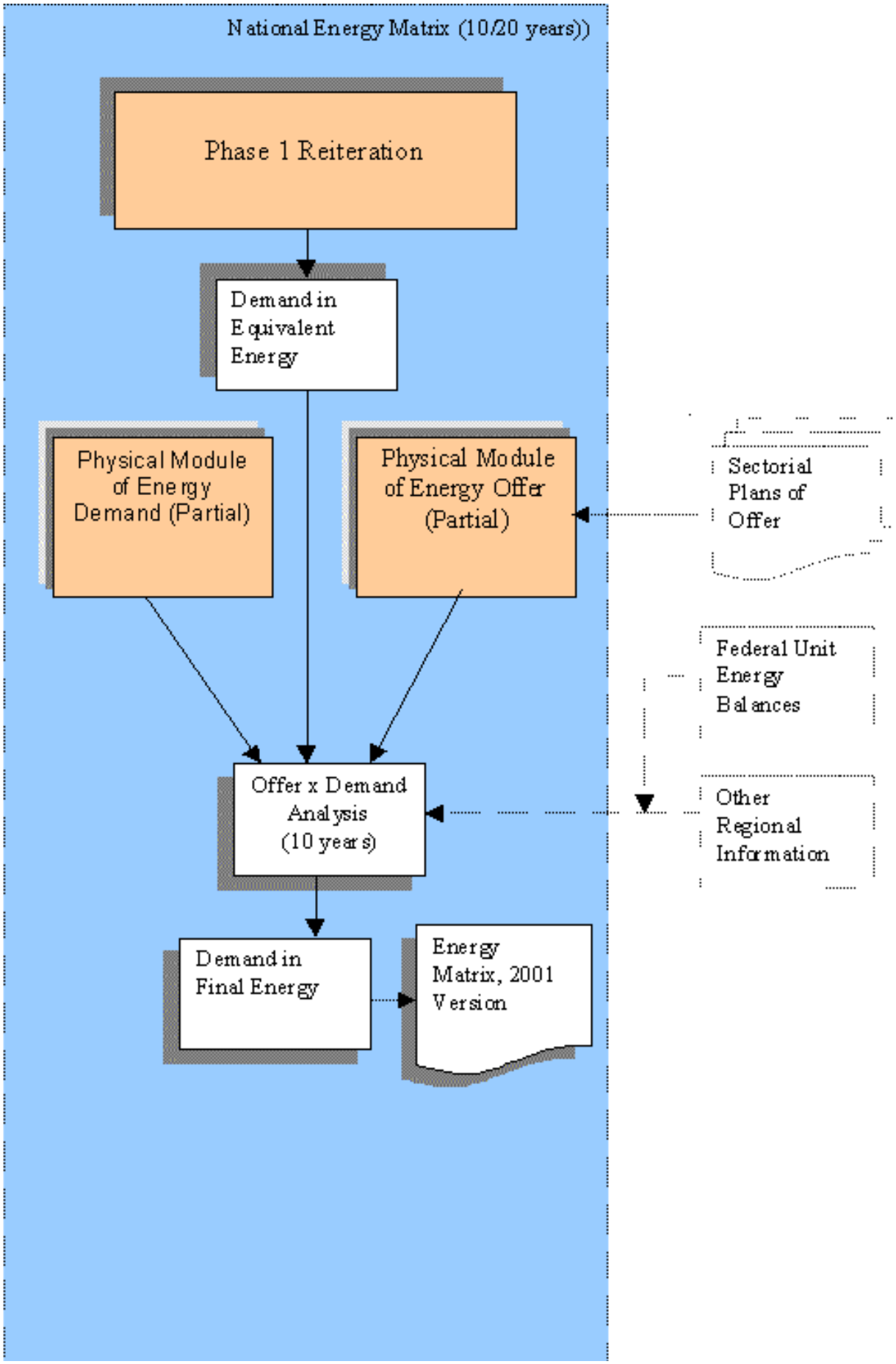
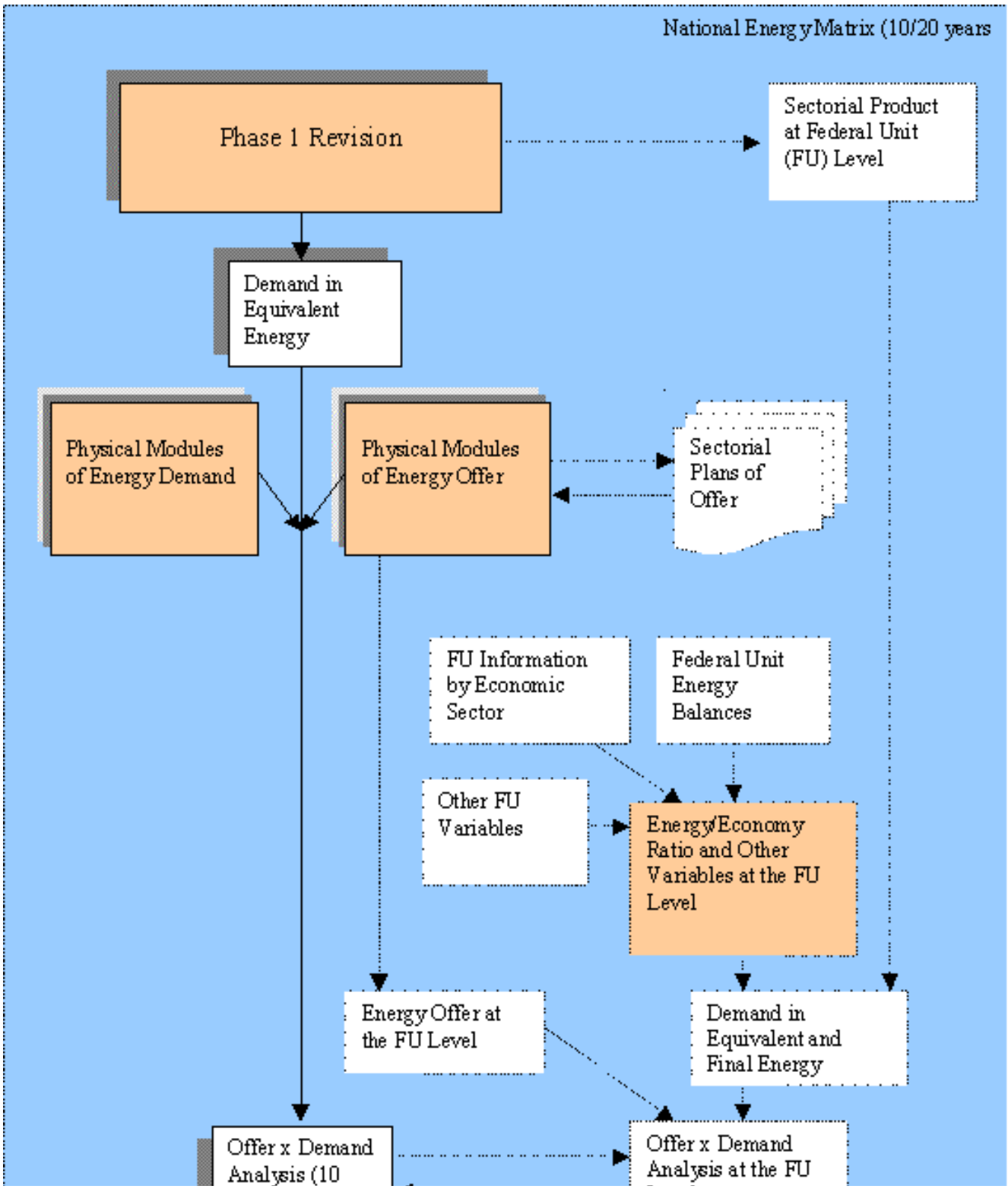
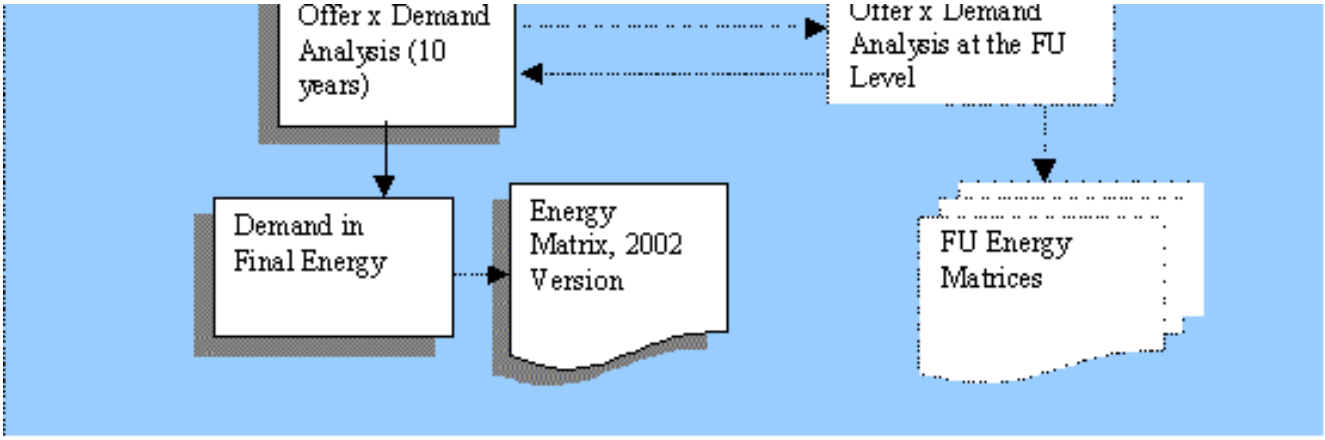


Figure 2.4**: 3rd Phase (12 months)**





2.4 - Demand in Equivalent Energy

The concept of equivalent energy developed from studies about useful energy is used for evaluating energy demand. The useful energy balance elaborated by the MME aims at determining for each economical sector the use of the energy source and the efficiency of its use. In uses where several energy sources are present it is possible to establish substitution equivalence among them

The sectorial demand evaluation in equivalent energy allows room for discussing the demand of different energy sources, using alternatives coherent with global demand. For example, the demand of the transport sector is determined in equivalent gasoline liters. Considering limitations of use and production, the specific demand of alcohol, gasoline, diesel, compressed natural gas, electricity and even LPG are determined taking into account the relative efficiency of these fuels. One can work with different hypothesis of final demand of each fuel (or other energy source) without loss of coherence in what regards global demand.

The same can be done with each industrial sector relative to heat demand, which is expressed in natural gas equivalent, considering the average equivalence. Specific demands of an energy source, in this or in another use, are considered by establishing a minimum use of the energy source by sector. Furthermore, the specific uses or almost exclusive uses of electricity are considered according to their identification in the useful energy balance.

The demand in equivalent energy by product is a "well behaved" variable - in many cases approximately constant - along time. Variables of this type are attractive for projections and they permit to associate energy demand and economical activity.

The participation of different energy sources is extrapolated from past experience when the possibilities and limitations of substitution were tested in vigorous substitution programs adopted in Brazil, mainly after the second petroleum shock.

3 - Products

The first phase of the Energy Matrix will be elaborated in the steps to be presented in what follows. Each step will consist of a report, elaborated by consultants contracted . The preliminary and reviewed results would be presented in the periodical ***e&e*** in the Internet, with SEN's

permission in each case, or by any other means deemed opportune by this Secretariat. All studied variables will take into account the historical behavior of a period of at least the last 25 years. In the macro aspects, the evolution in the last 50 years will be considered. The scenario presentation will show the assumed evolution compared with historical data.

Present data concerning countries with development levels similar to those assumed for the Country in the future will also be considered, aiming at orienting the scenario choice. Intermediary discussion meetings and examination of at least an alternative scenario are foreseen.

The final report will be presented at the end of each period and the first phase will be ended on June30, 2000.

The following tasks would be delivered at the end of the subsequent months. It is intended to generate at the end an Energy Matrix, preliminary version, which would be revised in the second phase. For this phase it is also foreseen an amplification of the instruments necessary for its elaboration. The third phase would be dedicated to render the Brazilian Energy Matrix regional, one of the objectives to be accomplished with the installation of CNPE.

The programs delivered to the contractors will be used at its discretion for an undetermined period of time. It will be supplied 10 (ten) report copies of each phase of the program. The software property and author rights for other uses belong to ***e&e***, taking into consideration the author's individual rights.

The steps are the following ones:

Steps	**Reports**	**Instruments**	**Month**
1st	1 - Description of the Macroeconomic Model and results of an initial reference scenario	1' - Supply of friendly model able to generate alternative economic scenarios from hypothesis of actions on micro-variables.	0
2nd	2 - Methodology of final energy conversion into equivalent energy. Methodology application to other countries.	2' - Equivalent energy balance able to generate spreadsheets by year, by sector and by energy source. Studies on consumption parameters from other countries aiming at orienting future consumption.	0
3rd	3 - Collecting of consumption data in equivalent energy by sector from 1970 on	3'- Lecture(s) presenting the economic projection model.	1
4th	4 -Economic model by sector. Presentation of historical results of consumption by equivalent energy, by sector. Analysis of energy source consumption by sector. Relevant data relative to offer and demand of energy source and national and regional planning.	4'- Friendly model of sectorial growth permitting the generation of coherent scenarios with the macroeconomic values chosen. Discussion on the macroeconomic scenario (the reference scenario will be chosen by MME). Excel tables with relevant data.	2

5th	5 - Revision of the basic macroeconomic scenario. Report about perspectives of specific consumption by sector in equivalent energy for the basic scenario.	5'- Discussion on the sectorial evolution scenario. Friendly model about energy intensity by sector, allowing for historical evolution that will permit the introduction of perspectives of efficiency changes.	3
6th	6 - Publication of the sectorial scenario revision. Projection of global and sectorial demand in equivalent energy. Publication of the sectorial consumption structure in equivalent energy by energy source.	6' - Seminar for presentation of the economic projection model.	4
7th	7 - Projection by type of fuel in equivalent energy and in natural units. Presentation of the final report in equivalent energy and evaluation of offer x demand	7'- Discussion of the preliminary results of the energy matrix in a seminar	5
8th	8 - Presentation of the National Energy Report - Preliminary Version	8'- Integrated friendly model of economic growth and energy demand with capacity of generating alternative scenarios.	6

4 - Staff

Carlos Feu Alvim Coordination and execution
Omar Campos Ferreira Execution
Frida Eidelman Execution
Othon L. Pinheiro da Silva Execution
Eduardo Marques Execution
Genserico Encarnação Jr.
Aumara B. Feu A. Marques Execution

Total Consultation 5040 hours

Note: Professor José Goldemberg that would supervise the team is now a CNPE member.

Steps	Reports	Instruments	Month
1st	1 - Description of the Macroeconomic Model and results of an initial reference scenario	1' - Supply of friendly model able to generate alternative economic scenarios from hypothesis of actions on micro-variables.	0
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3rd	3 - Collecting of consumption data in equivalent energy by sector from 1970 on	3'- Lecture(s) presenting the economic projection model.	1
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5th	5 - Revision of the basic macroeconomic scenario. Report about perspectives of specific consumption by sector in equivalent energy for the basic scenario.	5'- Discussion on the sectorial evolution scenario. Friendly model about energy intensity by sector, allowing for historical evolution that will permit the introduction of perspectives of efficiency changes.	3
6th	6 - Publication of the sectorial scenario revision. Projection of global and sectorial demand in equivalent energy. Publication of the sectorial consumption structure in equivalent energy by energy source.	6' - Seminar for presentation of the economic projection model.	4
7th	7 - Projection by type of fuel in equivalent energy and in natural units. Presentation of the final report in equivalent energy and evaluation of offer x demand	7'- Discussion of the preliminary results of the energy matrix in a seminar	5
8th	8 - Presentation of the National Energy Report - Preliminary Version	8'- Integrated friendly model of economic growth and energy demand with capacity of generating alternative scenarios.	6

APPENDIXES TO THIS DOCUMENT

1 - Preliminary version of macroeconomic model description;

2 - Preliminary version describing the process of converting data from final energy balance into

equivalent energy;

3 - Example of application of the method, including the physical model in the transport sector (lightvehicles) . (only in Portuguese)